DIGITAL-IN-HEALTH

Unlocking the Value for Everyone

WORLD BANK GROUP

Cover and graphic design: Theo Hawkins, World Bank

DIGITAL-IN-HEALTH

Unlocking the Value for Everyone

WORLD BANK GROUP

Table of Contents

Annexes

Boxes

Maps

Tables

Figures

Foreword

Over the past decades, the health of the world's population has improved. Fewer children are dying at birth or at a young age; individuals living with HIV can now enjoy good health for many years; and both men and women are living more comfortably and longer. Yet, for billions of people, the promise of a healthy, long, and productive life still feels unattainable.

Governments that have made progress in enhancing the health of their populations have applied digital technology to strengthen health systems, boost health financing, make public health more effective, and reach more underserved and vulnerable populations. It is becoming clear that the future of health care is embedded in technology and linked to innovations in data. No longer is digital health the purview solely of those who are curious about technology. Digital technology is at the core of efforts to strengthen health systems: digital-in-health.

As digital-in-health is integrated across essential health system functions, governments and stakeholders must maintain and reinforce the foundational building blocks that are necessary for digital technology to operate successfully. They must prioritize to solve significant health challenges, help different areas of the health system become connected to deliver new and better health services that the changing world requires, and scale up to ensure equitable access to health care for everyone. This will involve surpassing important challenges, but key lessons are already being learned: grow leadership, put data governance front and center, engage the private sector, create and build on the evidence on what works, and focus on long-term sustainability.

In 2022, the World Bank committed to supporting five pillars of the global agenda for digitalization and development: (a) digital infrastructure, (b) digital platforms, (c) digital enablers, (d) digital safeguards, and (e) the crosscutting areas of gender and social inclusion and regional and international collaboration. Investments in data and technology will be needed across health systems, education, and social protection to increase human capital. These investments should be aimed at building trust and capacity, realizing equity, and narrowing rather than widening the digital divide.

Now the real work begins: the extensive endeavor to achieve significant progress in digital technology and connected data systems that people will trust and all may access. Countries will drive the change.

The goal of this flagship report is to provide governments and other stakeholders with practical guidance on where to start, regardless of a country's digital maturity or fiscal challenges. The World Bank remains ready to assist countries everywhere in reaching their full potential in the use of digital technologies to protect and accelerate the growth of human capital.

Mamta Murthi
Vice President: Human Development
World Bank

Acknowledgments

This report is a deliverable of the Digital Health Flagship Program of the World Bank's Health, Nutrition, and Population Global Practice (HNP GP). The World Bank team responsible for producing the flagship report consisted of the following World Bank and International Finance Corporation (IFC) team members: Marelize Görgens (digital health team lead), Gianluca Cafagna, Charles Dalton, Tiago Cravo Oliveira Hashiguchi, Jammie Feliciano, Silu Feng, Kajali Goswami, Anna Koziel, Matthew Hulse, Ashini Patel, Christoph Rockmore, Zlatan Sabic, Malarvizhi Veerappan, and Yi Zhang. The team acknowledges the valuable contributions of the following colleagues and partners in producing the report:

Countries that shared their experiences and knowledge through case studies and other efforts: Ministries of health of the following countries: Argentina, Burundi, Cambodia, India, Indonesia, Lesotho, Maldives, Panama, Peru, Serbia, Tajikistan, and Vietnam.

World Bank staff and consultants who have supported aspects of the digital health flagship report analysis and provided inputs: *World Bank group staff:* Kyoko Okamura, Nejma Cheikh, Jed Friedman, Meera Shekar, Tamer Rabie, Stephen Dorey, Christoph Kurowski, Michelle Ashwin Mehta, Ana Maria Munoz, Monique Mrazek, Zara Shubber, Nagaraja Harshadeep (Harsh), Haishan Fu, Vyjayanti Desai, Jonathan Marskell, Cem Dener, Gabriel Catan, Christoph Kurowski, Suresh K Mohammed, Yovav Gavish, Tina George, Alex Twinomugisha, Victoria Strokova, Subhashini Subramanian, Iffath Sharif, Rahul Pandey, Mohini Kak, and Hermann Donfouet. *World Bank group consultants:* Yai Ellen Gaye, Wuleta Lemma, Robert Zimmermann, Megan McCormick, Harriet Blest, and Katherine Ward.

World Bank Digital Health Technical Working Group members: Ali Habib, Fatimah Abubakar Mustapha, Hermann Donfouet, Iffat Mahmud, Lombe Kasonde, Martin Mpungu Lutalo, Miriam Mamoon Zaki, Mohirjon Ahmedov, Nejma Cheikh, Opope Matala, Parviz Ahmadov, Reem Hafez, Ruchira Shukla, Sang Minh Le, and Somil Nagpal.

World Bank HNP GP digital health portfolio review team: Qi Xue, Kevin William Conklin, Yai Ellen Gaye, Isha Arora, Miheer Prakash, Alya Binti Shaiful Bahari, and Gunjan Maheshwari.

World Bank HNP GP leadership and communications team: Juan Pablo Uribe (Global Director), David Wilson, Francisca Ayo Akala, Tania Dmytraczenko, Michele Gragnolati, Trina Haque, Magnus Lindelow, Rekha Menon, Ernest Messiah, Aparnaa Somanathan, Gaston Sorgho, Monique Vledder, Feng Zhao, Mukesh Chawla, Toomas Palu, Alexandra Humme, Charlotte Ampaire and Clementine Murer.

World Bank peer reviewers of the Flagship report: Mariam Zaki (IFC), David Satola (LEG), Rami Aman (DD GP), David Wilson (Program Director, HNP GP), Somil Nagpal (East Asia and Pacific HNP GP), Keith Garrett (Practice Manager, DECAT), Stela Mocan (Practice Manager, ITS), and Alex Twinomugisha (EDU GP).

World Bank contributors to the implementation know-how briefs and case studies: Ali Habib, Aldilas Achmad Nursetyo, Aakash Mohpal, Dinesh Nair, Federica Secci, Gabriel Aguirre Martens, Lander Bosch, Maria Eugenia Bonilla-Chacin, Mirja Channa, Muhammad Hardhantyo Puspo Wardoyo, Noel Chisaka, Nareth Ly, Olivier Basenya, Pandu Harimurti, Parviz Ahmadov, Paul Jacob Robyn, Paula Giovagnoli, Rahul Pandey, Somil Nagpal, Suresh K Mohammed, Vanina Camporeale, Laura Di Giorgio, Laurence Lannes, Ha Thi Hong Nguyen, Reem Hafez, Lombe Kasonde, Nejma Cheikh, Chrys Thomas, Aida Gadiaga, Cem Dener, Jeremy Veillard, Hermann Donfouet, Anat Lewin, Saša Rikanović, Nada Teodosijević, Sang Minh Le, Boris Volkov, Gabriel Catan, Monique Mrazek, Harriet Stella Blest, and Giacomo Assenza.

External contributors and idea sharers: David Novillo (WHO EURO), Alain Labrique (WHO Geneva), Garrett Mehl (WHO Geneva), Ilona Kickbusch (Geneva Graduate Institute), Anurag Agarwal (Ashoka University), Adele Waugaman (USAID), Amarynth Sichel (USAID), Merrick Shafer (USAID), Daniel Rosen (US CDC), Karin Kallander (UNICEF), Sean Blaschke (UNICEF), Marcelo Jose D'Agostino (PAHO), Carine Gachen (GAVI), Rigveda Kadam (FIND Diagnostics), Marta Fernandez Suarez (FIND Diagnostics), Rebecca Distler (McGovern Foundation), Meredith Kimball (Gates Ventures), Lisa Ramon (Bill and Melinda Gates Foundation), Tracey McNeill (Bill and Melinda Gates Foundation), David Wilson (Bill and Melinda Gates Foundation), Ethan Wong (Bill and Melinda Gates Foundation), Jean Kagubare (Bill and Melinda Gates Foundation), Melissa Miles (Bill and Melinda Gates Foundation), Gaurav Bhattacharya (Bill and Melinda Gates Foundation), Patty Mechael (HealthEnabled), Smisha Agarwal (Johns Hopkins University), Dirk Muller (FCDO), Hannah Chirgwin (FCDO), Niki O'Brien (Imperial College London), Kirsten Mathieson (Transform Health), Barakissa Tien-Wahser (GIZ), Mark Landry (The Global Fund), and members of digital health donors group.

World Bank support staff: Jammie Feliciano, Susan Sebastian, Corinne Gonzalez, Marize de Fatima Santos, Juliette Makandi Guantai, and Vinod Beri.

World Bank design staff: Theo Hawkins and Richard Ponsonby.

The team apologizes to any individuals or organizations inadvertently omitted from this list.

Abbreviations

AI	artificial intelligence
ChatGPT	chat generative pretrained transformer
DD GP	Digital Development Global Practice (World Bank)
DPI	digital public infrastructure
EDU GP	Education Global Practice
GDHM	Global Digital Health Monitor
GOV GP	Governance Global Practice (World Bank)
GPT	generative pretrained transformer
GTMI	GovTech (government technology) maturity index
HIS	health information system
HNP GP	Health, Nutrition and Population Global Practice (World Bank)
ICT	information and communication technology
IFC	International Finance Corporation (World Bank)
IT	information technology
PAD	Project Appraisal Document
PPP	public-private partnership
SPJ GP	Social Protections And Jobs Global Practice (World Bank)
UHC	universal health coverage
WHO	World Health Organization

Navigating the Flagship Report

This report describes how governments can use digital technologies and data to deliver new, more, better, and seamless health services that people can easily want, access, and rely on. It lays out recommendations to be implemented by governments and other stakeholders to unlock the value of digital technology for all and describes how the World Bank can support this process along the way.

The report is structured as follows:

Chapter 1 describes the value of digital technology and data to low- and middle-income countries; it concludes that the time is ripe to unlock this value for everyone.

Reflecting on the origins of technology use in health care, **Chapter 2** provides a brief history of digital technology and data in health systems, as well as the World Bank's evolving focus on digitalization during the last 15 years.

Looking back, **Chapter 3** quantifies and describes the World Bank financing for digital health in the last 10 years, as well as the types of digital health investments made by other development partners and the private sector. It also summarizes the perspectives of patients, providers, and communities on the value of these investments and how to improve the value in the future.

Looking forward, **Chapter 4** defines the next wave of evolution to unlock the value for everyone: no longer a narrow focus only on digitalization, but an inclusive, embedded, and infused focus on digital-in-health.

Chapter 5 examines the readiness of low- and middle-income countries to embrace and realize a digital-in-health future. The maturity of digital health systems is examined in the context of the maturity of digital transformation across all of government. Based on case studies of country experiences, the chapter concludes with a description of 11 determinants that are instrumental in the ability of countries to extract the most value from digital technology and data for better health.

Chapter 6 offers 10 recommendations to help countries make progress in prioritizing, connecting, and scaling up digital technology and data for better health and describes how the World Bank can support countries along this journey.

Chapter 7 concludes by providing metrics of progress that governments and other stakeholders might want to consider as they pivot investments in digital technology and data to unlock the value for all.


24/7

CHAPTER 1

The **Value** of **Digital Technology** and **Data** for **Health** *and* **Health Care**

"If health care reform 1.0 was about improving coverage, I would say health care reform 2.0 is going to be about improving delivery. In all sorts of technology-enabled ways, that's the opportunity here."

Sachin Jain, Chief Medical Officer, CareMore Health System

Key Messages in This Chapter

- Improving health is becoming more difficult, not easier. Despite immense progress, long-standing health system challenges in low- and middle-income countries linger. Disparities in health and health care persist and have grown because of the pandemic. The challenges have been compounded by both sudden-onset and more slowly growing crises that increase the volume and types of health care required, a situation that is likely to continue for the foreseeable future. A pivot to preventive care and public health is also under way.
- Health systems are under pressure to deliver new, more, higher-quality, and seamless services during a difficult period of limited fiscal space.
- It is not only the kinds of health services that need to expand, improve, and change; populations that want to protect and improve their health and who need care have also changed.
- Responding to these challenges, health systems are—as complex adaptive systems—in constant flux. Policy makers and planners both engineer and react to these ongoing iterative cycles of change. The experience of successful countries shows that digital technology and data—designed and implemented iteratively with patients and stakeholders at the center—are key aspects of well-functioning health systems that are able to respond to the added pressures emerging in the twenty-first century.
- Digital technology and data can add immense value to health systems. Digital technology can strengthen health systems, improve health financing, make public health care more effective, and reach underserved populations. Digital technology can make health services more personal, prevent increases in health care costs, reduce differences in care, and make the job easier for those who provide health services. It can also enhance efficiency. For instance, connected electronic health records and virtual interactions such as telemedicine can generate up to 15 percent more efficiency gains and free resources to address the other needs of patients.
- For three reasons, the time is ripe for this value to be unlocked:
  - More health data than ever are being collected and are ready to be used.
  - Innovation is driven by the need to deliver new, more, better, and seamless health services and prepare for future crises with less funds, while addressing long-standing inequities.
  - Experiences during the COVID-19 pandemic have shown that digitalization can make a real difference.

Health Systems Face Significant and Growing Challenges

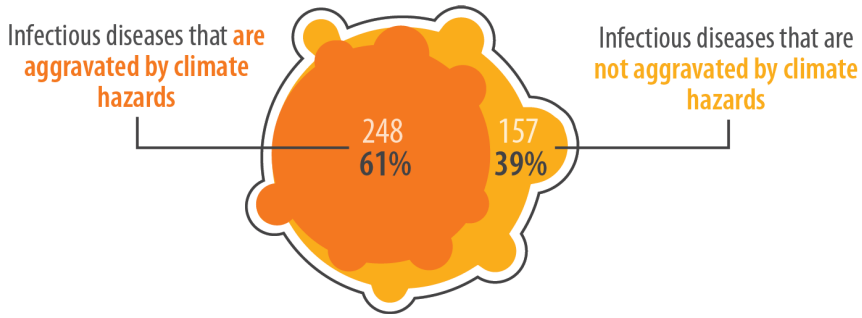
People all strive for health and well-being, and health systems support this goal. Humans strive to live long and happy lives devoid of illness and rich with opportunity, connection to others, and contributions to society. For this to materialize, a multifaceted approach is needed, one that includes *preventing* disease and injury, *promoting* health and well-being, and *providing* timely, high-quality, affordable, and well-coordinated health care services that people need and in which they play an active role. Health systems support efforts to prevent, promote, and provide for better health and well-being through good stewardship, the creation of resources, the supply of finance, and the delivery of services (Darrudi, Ketabchi Khoonsari, and Tajvar 2022).

Despite immense progress, long-standing health system challenges persist in low- and lower-middle-income countries. While the progress is evident, health systems in these countries are still in the grips of myriads of difficulties that impede their ability to deliver high-quality health services that everyone can easily access, afford, want to use, like, and value. Among the most intractable challenges facing health systems are inequity in health care delivery, resulting in disparities in health outcomes; too few skilled and too many underskilled health workers; inequality in the access to and affordability of health services; the inconsistent quality of health services; uncoordinated health care delivery; limited coordination between private and public sector providers; inconsistent clinical pathways for the same diagnoses; administrative complexity; overtreatment; piecemeal health information systems (HISs) with disjointed and unprotected data; insufficient financing; inefficient flows of funds; and a risk-averse culture wary of change. In addition, evidence is not being used adequately to guide health care, resulting in suboptimal, sometimes ineffective care. Indeed, according to one estimate, only 50 percent to 60 percent of care is delivered in accordance with the highest level of evidence or consensus-based guidelines, and the rate of adverse events (1 in 10) has not declined in over 20 years (Braithwaite 2018). There is also sizable inefficiency. Thus, Shrank, Rogstad, and Parekh (2019) reckon that nearly 30 percent of health care spending is wasted.

These enduring health system challenges have been compounded by both sudden-onset and more slowly growing crises, a situation that is likely to continue for the foreseeable future. In the past few years, these challenges have been amplified by sudden-onset, large-scale health emergencies, such as the COVID-19 pandemic, other disease outbreaks, such as periodic Ebola and cholera outbreaks, escalating conflict, and natural disasters, such as the 2023 earthquake in Türkiye. Furthermore, health systems must respond to more slowly growing health crises that add pressure, such

as (a) the impact of climate on health (Figure 1: over 60 percent of all known human pathogens will be aggravated by climatic hazards) (Mora et al. 2022, WHO 2021b); (b) the rising shares of older people with more complex, chronic medical needs; (c) significant increases in the need for mental health services; and (d) the growing burden of noncommunicable diseases, the cause of 75 percent of all deaths in the world in 2022.[1] Post-pandemic recovery continues to take a toll. Health systems must also account for the role of the systems in greenhouse gas emissions, considering that health care delivery contributes between 3 percent and 10 percent of global carbon dioxide emissions (Mercer 2019).

Figure 1 Proportion of Diseases Aggravated by Climatic Hazards



Source: Based on Mora et al, 2022.

Besides these challenges, a pivot toward public health and the integration of public health in health systems is occurring. In the first half of the twentieth century, gains in life expectancy were mostly driven by significant improvements in public health, while the contribution of medical care toward these gains was comparatively modest. By the 1960s, medical care emerged as the primary factor extending life expectancy. Yet, the life expectancy increases relating to medical care were more modest than the large increases in public health–driven life expectancy gains (Bunker 2001). This is because only 10 percent of preventable deaths are associated with medical care; the rest are related to lifestyle factors, environmental factors, and genetics, all of which require public health solutions (Shortell 2013). Demographic, nutritional, and epidemiological transitions are driving a rise in the share of the world's population that exhibits unhealthy lifestyles, which means this will be a bigger challenge in the future. It also means it is likely that public health–driven life expectancy increases will emerge in the future. For these anticipated gains to be realized, a 2023 Lancet Commission has suggested that closer

[1] "The Role of the Health Community in Climate Action: Taking Stock and Moving Forward," 76th World Health Assembly, Session 3, World Health Organization, Geneva, May 24, 2023, https://www.who.int/news-room/events/detail/2023/05/24/default-calendar/the-role-of-the-health-community-in-climate-action-taking-stock-and-moving-forward.

synergies among universal health coverage (UHC), health security, and health promotion are needed (Agyepong et al. 2023).

Disparities in health and health care persist and have grown because of the pandemic. The COVID-19 pandemic has highlighted the persistent challenge of inequity in health and health care. For example, more than half the world's population does not have timely access to surgical care. Thus, although they represent 48 percent of the world's population, low- and lower-middle-income countries account for only 6 percent of the surgical procedures performed annually (Meara et al. 2015). Only 29 percent of obstetricians are based in these countries, though these countries show the highest rates of childbirth. To improve equity, the global health community needs to focus on more than inequities in service delivery and in the distribution of health workers (PLOS Medicine Editors et al. 2016). It has been suggested that global health equity should be defined in terms of equitable health outcomes (products), but also in terms of how the services are delivered (processes) and the persons involved in designing and implementing the services (partnerships) (August et al. 2022).

It is clear from the above that health systems are under pressure to deliver new, more, higher-quality, and seamless services during a difficult period of limited fiscal space. Because of the pressure, more health service delivery opportunities need to be made available through the limited number of health facilities and by the limited number of health workers in the current environment of often stagnant or shrinking health budgets. This is particularly the situation in low-income countries and in the countries in fragile, conflict, and violent settings that need the most help.

Health care needs to be improved, expanded, and reformed, but the populations that access and depend on health care are also not the same now as they once were. Today's populations have different preferences, demands, needs, knowledge, and perceptions about their own health and health care relative to populations in the past. Today's populations are more highly digitally connected than ever and have a growing sense of the health care they want, how they want to access and receive health care, and the health information they are willing to share (Lupton 2021).

What will be required for health systems to adapt to these growing and shifting challenges? Health systems are complex and in a constant state of flux, characterized by incremental cycles of learning, adaptation, and change (Paina and Peters 2012). Making changes in health systems endure is difficult. Health systems often suffer from a take-up problem, a diffusion problem, and a sustainability problem (Braithwaite 2018). A 2017 global review across 60 health systems as diverse as the health systems of Rwanda and Vietnam found that four factors were common in successful efforts to achieve

effective, lasting change: (a) the acorn-to-oak tree principle (that is, a small initiative that tackles a specific problem may lead to systemwide impacts and change, instead of large, systemwide, long-duration reforms); (b) the data-to-information-to-intelligence principle (the role of information technology [IT] and data is becoming more critical for delivering efficient and appropriate care, but must be converted into useful intelligence); (c) the many hands principle (concerted action among stakeholders is key); and (d) the patient-as-the-preeminent-player principle (individuals are at the center of change) (Braithwaite et al. 2017). In all four of these areas, technology and data are relevant.

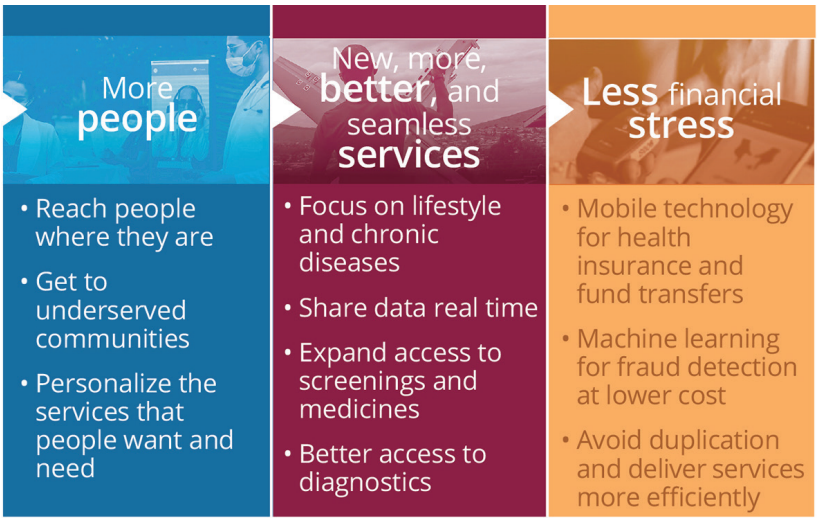
Digital Technology May Help Overcome Health Sector Challenges and Build Value

Technology and data—designed and implemented iteratively with and by patients and stakeholders—are clearly catalytic components of the current wave of health system changes. Digital technology and data can add immense value to health systems and to the health of the population in several ways:

a. Experiences in countries have shown that digital technology strengthens health systems, improves health financing, makes public health more effective, and reaches underserved populations.

b. Used effectively, digital technology makes health services more personal, prevents health care costs from increasing, reduces differences in care, and makes the provision of health services easier.

Figure 2 How Digital Technology Can Support Universal Health Coverage



Source: Adapted from Wilson et al. 2020.

c. Digital technology supports progress toward UHC (Figure 2). Digital technology and data by themselves are not sufficient to realize UHC, but they are necessary. Governments and other actors may not be able to address health challenges fully without them.

d. Digital technology and data can increase efficiency and save money. A review by Jousset et al. (2023) finds that the three largest economies in Africa—Nigeria, Kenya, and South Africa—could save 15 percent of health system costs by scaling up five digital solutions (Table 1). Given the constraints on fiscal space in the health sector faced by many low- and middle-income countries, knowing concretely that digital technology can improve efficiency is game changing.

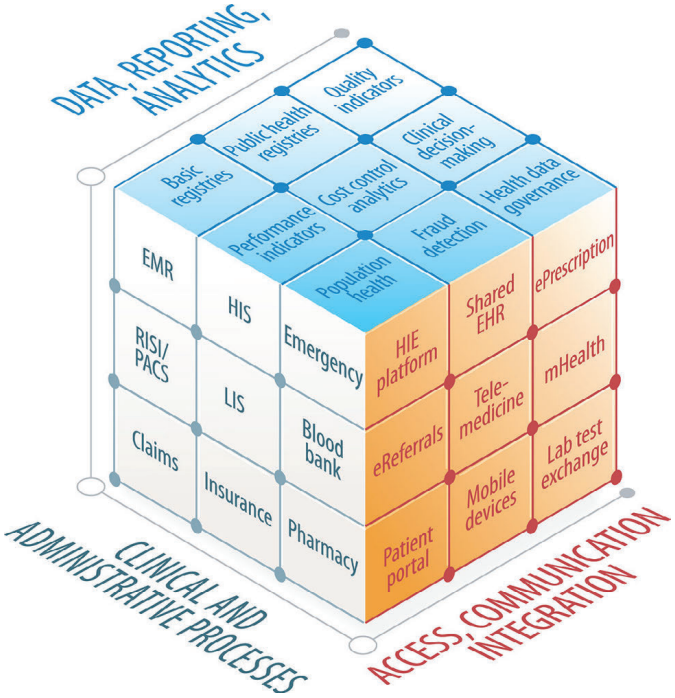
Table 1 Five Most Important Interventions to Save on Health Costs, Kenya, Nigeria, and South Africa, by 2030

Digital solution	% of total efficiency gains		
	Kenya	**Nigeria**	**South Africa**
Virtual interactions, which include video visits with doctor/clinician, remote monitoring, and e-triage to determine health care needed	**43%**	**35%**	**39%**
Going paperless through health information exchanges and electronic health records	**30%**	**26%**	**30%**
Decision intelligence systems (like supply chain predictive systems or clinical decision support, or hospital digital twin systems)	9%	10%	12%
Workflow optimization and simplification	10%	16%	11%
Patient-focused interventions, including patient self-care and patient self-service (like for appointment scheduling)	8%	13%	8%

Source: World Bank staff calculations based on data Jousset et al. 2023.

e. Digital technology supports health service delivery in terms of data and reporting, clinical and administrative processes, and communication and integration (Figure 3; and see details in Annex A)

Figure 3 Three Ways Digital Technology and Data Add Value to Health System Delivery



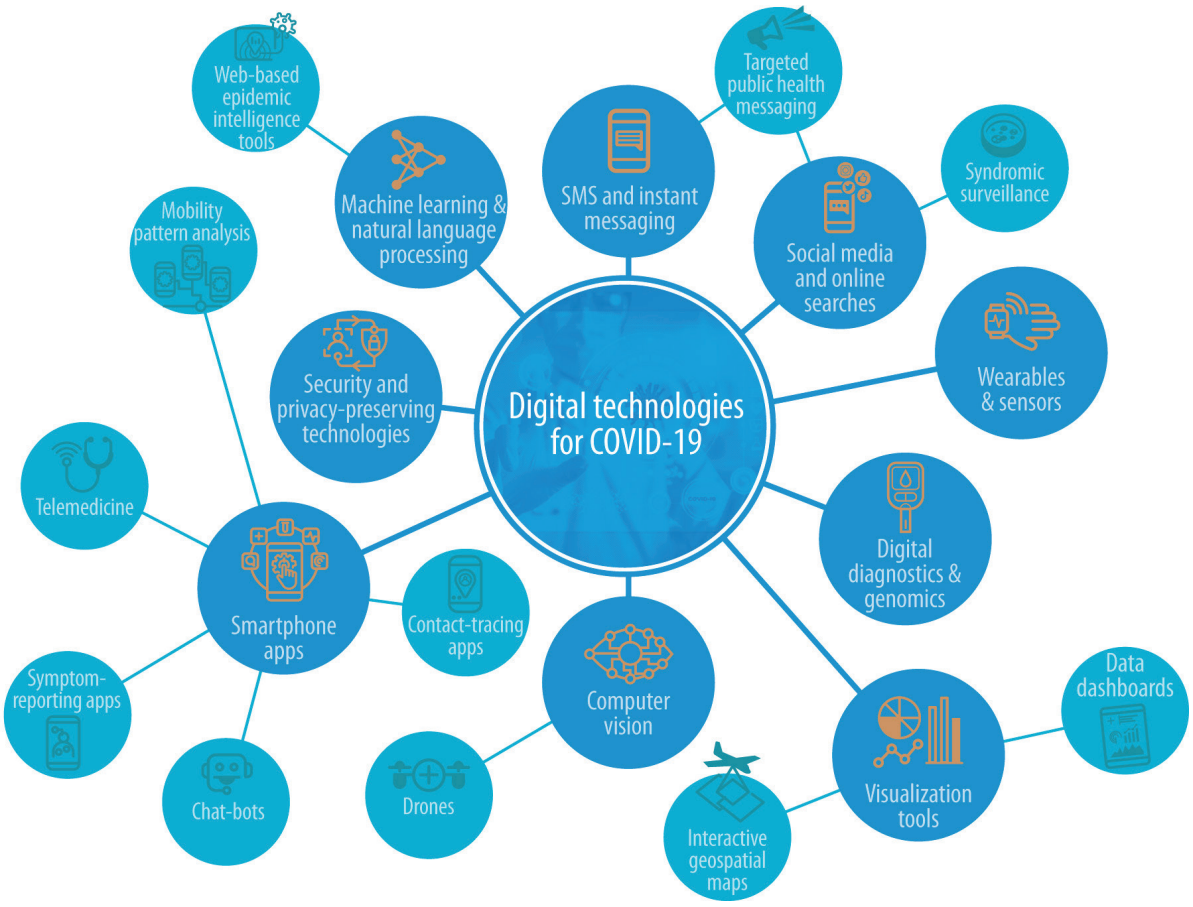
The Time Is Ripe to Unlock the Value for Everyone

There are three reasons why the time is ripe for the health sector to unlock the value of digital technology and data for better health for everyone.

First, in responding to COVID-19, new digital technologies were rapidly deployed, creating momentum. The COVID-19 pandemic brought about substantial changes in the way health care services are delivered, leading to an unprecedented surge in the use of digital tools for health service provision, the promotion of public health, and the administration of COVID-19 and other vaccines (Budd et al. 2021; Golinelli et al. 2020) (Figure 4). Technology was useful and important not only in the emergency services that COVID-19 required, but also for the durability of routine health services. The pandemic offered an opportunity to accelerate the implementation of digital health

solutions that may have been recognized as options prior to COVID-19 and to understand the preconditions that favored the implementation of such solutions, particularly in telemedicine (Baudier et al. 2023). This generated momentum in efforts to assimilate technology and data as central components in the ongoing evolution of health systems.

Figure 4 Range of Uses for Digital Technologies in Response to COVID-19

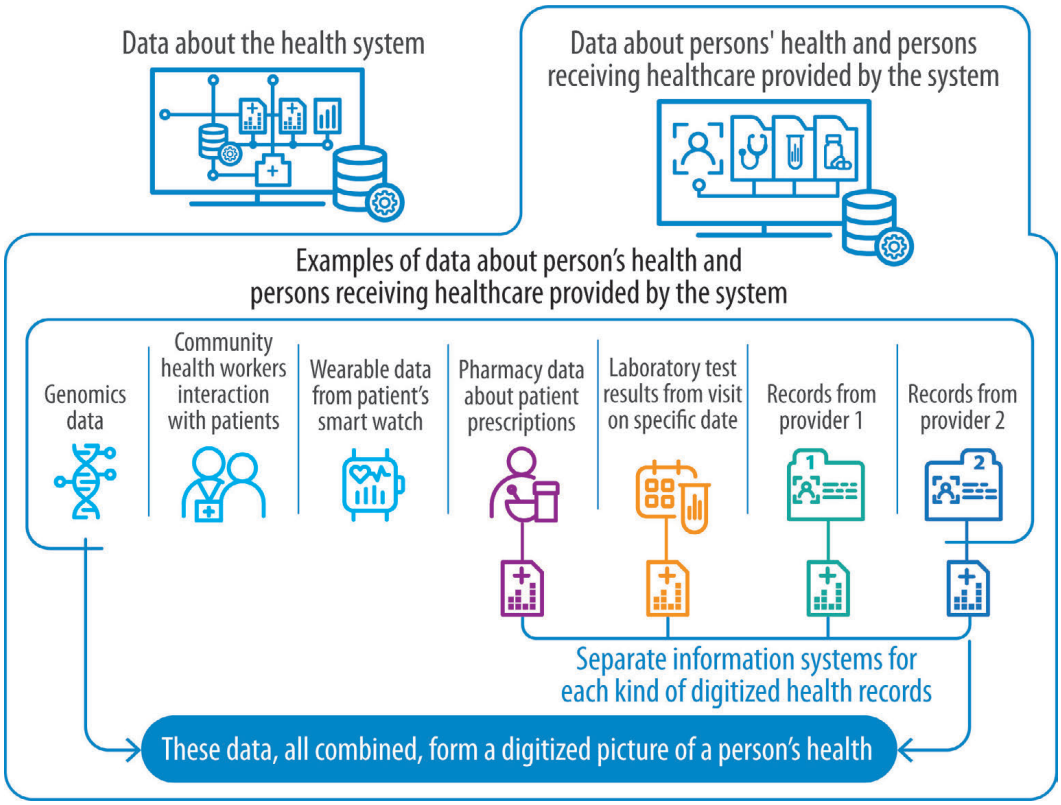


Source: Budd et al. 2020.

Second, the amount of data on health and health care is growing at staggering rates, but these data are not yet being used to maximum potential. Governments and other stakeholders have multiple sources of these data on health. Some of these data on health are generated in the health sector, while other data are located outside the health sector, such as data on social grants or the educational status of individuals (Figure 5). Globally,

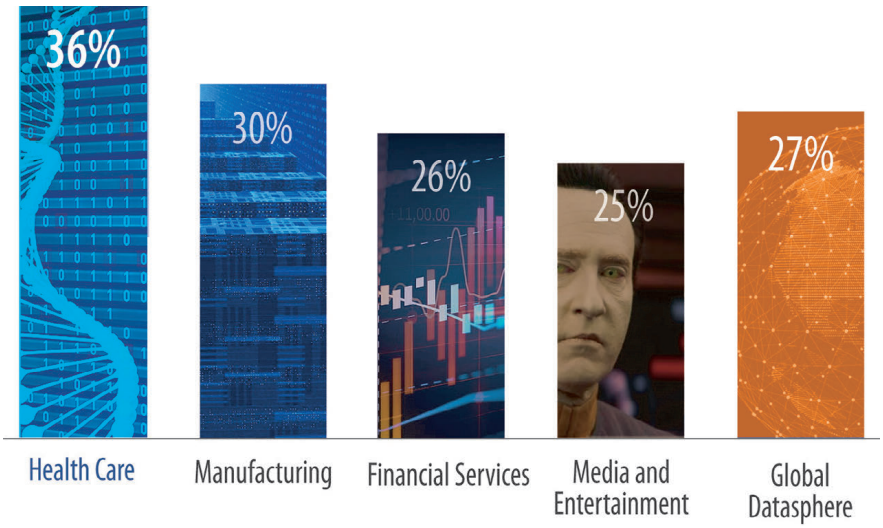
the amount of data has expanded and continues to grow rapidly. An estimated 30 percent of the global datasphere consists of health data (Reinsel, Gantz, and Rydning 2020). The health datasphere is the volume of health data flows in the world (Floridi 2007). Up to 2025, health data are anticipated to exhibit the highest compound annual growth rate of data in any sector (Figure 6). The academic literature—approximately 30 percent of which is relevant in the health sector—has exponentially increased in the last several decades. The annual growth rate has more than doubled, from 3 percent in the 2000s to almost 7 percent in the 2010s (Johnson, Watkinson, and Mabe 2018) (Figure 7). More than half is available in open-access journals.[2] These data are not being used. It takes, on average, 17 years for new medical evidence to be translated into routine medical practice (Morris, Wooding, and Grant 2011). That duration represents almost half the career of a practicing physician.

Figure 5 Types of Data on Health



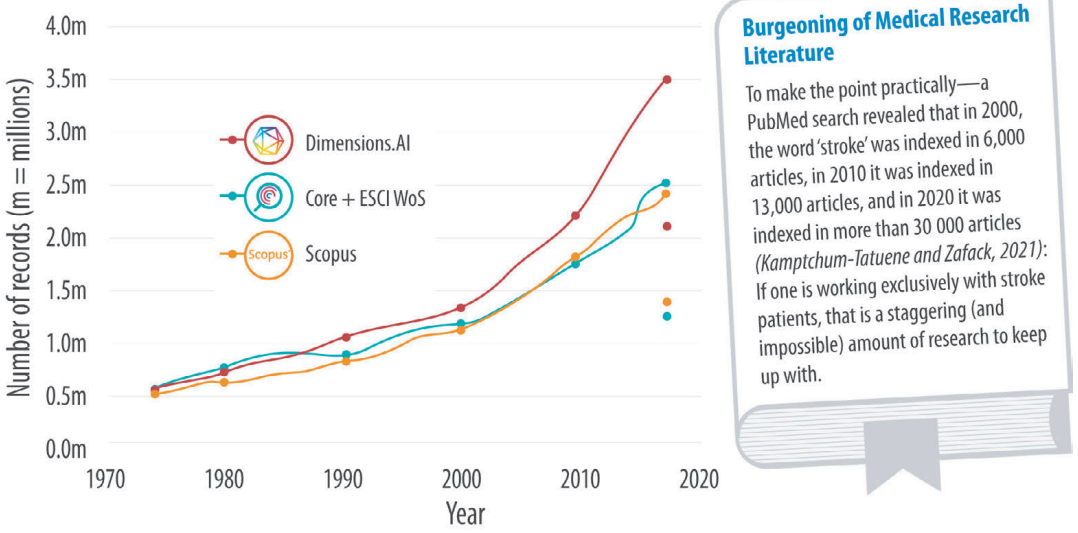
[2] Open Access Uptake by Countries/Regions (dashboard), International Association of Scientific, Technical, and Medical Publishers, the Hague, the Netherlands, https://www.stm-assoc.org/oa-dashboard/open-access-uptake-for-the-top-30-article-producing-countries-and-other-geographical-groupings/.

Figure 6 Compound Annual Growth Rate of the Global Datasphere: Health Data Grow the Most Quickly



Source: Coughlin et al. 2018; RBCCM 2019; Reinsel, Gantz, and Rydning 2020.

Figure 7 Growth in the Volume of Academic and Scientific Articles, 1975–2018

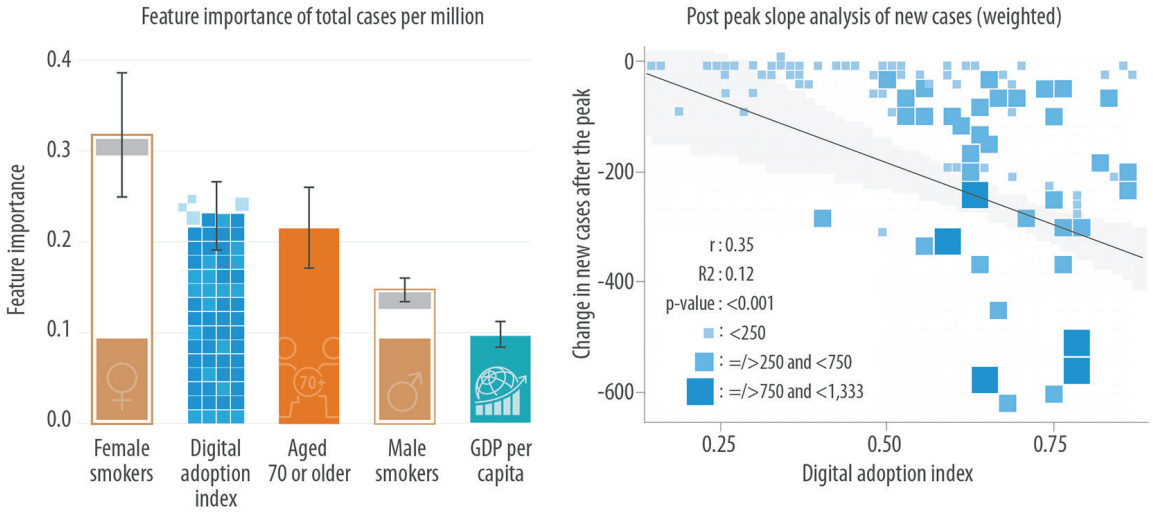


Source: Johnson, Watkinson, and Mabe 2018.

Note: With over 1.8 billion entries, Dimensions.AI is the world's largest linked research database. ESCI WoS = emerging sources citation index in the Web of Science. Scopus = a database of the academic publisher, Elsevier, with information about the abstracts and citations of Elsevier's published peer-reviewed literature. See Dimensions (dashboard), Digital Science, London, https://www.dimensions.ai/; ESCI WoS (Emerging Sources Citation Index, Web of Science) (dashboard) Clarivate, London, https://clarivate.com/products/scientific-and-academic-research/research-discovery-and-workflow-solutions/webofscience-platform/web-of-science-core-collection/emerging-sources-citation-index/; Scopus Preview (dashboard), Elsevier, Amsterdam, https://www.scopus.com/home.ur.

Third, countries with higher levels of digital adoption prior to the pandemic responded more effectively to the pandemic, exhibited more decisive government action, and, as a result, had fewer COVID cases and deaths. In their analysis, Heinrichs et al. (2022) find that a country's level of digital adoption (prior to COVID-19) was almost as influential as demographic and lifestyle factors in predicting COVID-19 deaths and cases (Figure 8). A scoping review of the causes of COVID-19 cases and deaths identified the lack of digital infrastructure as one of the strongest contenders (Figure 9). The data show that, as part of future pandemic preparedness efforts, the expansion of digital technology should become a cornerstone of health system resilience and pandemic preparedness.

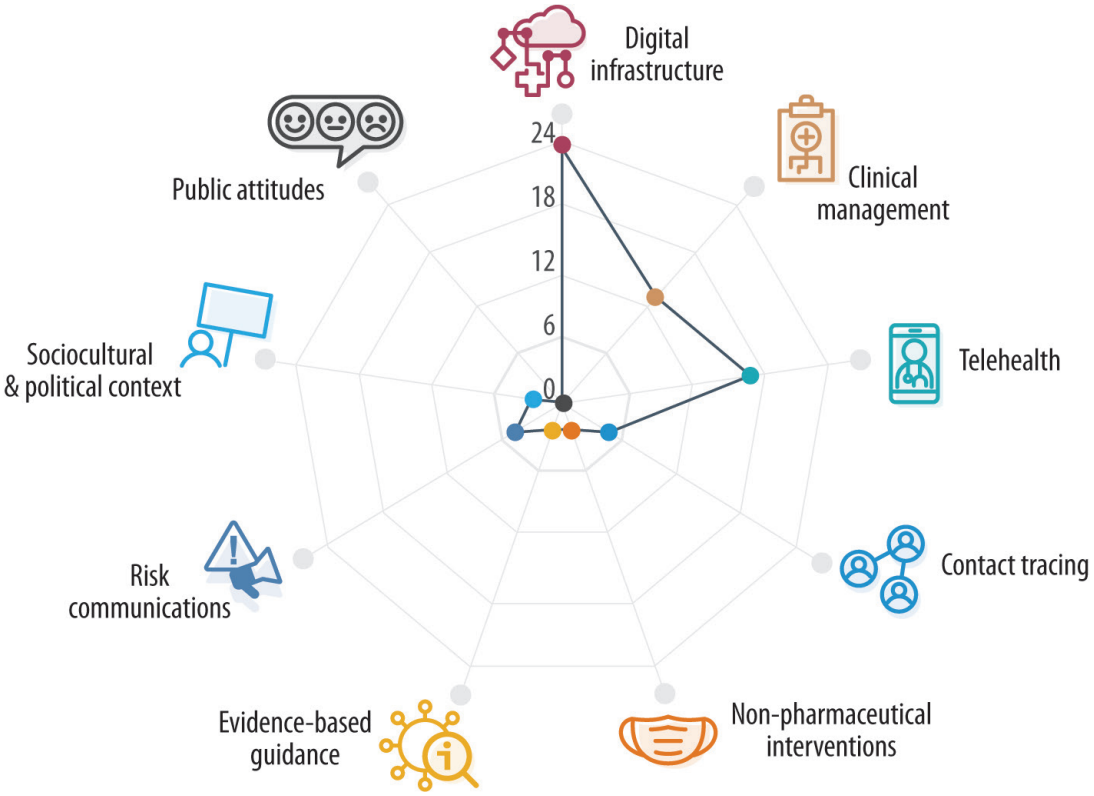
Figure 8 Links between Digital Adoption Prior to COVID-19 and COVID-19 Cases and Deaths



Source: Heinrichs et al. 2022.

Note: Panel a shows that the level of digital adoption prior to COVID-19 was as instrumental in determining the total COVID cases per million population as biological determinants, such as the share of women who smoke and the share of the elderly in the population. Panel b shows that countries with larger changes in post-peak new COVID-19 cases had higher levels of digital adoption prior to COVID-19.

Figure 9 Factors Contributing the Most to COVID-19 Deaths and Cases after the Peak



Source: Heinrichs et al. 2022.


24/7

CHAPTER 2

How it Started: Digital Technology and ***Data in* Health**

"The past is kind enough to give you lessons. The present is kind enough to give you opportunities. The future is kind enough to give you both."

Matshona Dhliwayo,
entrepreneur, philosopher and author

Key Messages in This Chapter

- Early efforts to introduce digital technology and data in the health sector focused on the digitalization of health data and on creating health information systems (HISs) to manage health data. The use of digital technology in health later expanded to focus on mobile applications in health care.
- The last decade has been monumental for digital health because of global initiatives, strategies, global principles, and commitments.
- The World Bank has undergone a journey to realize the promise of disruptive technology and digitalization for development. Throughout, the World Bank has been committed to supporting the efforts of governments and stakeholders to use digitalization to improve sectoral outcomes and systems, including through the World Bank health portfolio.

e-Health, m-Health, and Digital Health

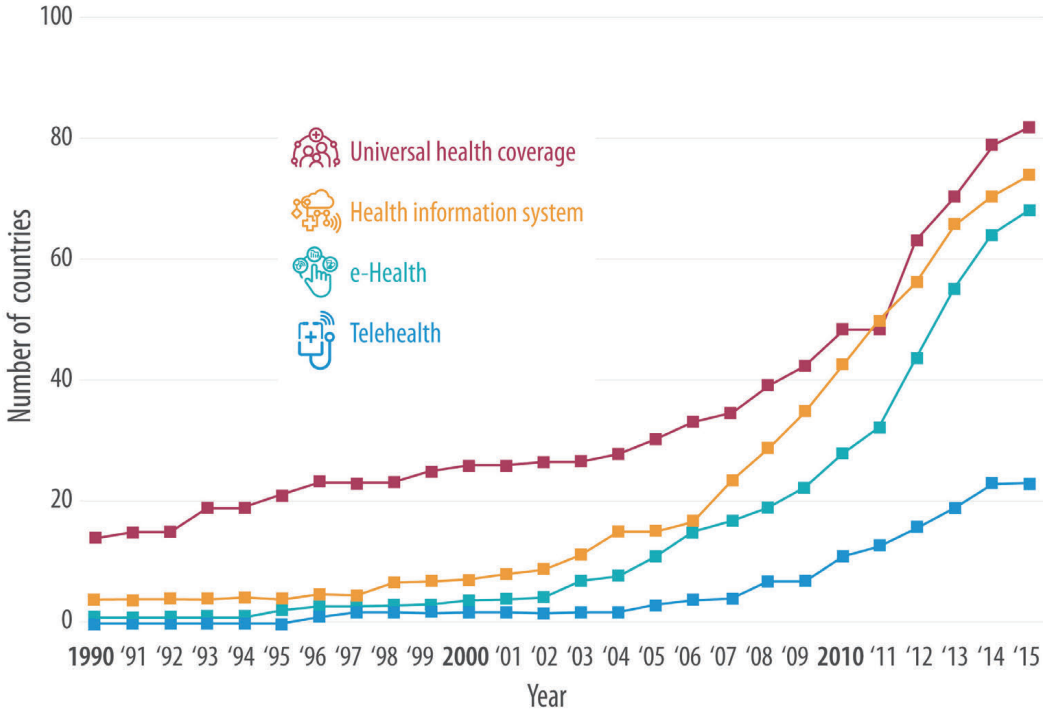
A focus on e-health in early 2000s: The origins of the term e-health can be traced to 2000. At the time, e-health was an attempt to expand the focus from medical informatics to the use of technology in the business of the delivery of health care (Pagliari, 2005). This is reflected in the definitions proposed by Eysenbach and Eng, as follows:

"e-health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies."
Eysenbach (2001,3)

"e-health: The use of emerging information and communication technology, especially the Internet, to improve or enable health and health care."
(Eng, 2004, 238)

The first World Health Assembly resolution on e-health—resolution WHA58.28—was passed in 2005. The resolution urged member states to draw up a long-term strategic plan for developing and implementing e-health services. It heralded a new era of digitalizing health data and creating HISs (Figure 10).

Figure 10 Countries with Strategies for Universal Health Coverage, e-Health, Health Information Systems, and Telehealth



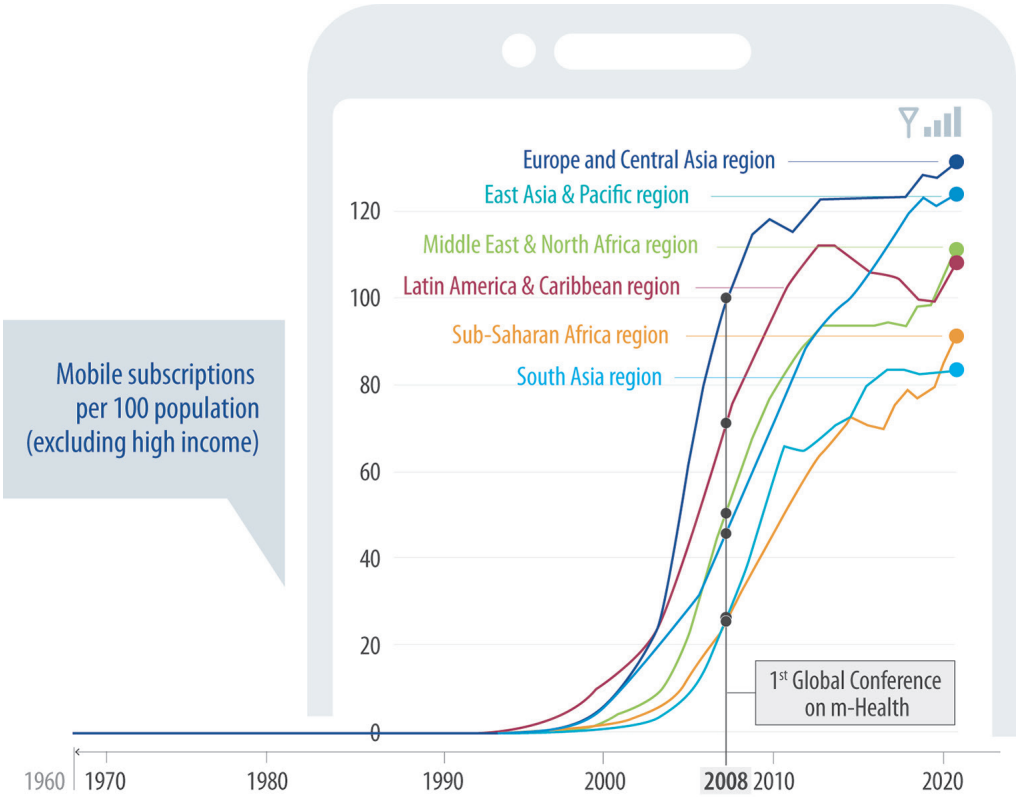
Source: WHO 2016

Because of the vast need and the attraction of the low-hanging fruit, e-health efforts initially focused on digitalizing health data and creating HISs. An HIS is a system that integrates data collection and the processing, reporting, and use of the information necessary for health systems to operate more effectively. Most countries have several HISs, such as a district information system (to manage health service delivery data in a district), a human resource information system (to manage health worker and health administrator data), a logistics management information system (to manage supply chains), and a laboratory information system (to manage data for clinical and public health laboratories).

By the late 2000s, the focus had broadened to m-health. In global health circles, the term m-health—shorthand for mobile health, or, more accurately, the application of mobile technologies in health care delivery—was first formally used at the 2008 e-Health Connect Conference, which brought together experts and stakeholders to explore the

intersection of health care and technology. At the time, m-health was defined as the delivery of health care services through mobile communication devices (Torgan 2009). An m-health application generates digital data that need to be managed through some type of information system. The expanding shifts in focus from e-health to m-health occurred during a period when barriers to entry were significantly lowered because cell phone subscriptions per 100 population had rapidly increased (Figure 11).

Figure 11 The Rapid Rise in Mobile Subscriptions per 100 Population, by Region, 1960–2021



Source: Mobile Cellular Subscriptions (per 100 People) (dashboard), World Bank, Washington, DC. https://data.worldbank.org/indicator/IT.CEL.SETS.P2.

Because the range of technologies and technology applications have expanded, the focus has broadened to include digital health. Digital health involves the knowledge and practices associated with the development and use of digital technologies to

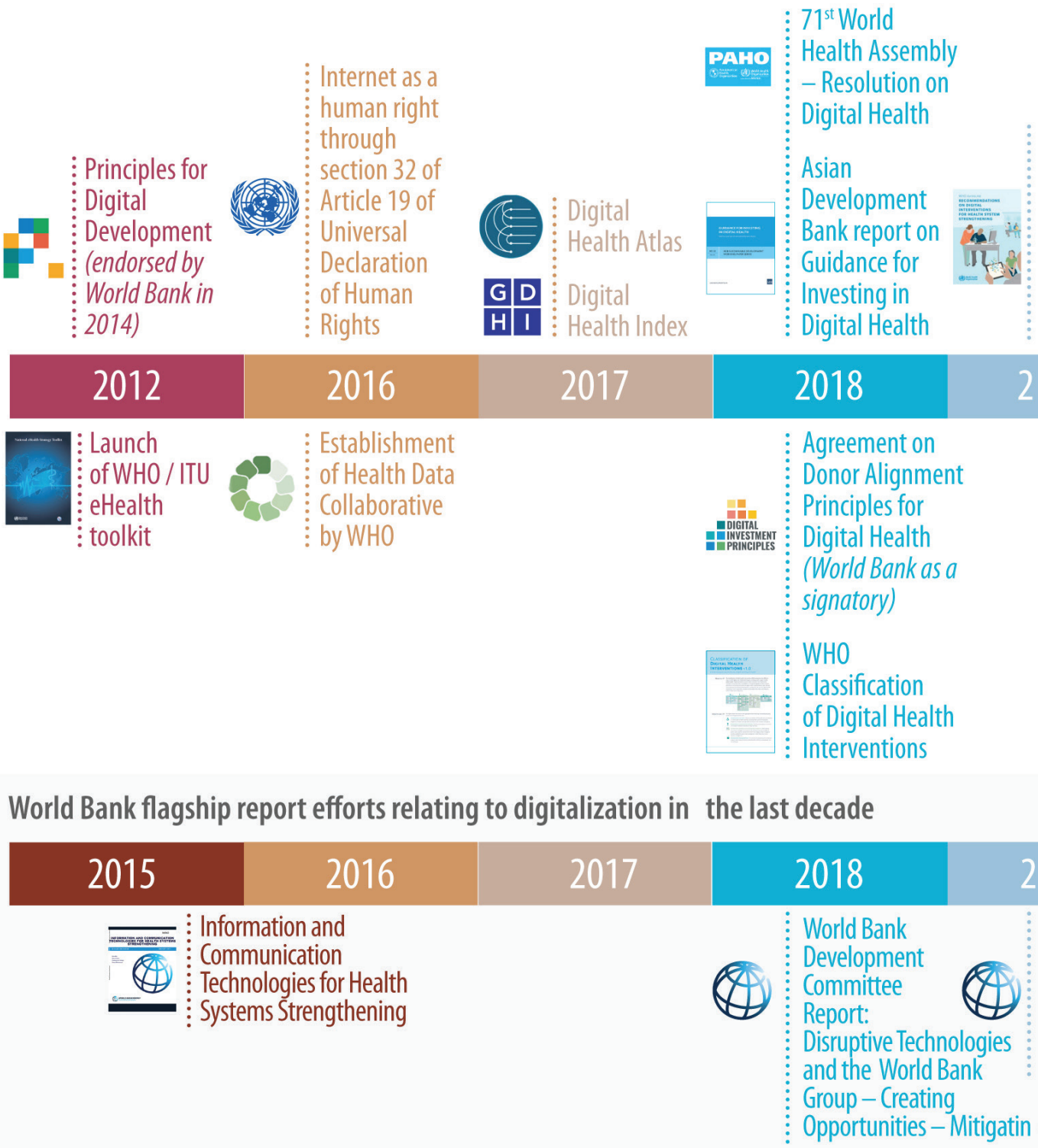
improve health (WHO 2021c). Digital health expands the concept of e-health to include digital consumers and a wider range of smart devices and connected equipment. It also encompasses other uses of digital technologies in health care, such as the internet of things, artificial intelligence (AI), big data, and robotics. Thus, digital health encompasses a wider range of technologies than m-health (for example, digital x-rays and their interpretation).[1] It is also focused on solving health system problems and improving health outcomes. A digital health intervention is "a discrete functionality of digital technology that is applied to achieve health objectives" (Xiong et al. 2023, 1).

Global Digital Health Milestones in the Last 10 Years

The last 10 years have been momentous in digital health. In many ways, 2012–22 can be regarded as a Rubicon on the long road to unlocking the value of digital technology and the use of data in health care. This period of digital awakening in the health sector is bookended by two momentous events: the 2012 launch of the Principles for Digital Development and the 2022 public release of generative AI tools (such as chat generative pretrained transformer 4 [ChatGPT4] and Stable Diffusion) (Figure 12). Notable achievements in this period include the publication of the "Global Strategy on Digital Health 2020–2025" of the World Health Organization (WHO), approved at the World Health Assembly in 2020 and developed in response to a World Health Assembly resolution on digital health in 2018 (WHO 2021c). The strategy focuses on four key objectives, all relevant for digital health investments: (a) promote global collaboration and advance the transfer of knowledge on digital health; (b) advance the implementation of national digital health strategies; (c) strengthen governance for digital health at national, regional, and global levels, such as the Asia e-Health Information Network, the Central American Health Informatics Network, and Health Informatics in Africa; and (d) advocate for people-centered health systems that are enabled by digital health.

[1] In some ways, the concept 'digital health' is a misnomer because health does not become digital, but, rather, digital technology is used to increase the value of health care for everyone.

Figure 12 Key Moments in Digital Health–Related Development Relevant to Low- and Middle-Income Countries



Report on the Age of Digital Interdependence

WHO Recommendations on Digital Interventions for Health System Strengthening

United Nations Secretary General's High-level Panel on Digital Cooperation

Launch of WHO's first SMART guidelines

Health Data Governance Principles proposed by Transform Health *(World Bank endorsed these principles)*

Revision of WHO Classification of Digital Health Interventions

019 | 2020 | 2021 | 2022 | 2023

WHO Global Digital Health Strategy

WHO Digital Implementation Investment Guide

USAID A vision for action in digital health

WHO and UNICEF launch Digital Health Center of Excellence (DICE)

Inter-American Development Bank report on The Golden Opportunity of Digital Health for Latin America and Caribbean

National Academy of Medicine report on The Promise of Digital Health: Then, Now, and the Future

2022 and beyond: Launch of several generative AI tools (ChatGPT and others)

019 | 2020 | 2021 | 2022 | 2023

World Bank Development Committee Report: Mainstreaming the Approach to Disruptive and Transformative Technologies at the World Bank Group

g Risks

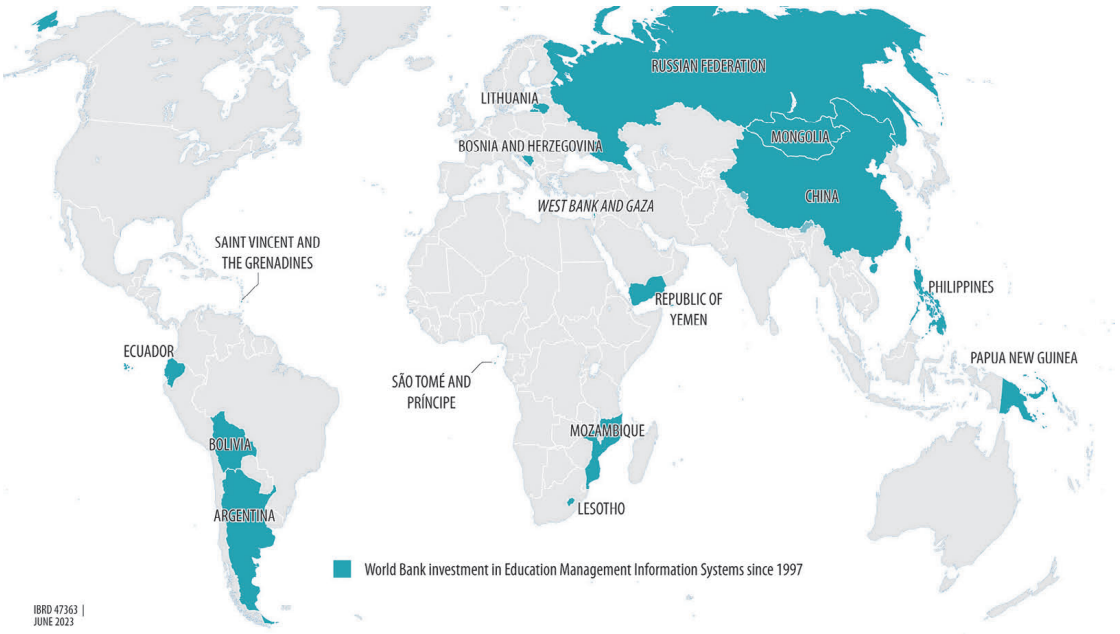
World Bank Independent Evaluation Group (IEG) Report: Mobilizing Technology for Development: An Assessment of World Bank Group Preparedness

World Development Report 2021: Data for Better Lives (World Bank)

The World Bank Journey in Digitalization and Development

Over the last several years, the World Bank has extensively supported governments in developing public sector information systems, particularly financial management information systems (Dener, Watkins, and Dorotinsky 2011), education management information systems (Map 1), social protection–related information systems, and health management information systems (Otto et al. 2015).

Map 1 World Bank Investments in Education Management Information Systems since 1997



Source: World Bank 2016a.

Building on these investments in information systems, the World Bank has been on a journey to digitalization and disruptive technology in development, in particular the transition from investing in information systems to recognizing the importance of the digital economy and the ways in which digitalization supports development goals. Key milestones during this period are the following:

2015 World Bank discussion paper: "Information and Communication Technologies For Health Systems Strengthening" (Otto et al. 2015). In this paper, Otto et al. outlined the ways in which information and communication technology (ICT) can be deployed to support health system strengthening. They also outline seven factors involved in advancing the e-health agenda, namely, (a) adequate physical infrastructure; (b) data and interoperability standards; (c) sufficient local capacity; (d) a supportive policy and regulatory environment, including an integrated national e-health strategy; (e) appropriate business models; (f) thoughtful partnerships aligned with local and national priorities; and (g) effective monitoring and evaluation.

World Development Report 2016: Digital Dividends: (World Bank 2016b). The key message of this report is that, while digital technologies have spread rapidly in much of the world, the digital dividends—that is, the broader development benefits from the use of these technologies—have lagged. In many instances, digital technologies have boosted growth, expanded opportunities, and improved service delivery. Yet, the aggregate benefits have been disappointing and unevenly distributed. If digital technologies are to benefit everyone everywhere, the remaining digital divide, especially in internet access, must be reduced. The adoption of more digital technologies will not be sufficient. To obtain the most from the digital revolution, governments and stakeholders will also need to enhance the analog complements by strengthening regulations that ensure competition among businesses, adapting worker skills to the demands of the new economy, and ensuring that institutions are accountable.

2018 World Bank Report: “Disruptive Technologies and the World Bank Group: Creating Opportunities, Mitigating Risks” (World Bank 2018). This report points out that traditional pathways to overcome critical development challenges are increasingly subject to technology-based disruptions. Disruptive technologies pose new risks, including to economic and social inclusion and to environmental and systemic sustainability. Despite the risks, failing to take advantage of the opportunities that disruptive technologies offer could be even more costly. In the report, the World Bank commits to supporting countries in taking advantage of the opportunities and mitigating the risks associated with disruptive technologies by operationalizing the build-boost-broker value proposition.

2019 World Bank Report: "Mainstreaming the Approach to Disruptive and Transformative Technologies at the World Bank Group": (World Bank 2019). In this report, a follow up to the 2018 report on Disruptive Technologies (World Bank 2018), the World Bank committed to five corporate actions to mainstream disruptive technology in development.

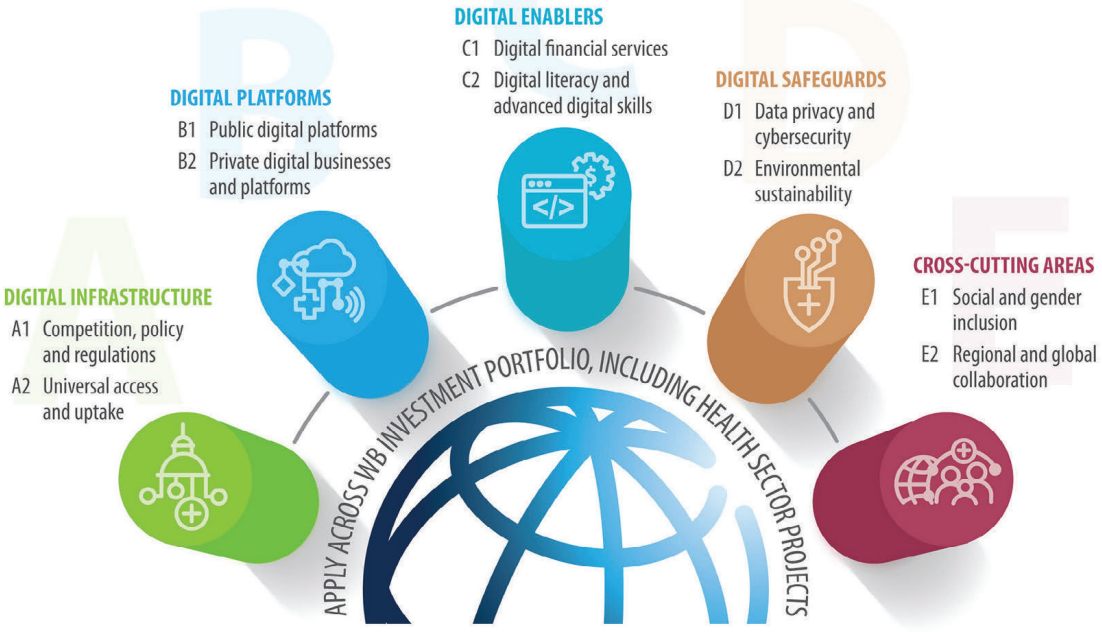
2021 Independent Evaluation Group Report: Mobilizing Technology for Development: An Assessment of World Bank Group Preparedness (IEG 2021). This evaluation seeks to answer the question, how well prepared are the International Finance Corporation (IFC) and the World Bank to help clients harness the opportunities and mitigate the risks posed by disruptive and transformative technologies? The answer in 2021 was, given the accelerating pace and complexity of technological change, the World Bank is not yet sufficiently well prepared, despite some areas of strength. Based on this evaluation, the World Bank has increased its efforts to build internal capacity and to source specialist skills to apply digital technology in World Bank operations.

World Development Report 2021: Data For Better Lives (World Bank 2021). Today's unprecedented growth in data and the ubiquity of data in the lives of individuals are signs that the data revolution is transforming the world. Yet, much of the value of data remains untapped. Data collected for one purpose have the potential to generate economic and social value in applications far beyond those originally anticipated. But many barriers stand in the way, ranging from misaligned incentives and incompatible data systems to a fundamental lack of trust. *World Development Report 2021* explores the tremendous potential of the changing data landscape to improve the lives of poor people, while also acknowledging the potential of data to facilitate activities that may harm individuals, businesses, and societies.

2022 World Bank Report: "Digitalization and Development" (World Bank 2022a). The COVID-19 pandemic has rapidly accelerated the take-up of digital products and services in developing countries. Digital platforms and services have enabled innovations that have helped reduce the health, social, and economic costs of COVID-19. They offer great potential for support in building resilience and preparedness against future crises and in mitigating and adapting to climate change. However, the pandemic has also demonstrated the importance of erecting strong, inclusive digital foundations during normal times that

governments and stakeholders may rely on in realizing digital solutions to lessen the impacts of crises effectively and, more broadly, to contribute to the twin goals of reducing poverty and promoting shared prosperity. This report defines five World Bank policy priorities to maximize the development dividends of digitalization, while managing risks (Figure 13). These corporate priorities are important beacons for World Bank investments writ large. They are also priorities in investments in digital technology to achieve enhanced health outcomes.

Figure 13 World Bank: Five Policy Priorities to Support Digitalization and Development



Source: World Bank 2022a.


24/7

CHAPTER 3

Looking Back: **Digital Health Investments** *in the* Last **10 Years**

"When spiders unite,
they can tie up a lion."

Ethiopian Proverb

Key Messages in this Chapter

- *The World Bank* recently undertook a detailed analysis of its investments in digital health in the last 10 years. The digital health portfolio assessment shows that (a) the World Bank has supplied significant support to countries in their digital health efforts (to a value of slightly less than US$4 billion, that is, 6 percent of the World Bank health portfolio); (b) investment projects in other sectors have contributed 49 percent of digital health–related investments; (c) the investments have been largely concentrated in South Asia and Sub-Saharan Africa; and (d) 82 percent of the investments have focused on health information systems (HISs) and the foundational building blocks of digital health.

- *Other development partners* have also invested in digital health. They have shared four key trends in these investments: (a) most investments have also been in HISs, mainly for the purpose of using these systems to obtain data for reporting; (b) ongoing system maintenance costs have been underestimated; (c) digital capacity and literacy are weak and require ongoing investment; and (d) in future, more focus is needed on the digital health ecosystem.

- *The private sector* is an innovator, developer, and user of digital technologies in health care. Digital technology applications offer opportunities to reset and expand the relationship between the private and public sectors in recognition that both are needed to resolve the bigger challenges.

- *Patients, providers, and communities* have strong and divergent views on whether and which digital technology would be most useful. While patients and providers see advantages, and some demand the technology, they prefer to use digital technology in administration (for instance, appointment scheduling and access to medical records). There is less demand for digital technology in diagnostics or clinical care. Building trust and familiarity in using digital technologies in diagnostics and clinical care will require regulatory processes greater capacity.

- *There is remarkable agreement across diverse stakeholders on what should be done to make digital investments work for the benefit of everyone:* (a) expanding foundational infrastructure to connect every facility, every health worker, and every patient; (b) addressing fragmentation and promoting interoperability and integration; (c) involving those individuals who will use the technologies in the design of digital solutions; (d) building digital skills and awareness; (d) improving regulations to ensure trustworthiness; (e) choosing technologies that solve health sector problems and reduce disparities in health and health care; (f) ensuring continued funding; and (g) developing robust data governance systems. Heeding the voices of stakeholders will be instrumental in future success.

This chapter describes the current landscape of investments in digital health by the World Bank, other development partners, and the private sector. It also outlines the perspectives of patients, providers, and communities about investments in digital health and the appropriate targets of future investment.

The Findings of Other Assessments of Investments in Digital Health

Understanding the sources and targets of investment in digital health is not straightforward. This is because investments in digital health are not included as a separate reporting code by the Development Assistance Committee of the Organisation for Economic Co-operation and Development. Development partners therefore do not report separately on development assistance in digital health for the databases of the committee. This is also the case among governments. Transform Health (2022) thus finds that information on the estimated share of annual public expenditure on health committed to digital health is not routinely available in most countries.

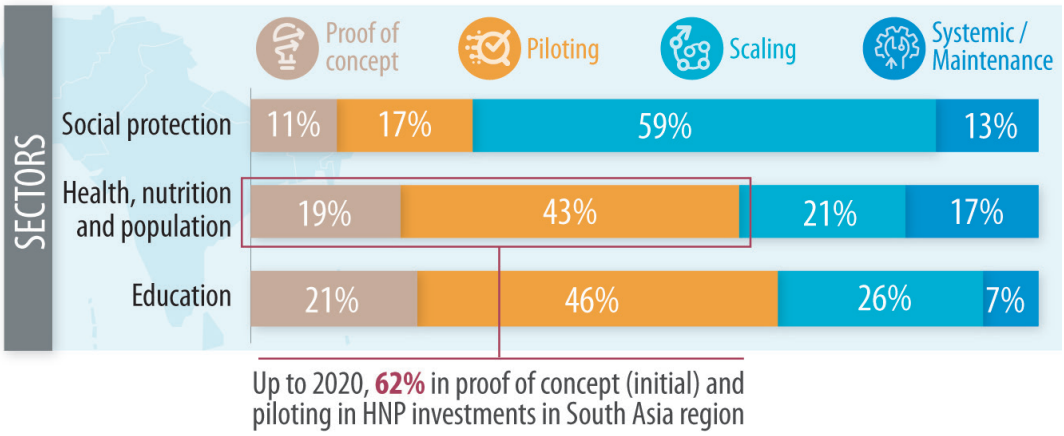
Given that comparable information on digital health investments is not available, World Bank analysts examined the approaches and results of three other assessments: (a) a 2021 report published by the World Bank on converging technologies and development (Bashir et al. 2021), (b) the WHO Digital Health Atlas, and (c) a global assessment of digital health investment needs (Transform Health 2022).[1] Only then did the analysts design the methodology of the World Bank portfolio assessment.

a. **The 2021 World Bank report on converging technologies and development** used a portfolio review method to estimate World Bank investments in disruptive technology to promote human development in South Asia (Bashir et al. 2021). The result of the effort is illustrated in Figure 14, which shows that 62 percent of disruptive technology investments in the health sector are in the proof-of-concept or piloting stage, while fewer are in the scaling-up or maintenance stage.

b. The **WHO Digital Health Atlas** invites, on a voluntary basis, any organization (including ministries of health or digital solution providers) to capture digital health investments in an online database. Aggregating these data by region, gives a sense of the volume of digital health investments in countries and regions. The latest data, shown in Table 2, suggest that most digital health activity occurs in Africa and South Asia.

[1] Digital Health Atlas (platform), World Health Organization, Geneva, https://digitalhealthatlas.org/en/-/.

Figure 14 World Bank Investment in Disruptive Technology, Health, Education, and Social Protection, South Asia, 2020



Source: Bashir et al. 2021.

Table 2 Digital Health Projects Captured in the Digital Health Atlas

World Bank region or subregion	Digital health projects, number
East Asia and Pacific	24
East and Southern Africa	315
Europe and Central Asia	54
Latin America and the Caribbean	38
Middle East and North Africa	105
South Asia	174
West and Central Africa	144

Source: Data of July 14, 2023, Digital Health Atlas (platform), World Health Organization, Geneva, https://digitalhealthatlas.org/en/-/.

Note: Participation in nourishing the atlas with data is voluntary, and the data are not independently verified. Duplication is therefore possible. Thus, a ministry of health and a vendor could submit data on the same intervention for entry in the atlas database. However, there is no reason to assume that under- or overreporting is more prevalent in one region than in another. The data are useful for obtaining a view on the geographic differences in the volume of projects.

c. **Transform Health's 2022 assessment** finds the investment needs in digital health at around US$12.5 billion (US$7.1 billion–US$20.5 billion) in nine priority areas of investment (Table 3).

Table 3 Digital Health Investment Estimates, by Priority Area

Investment area 5-year costs. Costs in 2021, US$ millions	**Low-cost scenario**	**Medium-cost scenario** *(most realistic)*	**High-cost scenario**	**5-year breakdown** *(based on the medium scenario)* Yr1 Yr2 Yr3 Yr4 Yr5
Digital connectivity infrastructure (connecting every health worker, health facility and household)	4,820	9,693	17,001	
Telemedicine (provision of health care services at a distance)	819	983	1,228	
Decision support (digitalized job aids combining patient health information and clinical protocols)	515	618	772	
Health financing (digital approaches for monitoring and reporting stock levels)	400	480	600	
Supply chain management (digital approaches to manage financial transactions)	255	306	382	
Data exchange and interoperability (multiple systems communicating and exchanging data)	139	167	209	
Client identification and registration (identifying and enrolling clients in a patient portal)	118	141	177	
Enterprise architecture, including governance, guidelines and standards for interoperability	79	95	118	
Data and digital governance (regulating the use of digital technologies and data)	17	20	25	
Total 5-year cost	**7,162**	**12,503**	**20,512**	

Source: Transform Health 2022.

Note: Yr = year.

These assessments show that consistent global data on the extent of investments and the type of investments in digital health are not available and that a taxonomy of the types of investment does not exist. They also show that there is a significant need for investment in digital health and that the most significant future investments are likely to occur in digital connectivity infrastructure, estimated at 67 percent to 82 percent of total investment financing needs (Transform Health 2022).

Investments Related to Digital Health in the Last 10 Years

The World Bank recently undertook its first-ever digital health portfolio assessment. The review has focused on investments led by four World Bank global practices. These four have the greatest likelihood of being associated with digital health–related investments in 2012–22, as follows: (a) Health, Nutrition, and Population Global Practice (HNP GP), (b) Digital Development Global Practice (DD GP), (c) Social Protection and Jobs Global Practice (SPJ GP), and (d) Governance Global Practice (GOV GP).

The goal of the portfolio assessment was to quantify the following: (a) the volume of digital health–related investments by the World Bank, (b) digital health–related investments by region, (c) the volume of investment in specific areas of digital health. The review entailed four steps (see Annex B).

Table 4 Digital Health–Related Investments, by Type and Region, 2012–22

	Leading GP, US$ millions				
World Bank region	**HNP GP**	**DD GP**	**GOV GP**	**SPJ GP**	**Total**
East Asia and Pacific	86	20	19	10	135
Eastern Europe and Central Asia	232	40	5	11	288
Latin America and Caribbean	354	75	0	45	474
Middle East and North Africa	203	1	12	0	216
South Asia	469	225	77	282	1,053
Sub-Saharan Africa	661	561	427	135	1,784
Global / multi-region	12	0	0	0	12
Total	**2,017 (51%)**	**922 (23%)**	**540 (14%)**	**483 (12%)**	**3,962**

The review shows that, overall, the World Bank invested slightly less than US$4 billion in digital health–related efforts in 2012–22. Of the total, 51 percent was in health sector projects, and 49 percent was managed by other sectors (DD GP, 23 percent; GOV GP, 14 percent; and SPJ GP, 12 percent). Of the World Bank's total HNP investment portfolio of US$32.8 billion, 6 percent (US$2.0 billion) went for digital health–related investments in 2012–22. Sub-Saharan Africa accounts for the most investment (Table 4). The total investments in digital health initiatives in the region stood at US$1.78 billion. South Asia ranked second. Digital health investments there reached around US$1.05 billion, even as the region reported a lower number of digital health interventions relative to other regions.

The bulk of the investments (84 percent) were foundational or functional (Figure 15). The large number of GOV GP investments in digital solutions may derive from the focus of this global practice on GovTech initiatives involving a whole-of-government approach to public sector modernization. HNP GP differed from other global practices in its focus on HIS investments , while the largest investments of the remaining global practices were in foundational aspects. This shows the complementarity among the investments across the four global practices.

Of the World Bank's total HNP investment portfolio of US$32.8 billion in 2012–22, 6 percent (US$2.0 billion) was in digital health–related investments. The bulk of HNP-managed investments focused on HISs (51 percent of the HNP GP investments). The temporal trends in investment reflect this, too. The most substantial area of growth in HNP-managed investments in digital health was in HISs (Figure 16).

Figure 15 Digital Health–Related Investments, by Type and Region, 2012–22

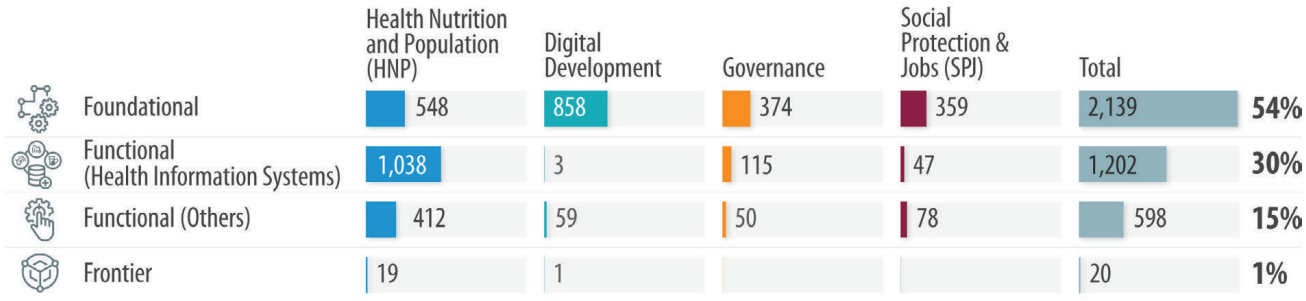


Figure continued...

Figure 15 Digital Health–Related Investments, by Type and Region, 2012–22 (continued)

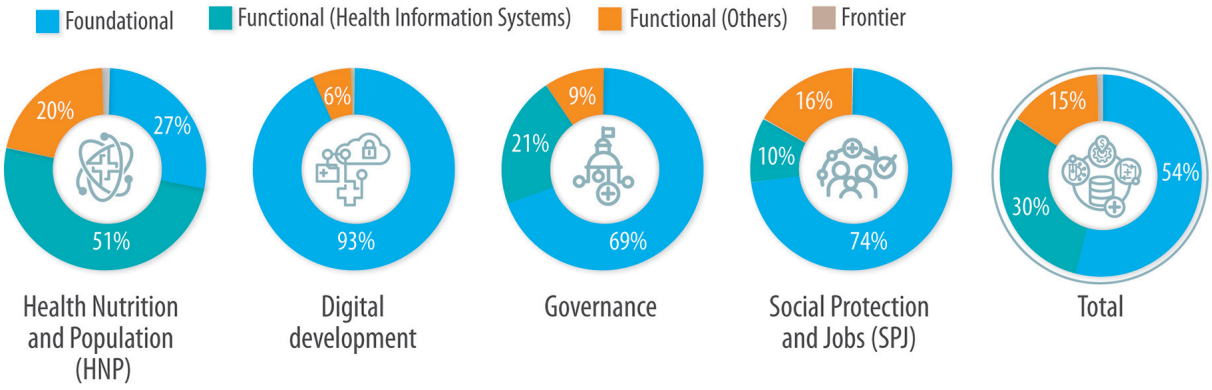
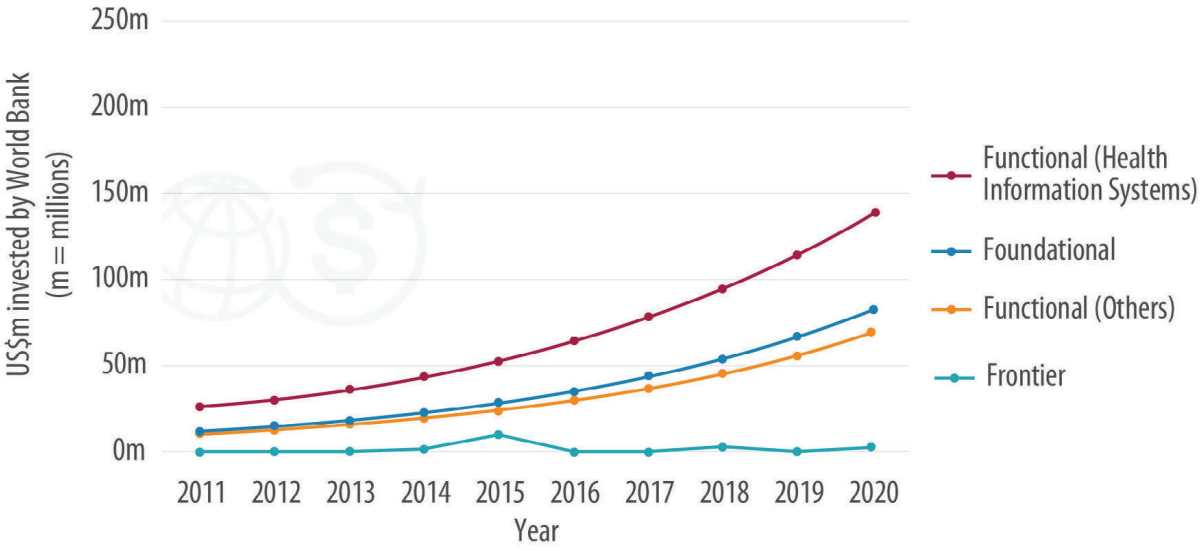


Figure 16 Changes in Type of World Bank Digital Health Investment Prior to COVID Programs, 2011–20



If the investments are broken down by investment subcategory, **the greatest emphasis in 2012–22 was on providing technology infrastructure**. A substantial share of the investments under the HIS category were directed toward the subcategories of analytics, surveillance and disease monitoring, financing, and patient-centric investments (Table 5).

Table 5 Number of Projects and Volume of Digital Health–Related Investments, by Subcategory, 2012–22

Foundational	Number of projects	Investments (millions $)
Technology infrastructure – hardware and connectivity	101	568.2
Governance of digital health solutions and health data	118	553
Enterprise architecture	76	495.1
Identification and Registries	50	327
Capacity in the design, management and use of digital health solutions in the health system	51	195.4
Functional (Health Information System)	Number of projects	Investments (millions $)
Health Information Systems (Analytics)	124	628.6
Health Information Systems (Surveillance and Disease monitoring)	37	215.6
Health Information Systems (Financing)	32	169.7
Health Information Systems (Provider or patient-centric)	16	97.9
Health Information Systems (Logistics' Supply chain)	18	77
Health Information Systems (Laboratory, Management System)	4	13
Functional (Other)	Number of projects	Investments (millions $)
Client-facing digital health information applications	89	399.4
Digitally enabled health service delivery redesign	28	141.02
Linking healthcare providers and clients through virtual service delivery	12	49
Human Resources for Health	8	8.7
Frontier	Number of projects	Investments (millions $)
Other emerging and Frontier technologies	9	18.97
Artificial intelligence/machine learning-based applications for health service delivery	1	0.8

Note: The number of projects = health interventions in individual projects mapped to more than one subcategory.

Disaggregating the results indicates that **most of the investments in analytics were focused on** (a) health management information systems; (b) performance and quality dashboards; and (c) location mapping services (Table 6).

Table 6 World Bank Funding for Digital Health, by Subcategory of HIS-Related Investments, 2012–22

Analytics	Number of projects	Investments (millions $)
Health managed information systems (HMIS), such as DHIS2	51	294.8
Performance and quality dashboards	46	246.6
Location mapping (using geospatial analytics)	7	52.2
Public health data collection and reporting systems (NCD & CD registries, public health reporting...)	14	25
Health data warehouses BI/analytical systems	6	10.1
Financing	Number of projects	Investments (millions $)
Electronic Financial management information systems (iFMIS) – desktop or web-based	11	61.7
Health/Social insurance systems (beneficiary registry, claims processing system, Digital insurance processing claim system, premium collection, system,...)	6	40.7
Digital payrolls for health workforce	5	40.4
Performance based payment information management systems (e.g., capitation reporting, PBF indicators reporting, etc.)	10	26.9
Surveillance and Disease Monitoring	Number of projects	Investments (millions $)
Public health and disease, surveillance management, information, system, digital component of IDSR (integrated disease and response system)	32	208.3
Digitized/Digital forms for contact tracing, case-based reporting	5	7.4

Table continued...

Table 6 World Bank Funding for Digital Health, by Subcategory of HIS-Related Investments, 2012–22 (continued)

Provider or Patient centric	Number of projects	Investments (millions $)
Communication with health system, clients for medication, reminders and other purposes	10	57.5
Electronic medical records (EMR), such as Epic and other systems	2	24.4
Pharmacy information systems	1	9.7
Clinical decision support systems (CDSS)	1	5.4
Electronic health records (EHR)	2	0.9

Note: The number of projects = health interventions in individual projects mapped to more than one subcategory.

The World Bank digital health portfolio assessment shows that (a) the World Bank has invested substantially in the last 10 years (US$3.962 billion; 6 percent of the HNP GP health portfolio); (b) aside from HNP GP, projects managed by several global practices contributed 49 percent of digital health–related investments; (c) investments have largely been in South Asia and Sub-Saharan Africa; and (d) 84 percent of the investments are focused on the foundational and HIS areas of digital health.

Investments in Digital Health by Other Development Partners

The World Bank held discussions with several development partners to learn about their experiences in supporting digital health. Information was provided on the nature, volume, and challenges relating to their investments. Key themes emerging from the discussions are as follows:

- Akin to the World Bank's historical focus, **most digital investments by development partners are focused on HISs and the data HISs produce.** The availability of data is the key metric of success of investments in these systems. Typically, investments have been most prevalent on three types of HISs: logistics management information systems, health management information systems, and electronic medical records. These last Investments are more recent and cover most of the more pressing investment needs.

- **Some past digital health investments have not led to scaling-up as planned,** primarily because of overly optimistic expectations, basic infrastructure challenges (lack of electricity and lack of mobile or fixed internet connectivity), the lack of long-term planning, challenges arising from fragmentation, the lack of sustainable financing after the initial investment, a lack of government readiness and capacity, a lack of norms and standards for interoperability, a lack of connectivity and functional IT infrastructure (hardware), and a lack of evidence on what works and how this works best.
- Beyond information systems, investments have **focused on individual digital health interventions**, such as mobile applications aimed at specific population groups or digital medical devices, for example, digital X-ray devices.
- **The lack of capacity and digital literacy remain key challenges** and hamper the success of digital health investments. As a result, development partners have invested significantly in capacity building in digital health, and their coordination efforts are substantial.
- Success in digital health requires good infrastructure and a **well-defined health data plan** to determine how all the data will be collected and organized.
- There has been **mixed success in the engagement with the private sector,** and the experiences of the private sector have been mixed in working with governments on digital health solutions.
- Once a system has been developed, **the annual maintenance cost of system operations** tends to be higher than expected, at around 30 percent of the total initial upfront investment. These costs have not always been included in the initial planning.
- In the future, **digital health investments need to focus more on the ecosystem and other foundational areas, such as digital health governance,** instead of focusing exclusively on discrete information systems or discrete digital health interventions. This suggests that investments should be focused on interoperability, cloud computing, and other system-level efforts.
- **Development partner budgets for digital health range** from US$50 million a year to US$135 million a year. Concurring with the information in the WHO Digital Health Atlas, a significant component is in South Asia and Sub-Saharan Africa.

Private Sector Partner Perspectives on Investment in Digital Health

The private sector plays various roles in the digital health space. It is an innovator and developer of digital health solutions, and private sector companies that deliver health care also apply digital health solutions (Figure 17).

Figure 17 The Opportunity to Engage with the Private Sector on Digital Health

Note: UHC = universal health care.

In a 2023 IFC survey conducted through LinkedIn and key informant interviews, private sector stakeholders—health care delivery companies that rely on digital health solutions and technology companies that provide digital health solutions—shared their views on using digital technology in health care. Four issues came to the fore: (a) waxing and waning levels of awareness about digital health; (b) the importance of consistent strategy, financing, and investment; (c) the need for integration and regulation; and (d) the underappreciated challenge of implementation and capacity.

a. Waxing and waning levels of awareness about digital health

- is increasing about the nature of digital health and what it offers organizations that provide private health services. Yet, digital health is not uniformly understood. Local market conditions directly impact the level of digital health maturity and utilization.
- COVID-19 demonstrated the necessity of digital health. Since the pandemic, the urgency of adopting digital technologies, although still acknowledged, has slipped off the radar.
- There is a lack of appreciation of the extent of foundational investments needed (such as in connectivity) to make digital health interventions work.
- Digital initiatives are not front of mind among executive boards or senior managers. Successful adoption requires senior-level ownership.
- Awareness about the need for health standards for data exchange, security, data protection, and hardware has increased, but more should be done.

b. Importance of consistent strategy, financing, and investment

- An increasing number of organizations have developed or are developing digital health strategies, but these have not yet been implemented. Many digital health strategies focus on cybersecurity, telehealth, digital patient administration, electronic health records, data analytics, performance management, and workflow simplification.
- Selecting the most useful digital interventions is difficult, as is understanding how to integrate these interventions into the existing architecture and identifying the appropriate contract model.
- Implementing digital health initiatives is often restricted by funding challenges. To secure financing, these investments require a clear business case (investment, return, benefit), that is, the value proposition needs to be clear.

c. The need for integration and regulation

- The integration with existing systems is a recurring problem in the adoption of digital approaches, especially in hardware, connectivity, and data storage. This is a key barrier to broader adoption.

- Regulation continues to be a constraint on digital health in many markets, although there has been recent positive movement. Regulatory compliance is an area of growing focus.

d. Under-appreciated challenge of implementation and capacity

- Access to implementation skills continues to be a significant barrier to the broader adoption of digital health. The skills investment required for digital health development, implementation, and successful deployment are an expanding need in many markets.
- Data access is a constant challenge, as is the lack of the ability to analyze the available data given the siloed nature of locations. Data analysis skills are a major issue because of the skills gap.
- Phased digital adoption is being increasingly considered because of funding and capacity constraints. The careful planning of initiatives is therefore required.
- There is a growing realization and expanding focus on the importance of data. Senior management and some executive boards are examining the widening focus. Senior ownership of the topic and understanding at the top are critical to success.
- Some organizations now offer training in big data to enhance understanding and awareness.

A field study in Kenya confirms these issues (Muinga et al. 2020). Private sector vendors reported in the study that implementation is constrained by funding problems, the priority on services, the lack of confidence among users in new technologies, and the lack of appropriate data-sharing policies. Although the study highlights specific problems, it also points to opportunities for the public and private sectors to work together in more meaningful and mutually beneficial ways in emerging markets. This would foster an environment wherein digital health solutions are affordable, well regulated, integrated, and of good quality and solutions can be implemented and financed sustainably. (Annex C provides information on possible approaches the private sector might want to adopt in this area.)

Digital Health Investments: The Perspectives of Patients and Providers

Patient Perspectives

In the last 10 years, more patients have looked for health information online or interacted with online health services. In Pakistan, over 60 percent of students indicated that they looked for health information online (Tariq, Khan, and Basharat 2020). In a study among more than 250,000 people in the United States, the share who had searched for health information online had risen from 47 percent to 55 percent in 2011–18 ($p < .001$), and the share that had used technology to interact with the health care system had more than doubled, from 13 percent to 27 percent ($p < .001$). However, substantial variation existed in the degree of adoption across clinical and sociodemographic subgroups, and the assimilation of technologies proved uneven across various subsets of the population.

Patient perspectives on digital health are diverse. Both positive and negative perceptions exist (Table 7). The perceptions depend on several factors: age, technological proficiency, level of engagement in technology design, the nature of the health concerns, the level of knowledge and confidence exuded by health care providers, the extent to which evidence is available that technology delivers better health, and the personal comfort of patients with sharing health data digitally.

Table 7 Patient Perceptions of Digital Technology and Data in the Health Services They Use

POSITIVE PERCEPTIONS: comfortable with and want more digital services	NEGATIVE PERCEPTIONS: factors that may make patients reluctant to use digital technology or data
Convenience and accessibility, particularly in the case of noncommunicable disease. Patients appreciate the convenience digital health technologies offer. Telehealth consultations, online appointment scheduling, and digital access to medical records can make managing health easier, especially among people with mobility issues or who live in remote areas (Helleman et al. 2022). One area specifically mentioned is diseases that require elevated care, such as noncommunicable diseases (EPIS 2019).	***The user-friendliness of technology.*** Some patients find digital platforms difficult to navigate, which can cause frustration and limit their willingness to engage with digital health systems (Bally et al. 2023).

Table continued...

Table 7 Patient Perceptions of Digital Technology and Data in the Health Services They Use (continued)

POSITIVE PERCEPTIONS: comfortable with and want more digital services	NEGATIVE PERCEPTIONS: factors that may make patients reluctant to use digital technology or data
Improvements in quality of care. Patients have indicated that technology could support their long-term chronic disease by helping them track their symptoms, actively manage the different manifestations of their condition, collaborate with their medical team on decisions, and find information, knowledge, and support.	***Reductions in quality of care.*** Some patients are concerned about the quality of care that they receive through digital health services. For example, in telehealth, patients might worry whether their health care provider can accurately diagnose and treat their conditions without a physical examination (Barony Sanchez et al. 2022).
Personalization. Patients are excited by the fact that digital health technologies may provide personalized care experiences, such as tailored treatment plans based on data analytics (Dohse 2022).	***Data consent concerns.*** Some patients have concerns about the privacy, protection and security of their health data. These concerns can impact the level of trust and, consequently, patient engagement with digital health systems (Bally et al. 2023). Willingness to share data could be increased by ensuring the ability to consent to data use, consumer access to the data collected from them, ethical and regulatory oversight, and ability to delete data altogether (Gupta et al. 2023).
Hope that digital technology can minimize the care coordination challenges that patients face. A recent survey in the United States found that patients and would-be patients spend over 8 hours a month coordinating medical care, that they find it overwhelming, and that they delay care because of these care coordination challenges (AAPA 2023). Data integration technology should be able to address these challenges.	***Concerns about the digital divide.*** The digital divide might hinder vulnerable populations from accessing the health services they need. In many cases, alternatives to digital service delivery were not available or known to these populations. This is a particular concern to populations in rural areas, persons living with disabilities, and women and children (Kaihlanen et al. 2022).
Trust in and preference for technology-based solutions. Individuals have varying levels of trust in the use of digital or AI technologies for medical care, including diagnosis and treatment. An experiment by Robertson et al. (2023), for example, showed that, in a US setting, vulnerable populations (minorities and older persons) and less well educated persons are less likely to want to receive or trust a diagnosis from AI-driven technology that interprets digital radiological images. On the flipside, physicians can influence this outcome. Thus, in the same study, an explanation and recommendation by a physician to use the AI-based device raised the likelihood of use by 48 percent.	***Lack of interest in technology and low levels of self-efficacy affect the use of technology in health care.*** Particularly among vulnerable populations that are not used to technology, the desire to apply technology, the belief that one may affect one's own health in a positive way, and the trust that technology might support health may not be as prevalent (Barony Sanchez et al. 2022). There is also a sense of skepticism, and patients need more evidence that technology works (EPIS 2019).

Health Care Provider Perspectives

Health care provider views of digital health. Based on the limited information available on the views of health care providers on digital technology, the opinions about investments in technology for health care delivery are mixed (Table 8). This conclusion is echoed in a survey of health care providers on telemedicine services that the World Bank conducted in the Maldives to assess the readiness for telemedicine applications. While providers were supportive of such an innovation, they also expressed reservations about the preparedness of health care facilities to add telemedicine as a service.

Table 8 Technology in Health Care: Advantages and Disadvantages from the Perspective of Health Care Providers

Advantages	Disadvantages
• Harmonize out current conflicts between the increasing marketization of health care systems and professional ethical demands (Lenz 2021). • Create a deeper doctor-patient relationship (Győrffy, Radó, and Meskó 2020). • Telemedicine may reduce costs (Wernhart, Gahbauer, and Haluza 2019). • It is premature to address patient autonomy, time and resources savings, and health and behavior change promotion. More research is warranted that focuses on reducing barriers, minimizing disadvantages, and assessing the clinical value of commercially available digital health technologies (Tomasella and Morgan 2021). • Improved efficiency and effectiveness at work that benefit the patient and the institution (Sau, Jaggi, and Cairns 2019). • Empowering patients who value their independence (Nakrem et al. 2018).	• It may undermine the demand for medical autonomy, a central element of the medical ethos (Lenz 2021). • Uncertainty about whether the data can be trusted and uncertainty about the reliability of the data (Wernhart, Gahbauer, and Haluza 2019). • Concern about the unknown ways in which technology could change the doctor-patient relationship if the patient has access to the same data at the same time as the doctor (Győrffy, Radó, and Meskó 2020; Wernhart, Gahbauer, and Haluza 2019). • Barriers related to the loss of time in clinical visits because of technical issues, the lack of IT support, the lack of confidence in IT skills and knowledge, and the inability of patients to access technology (Sau, Jaggi, and Cairns 2019; Zaresani and Scott 2020.

Civil Society Views on Technology Access

Perspectives on digital access. Perspectives on digital access. A 2023 study involving 7,500 civil society voices in 136 countries identified large gaps in technology access, content, and skills (Connect Humanity 2023). The study results indicate that it is too expensive to access the internet, that the digital skills required to participate are lacking, and that security is a concern, that is, feeling safe to participate in the public forum offered by the internet.

"Taken together," Webb (2023) reports, "this means that we are excluding our most vulnerable community members from civic discourse, access to jobs, and the ability to be in virtual fellowship with others who share common interests."

Perspectives on digital health efforts. Van Stam (2022) has collected the perspectives of community stakeholders in Africa on digital health investments and found the following:

- **The need to support foundational infrastructure:** "We are devising nice ideas that we cannot implement, because the underlying infrastructure is not there" (van Stam 2022, 664).
- **The need to address fragmentation and siloed systems: "**Many donors support the health sector. The tendency has been mainly siloed data systems, siloed implementation. In most cases, these are not really interoperable, with even national systems. As a result, the health sector struggles with a lot of siloed implementations, which is mainly driven by donor funded initiatives" (van Stam 2022, 665).
- **Importance of collective development and human-centered design:** "A sustainable e-health solution is best designed and developed organically and interactively with stakeholders within the context and setting in which it will be applied and in alignment with the existing health, education, and technology enterprises" (Scott and Mars 2013, 2).
- **Use technology to solve actual health problems:** "We talk about it, but, in an African country, for instance, as in many other countries, I haven't yet seen a single digital service that I think is useful…I have not seen any digital health service that is there and is working for the people" (van Stam 2022, 666).
- **Cultural relevance and equity:** "Equity comes into play; if we adopt digital health—or any technology for that matter—we must scan the landscape, look at the communities: what do they want and what do they lack for them to be digital? Ignorance comes into play when we come in with technologies and ignore the cultures of the areas, we ignore the configuration of the communities. . . this will result in technologies not really being embraced by communities" (van Stam 2022, 666).

There is **remarkable coherence in the perspectives of the private sector, patients, providers, and communities on what should be improved to unlock the value of digital health for everyone,as follows**: expand foundational infrastructure; address fragmentation, interoperability, and integration; design with the participation of individuals to ensure relevance and encourage use; build digital skills and awareness; improve regulations to ensure trustworthiness; focus on technology that solves health sector problems; make the case for why it is valuable to ensure continued funding; and guarantee data protection and privacy. These value components should be given careful consideration in future investments to embed digital technology and data as an integral part of health service delivery and health systems.


24/7

CHAPTER 4

Looking Forward: A **Digital-in-Health** Future

"The advance of technology is based on making it fit in so that you don't really even notice it, so it's part of everyday life.."

Bill Gates

Key Messages in This Chapter

- The perfect storm of opportunity for the next wave of transformation in health care – through personalization, technology take-up and scale, and person-centered approaches – is here. The time to act is now.
- What does the future of health care look like? It is infused with embedded technology and data in a way that is both invisible and that enables preferred, personal, preventive, and predictive health care to be accessible to everyone when they want it and in the form they want.
- This requires a cultural, organizational, and behavioral transformation in health care service delivery and health care system management that typically evolve through three stages, from digitalization to digital for health, and to digital-in-health.
- Digital-in-health means considering the digital aspects of every part of health care delivery, public health, and health system management: how to design them and how they work together to create a health digisphere. Every country's health digisphere will be different and unique to the country's health system, opportunities, and challenges.

This chapter looks forward to the future of digital technologies in health and health care. It describes the latest advances in digital technology and what they mean for health. It defines the concept of digital-in-health, which is a mindset change that is needed if countries are to unlock the value for everyone.

Advances in Digital Technology for Better Health

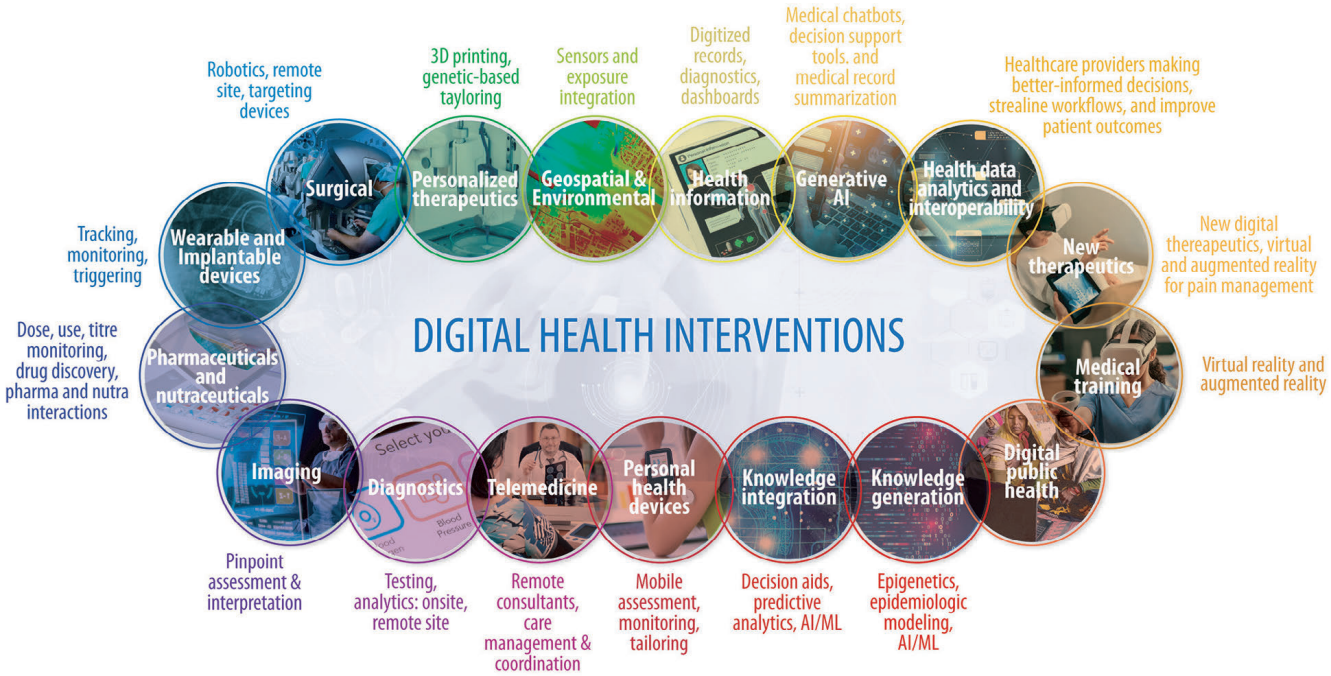
Health care is entering a period of profound and accelerated change. Much like the human body, health systems are involved in constant change: cycles of organic growth, adaptation, stagnation, apoptosis, and renewal. The change has been accelerated by the disruptions of the COVID-19 pandemic. The advances facing the health sector are beyond the introduction of a new technology or digital solution to digitalize an existing process. They are more profound. The transformation occurring in the health sector is existential: person-centered health care that embraces new medical and health discoveries, the integration of once separate disciplines, and an expanded understanding of what is necessary to live life well. Health care is about to transition into a system that

is centered on the patient, focuses on virtual and in-home treatments, and linked closely to outpatient care. Driven by data and analytics, it will prioritize value, while embracing transparency and interoperability. Enabled by cutting-edge medical technologies, it will become an integrated system (Singhal, Radha, and Vinjamoori 2022).

The period of change will be characterized by the democratization of health care and a cultural transformation in the delivery and perception of health. Technologies that are disruptive, but yet provide accessible, digital, and factual data to patients and caregivers will trigger a shift in health care culture. This change will be characterized by an equitable relationship between doctors and patients, mutual decision-making, and a more democratized approach to health care (Meskó et al. 2017).

It will also be characterized by rapid technological advances not seen in a generation. Figure 18 shows the key areas of expansion already under way. These trends represent only a glimpse of the mushrooming field of digital technology in health. One of the main areas of rapid advancement is generative AI (Box 1).

Figure 18 Burgeoning Applications of Digital Technology in Health and Health Care



Source: Based on Abernethy et al. 2022.

Box 1 The Revolutionary Opportunity (and Risk) Associated with Generative AI

In the world of artificial intelligence (AI), November 2022 was a watershed. The launch of chat generative pretrained transformer (ChatGPT) by Open AI sparked a flurry of unprecedented activity in a specific kind of AI, namely, generative AI. Generative AI is a sophisticated way of (a) predicting the next likely sequence of words or image pixels from a set of images or words and (b) pretraining a model on a large dataset so that it does not need to retrain itself every time it is presented with new query. AI thereby appears to the observer to be able to generate text or images. The two main new categories of tools are advanced AI–based conversational software and image generators.

First is the new generation of conversational software (initially, mainly chatbots), such as Open AI's ChatGPT and Google's Bard. Similar to many of its peers, ChatGPT is a conversational software chatbot, that is, a computer program that responds to a question (or prompt). It is special because it relies on advanced data analytics—neural networks—and a vast amount of publicly available data to formulate responses. Because ChatGPT and other, similar generative AI tools have been established with a certain level of randomness, the same question will yield a different response at each pass. The generative pretrained transformer depends on algorithms that have already been trained in language structure on large datasets, and, so, it does not need significant new data for additional prediction. The generative AI analytical engine has great potential in health care and health systems, especially if it has been trained on medical texts and images and has a foundational medical language in which it can communicate.

Second are AI image generators, including Dall-E and Stable Diffusion. These represent another family of generative AI software that can produce original images from scratch once the image has been described in words, or it can extract text from images. Thus, it can interpret images and explain them in words or create images based on word descriptions.

These technologies have application potential in the health sector, particularly because the analytical engines that underpin generative AI tools are pointed inward using health records and other medical data. Applications require careful thought. These tools can augment the efforts of health workers and health system managers and streamline how services are provided. So, they are augmented intelligence tools rather than AI tools. Three specific areas in which early adoption is most likely, particularly in low- and middle-income countries, are all related in some way to the summarizing of information, as follows:

- **Joining, summarizing and querying various types of disconnected health records.** One can use these tools to read, interpret, summarize, and query a wide variety of medical records that are in systems that are not interoperable or even in the same format. In one example, 30 pages of different types of medical records from

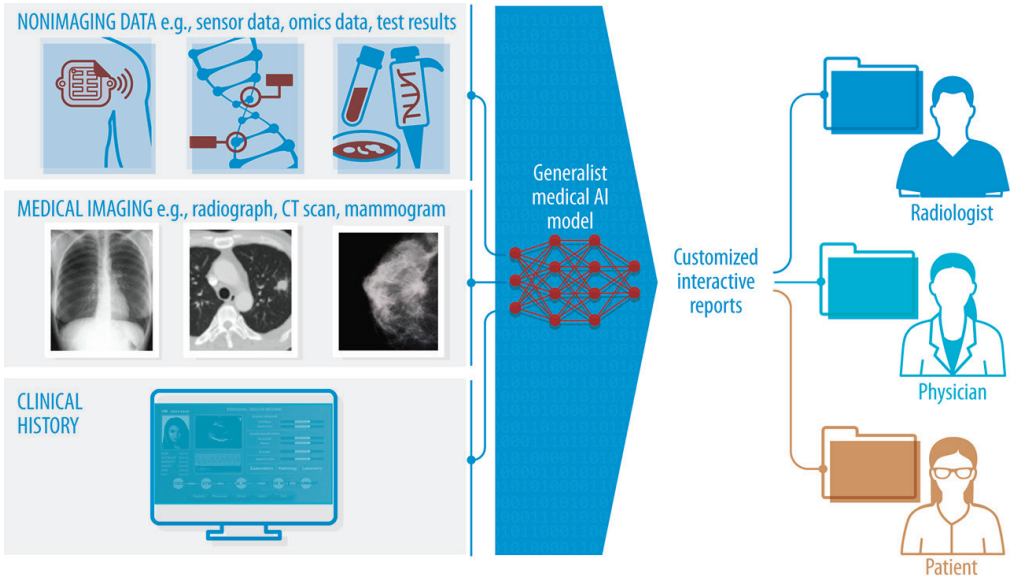
Box continued...

Box 1 The Revolutionary Opportunity (and Risk) Associated with Generative AI (continued)

one patient (from an EKG readout to prescriptions to a doctor's clinical notes to a patient's self-completed medical history) was summarized in a one page clinical summary by the generative AI tool in a matter of seconds (Elizarov 2023). And, in another example,[1] a generative AI model is used to extract medical data from a variety of PDF files and handwritten documents through a query function. This family of AI tools can immediately help solve the conundrum of legacy systems and combinations of paper and digital medical records.

- **Supporting clinical decision-making, specifically among front-line workers and in areas of health care with more repetitive functions such as radiology.** There is an acute shortage of radiologists in low- and middle-income countries. Rajpurkar and Lungren (2023) show how generative AI tools may be used to collect and summarize inputs from radiologists, physicians, the AI tool, and a patient medical records to support more highly informed choice (Figure 19). Lång et al. (2023) examine the results of one of the first-ever randomized control trials comparing AI and radiologists. In their prespecified clinical safety analysis, they show how AI-assisted screening detected breast cancer at the same rate as standard double readings by radiologists working in pairs, while simultaneously reducing the screen-reading workload of radiologists by an impressive 44 percent. They conclude that AI-based breast cancer screening is safe.

Figure 19 Use of Generative AI in Radiology



Source: Rajpurkar and Lungren 2023

Box continued...

[1] Rikai: Lazarus Forms (dashboard), LazarusAI, Lazarus Enterprises, Cambridge, MA, https://www.lazarusforms.com/rikai.

Box 1 The Revolutionary Opportunity (and Risk) Associated with Generative AI (continued)

- **Accurate and conversational medical chatbots as entry points to health care**. COVID-19 unleashed a rush in many countries to set up telemedicine services. If medically accurate chatbots were available for initial triaging and trusted by the public and providers, they could make telemedicine more effective. A medical chatbot could perform the first level of triage, prior to referral to a health facility (if needed). This would make medical chatbots the future entry points to health care.

Because these generative AI solutions are pretrained, they do not require large datasets, complicated machine learning, or high-level skills to operate. This significantly reduces the barrier to entry in low- and middle-income countries. However, with potential promise comes potential peril. Real challenges need urgent responses, and many of these apply more broadly to AI systems beyond generative AI, as follows:

- **Regulation.** Medical devices that use AI to derive (potential) diagnoses or recommend treatments need to be subject to rigorous regulatory processes akin to pharmaceutical approval processes (regulation either as medical devices or as medical products). Such regulatory systems are nascent in many low- and middle-income countries. Regulatory mechanisms should also include human-in-the-loop principles to implement practices that allow for humans to have oversight in validating models and removing the black box nature of AI models (Buckley et al. 2021).
- **Trust.** These tools will only enjoy widescale use if they are trusted and valued as an integral part of the health care delivery network, augmenting the work of health workers, making their jobs easier, and allowing them more time with patients, that is, if they facilitate augmented intelligence among health workers and clients of health systems.
- **Data protection**. Patient privacy will be more at risk than ever in what could be a rush to bring all the disparate medical data together. It's important to ensure that personal data is used only for limited and identifiable legitimate purposes, that only data that are necessary for the purpose are collected and processed, that data subjects have certain rights over their data, and that data collectors and processors have certain obligations in handling personal data.
- **Knowing who's who in a health system.** Without unique identifiers that enable medical records to be linked to individuals and across the locations where the individuals have received health care, usefulness will be limited.
- **Bias.** The biases in AI systems and the ethics surrounding the development and use of these systems have been topics of long-standing debate. Addressing the biases in AI systems, including in generative AI, will require steady research to

Box continued...

Box 1 The Revolutionary Opportunity (and Risk) Associated with Generative AI (continued)

understand and remove the biases, regulatory mechanisms to establish responsible processes for mitigating risks, medical education, and improvements in access to representative and high-quality health data (Arora and Arora 2022).

- **Narrowing the digital divide.** The more rapidly new technologies are introduced, scaled up, and used, the narrower the divide between these tools and the versatility of many health care systems in low- and middle-income countries.

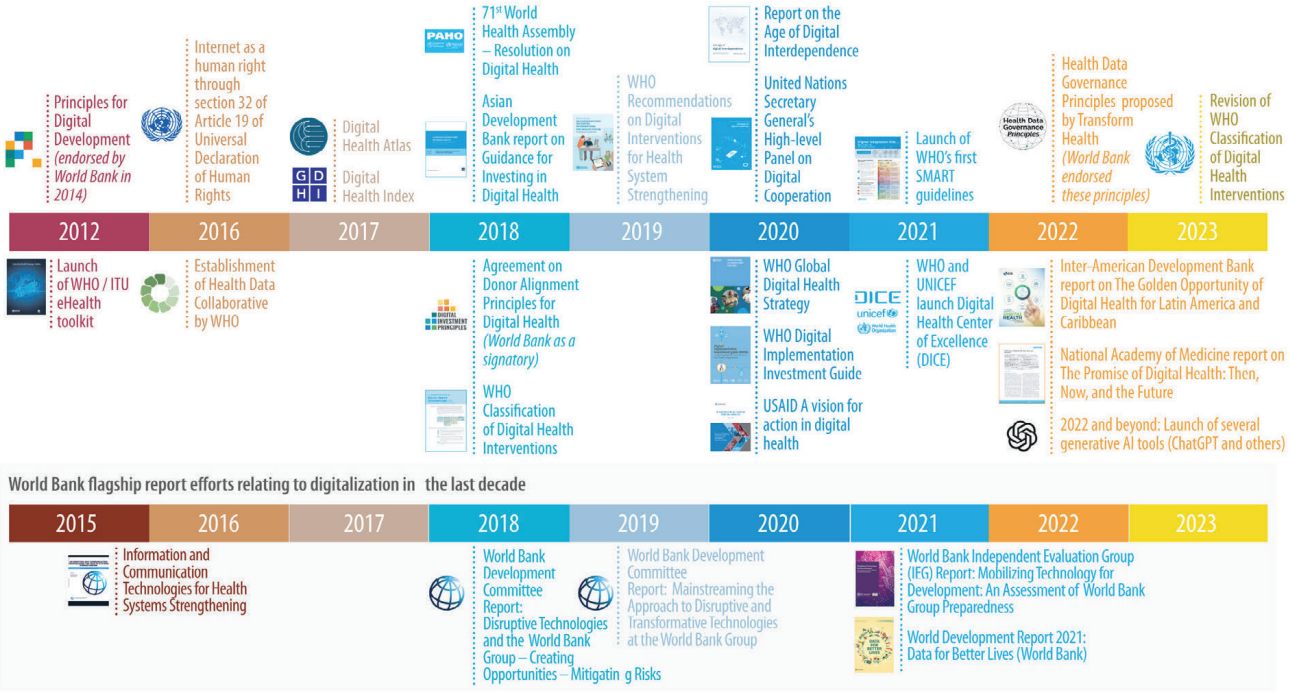
In considering the potential of AI, the climate dimensions should also be considered. There is a growing dialogue on the awareness of climate issues throughout the health sector in regard to the development and use of digital technologies[2]. AI technologies typically require significant computing power, which is energy intensive. What frameworks are available to support the intelligent procurement of digital health equipment that is financially feasible and environmentally safe and that is associated with recycling programs that adhere to ecologically sound practices and are easy to implement? Where are the biggest impacts that can be made and what needs to be considered in including sociotechnical factors among the impacts, such as safety and community and social environmental justice? If frameworks, guidelines, and tools are created, where can people access information to estimate environmental and financial sustainability in terms of the investments they have made? For hospitals or health care centers that cannot afford to pay for such information, how can change be empowered and facilitated? How can one propose finding supplier information on environmental impacts if there is no access to such information because a company does not supply it? Not much data are available in product or software life-cycle work that describe the environmental impacts of storing or processing data beyond the energy costs of data centers and the rare materials used in digital devices, making it difficult to know what to do.

[2] "The Role of the Health Community in Climate Action: Taking Stock and Moving Forward," 76th World Health Assembly, Session 3, World Health Organization, Geneva, May 24, 2023, https://www.who.int/news-room/events/detail/2023/05/24/default-calendar/the-role-of-the-health-community-in-climate-action-taking-stock-and-moving-forward.

As health systems undergo this next wave of transformation to reduce inefficient processes incrementally and deliver new, better and seamless services, technology and data will be an integral part of the process. But technology will not drive the change. It will support, augment, and accelerate the changes that health systems will continue to undergo. The accumulation of data on health and health systems in a country, the information systems that manage these data, and the digital technologies that generate and use the data to deliver or improve care all need to work in concert and as an embedded, infused part of health systems. A country's data on health, HISs, and digital technologies can be thought of as a country's health digisphere.

A country's health digisphere is the hub of all data and digital technology related to health in a country. Digital health can be understood as a combination of the following: (a) data on health (including health sector data and data outside the health sector), (b) the ecosystems of HISs and e-health, (c) digital technologies, and (d) digital health interventions that support health care delivery and health system management. This constitutes the health digisphere, which should be managed in an integrated way (Figure 20). How a government and stakeholders organize the health digisphere and what they allow to be included are instrumental in their ability to reap the benefits of digital technology that is infused in and an integral part of health services and health systems.

Figure 20 The Health Digisphere: Health Data, Information Systems, Technologies, and Interventions

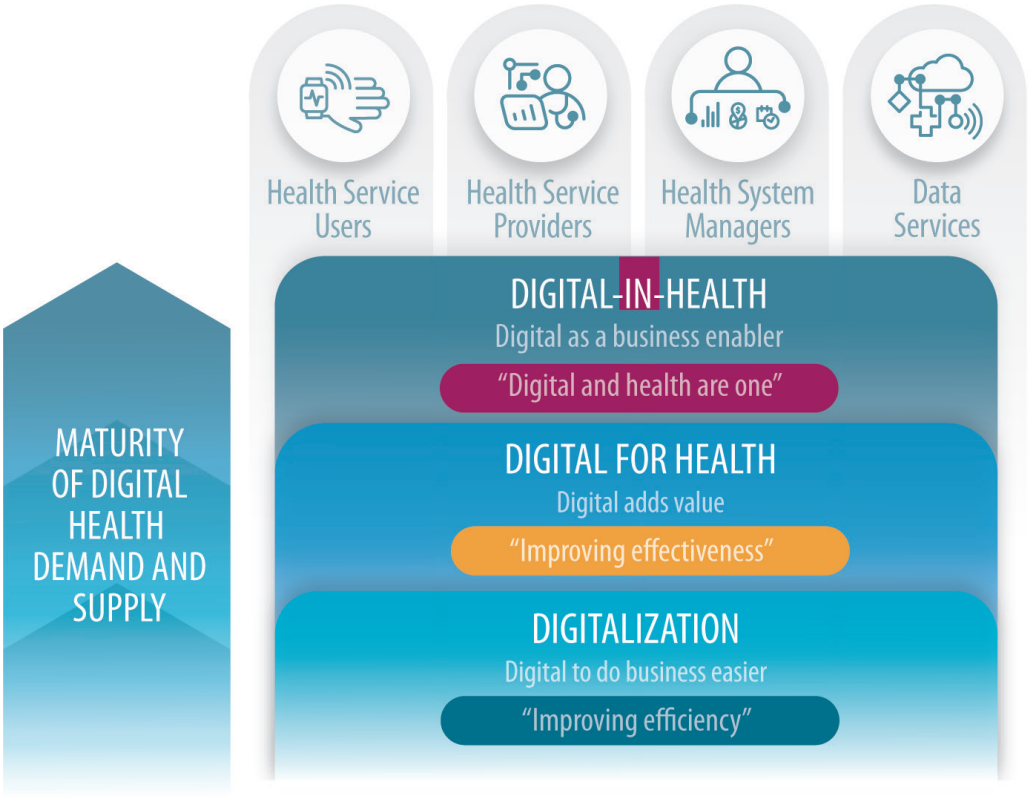


What Is Meant by Digital-in-Health

As demand for digital technologies in health grow, the supply will mature too and change. Almost all financial transactions today have a digital component though not all are included under the heading digital banking. Cell phones have become ubiquitous, but they are not always referred to as digital communication. As the demand and supply of digital technology grow and mature, they become more embedded and invisible. The same will occur in health and health care. The health digisphere will fuse into health systems,

invisible yet active in all aspects of public health, health service delivery, and health system management. It will become part of and accelerate the cultural, organizational, technological, and behavioral evolution of health systems. As the demand for digital technologies in health grows, the supply will mature and change. This growth and maturation will take place in three stages: from digitalization to digital-for-health and from digital-for health to digital-in-health (Figure 21).

Figure 21 From Digitalization to Digital-in-Health



Source: Adapted from Nolan and Croson 1995; Wiggers, Kok, and de Boer-de Wit 2004.

Stage 1: **Digitalization: focus on data, reporting, and process efficiency.** The focus is typically on creating HISs, connecting health facilities, and collecting digital data from health care providers so they can use the data in reporting to health care managers and in insurance claims. The focus is on data and the digitalization of existing work flows and administrative processes not to change or improve them for better health outcomes or health system performance. At this stage, the demand and supply of digital health are rudimentary, and ministries of health tend not to pay much attention. ICT

is mostly viewed as a cost in the health system. The potential value added of ICT beyond process efficiency is not recognized, visible, or valued. Indeed, digitalization can increase transaction costs and technical debt in the short term. Virtually all countries have started here, and this is what much of the financing for digital health have focused on to date (see Chapter 3).

Stage 2: **Digital-for-health: a focus on isolated digital health solutions**. In this stage, the focus expands from digitalizing data and supporting administrative processes to integration and the effectiveness of clinical and administrative processes. Data and technology become part of daily operations and lay the groundwork for the transformation of health care service delivery, financing, and behavioral and regulatory models in the public and private sectors. Value is possible in terms of the quality, scope, and scale of the services provided. Costs related to digitalization rise because digitalization transforms processes and work flows. Digital technology and data are recognized as factors in the success of operations and in reaching health care system goals. The demand for digital technology and data matures. Business processes become technology dependent because they are typically reengineered around technology. The optimization of ICT infrastructure and ICT-related cost reductions are also part of this stage. Many countries are at this stage, that is, Global Digital Health Monitor (GDHM) maturity levels 2–3.[3]

Stage 3: **Digital-in-health: technology and data become indistinguishably embedded and assimilated in transformed health systems and health care.** In this stage of growth, digital technology and data have become fully embedded in health systems. As part of a whole-of-health-system approach, they are embedded in health delivery and management and become a person-centered health enabler. New modalities of health service delivery and even new health services become available. The health care system deploys effective mission-critical digital ecosystems that integrate, accelerate, and improve the quality of person-centered health care. High-quality health care requires digital technology and data. Service delivery models and processes are transformed. They become readily able to adapt to changing health care needs and new modalities of service delivery. They respond with resilience to emergencies. Separating digital health strategies from health care strategies is no longer possible. At this stage, digital technology and data are an organic foundational block that enhances the ability and desire of individuals to manage and improve their own health.

[3] GDHM (Global Digital Health Monitor) (dashboard), GDHM, Washington, DC, https://digitalhealth-monitor.org/. Also see Annex D.

Demand has matured dramatically, which triggers the supply of more highly sophisticated digital health solutions (GDHM maturity levels 4–5).

Digital-in-health is a cultural and structural evolution in the way health is achieved. It is the antithesis of using ICT to support health care systems, digitalizing health data, or creating digital solutions for existing (inefficient) health services without changing these processes. With a digital-in-health mindset, the focus shifts from supporting providers and systems to personalized care, citizen engagement, and patient empowerment (Table 9). Digital-in-health facilitates a holistic approach to health whereby healthy living, prevention, public health, and health care are parts of the same integrated and distributed continuum, which is fragmented but connected.

Table 9 How Is Digital-in-Health Different from Digital Health

 **Digital health in the past and today**		 **Digital-in-Health in the future**
The use of ICT for health	→	The cultural and structural transformation of health care service delivery and health care system management
Focus on providers, medical records, and integration	→	Focus on patient engagement and empowerment: personalized holistic view, reach everybody, real-time data collection, patient-reported outcomes
The domain is within the health care system: focus on diagnosis and treatment	→	Healthy living, prevention, and health care are one: focus on prevention and management
Provider and supply focused	→	Person and patient focused
Individual solution focused	→	Interoperable system focused
Focus on the technology	→	Focus on the problem that is to be solved
Focus on the creators of the technology	→	Focus on the users of the technology
Immense fragmentation	→	Less fragmentation and increased connection across interventions
Pilotitis of digital health interventions, that is, excessive small pilot projects without scaling-up	→	Focus on widespread implementation and maintenance
Donor-driven	→	Government- and stakeholder-led
Digital health outside of mainstream delivery	→	Digital health embedded in every aspect of health care delivery and health system management
Digital health strategy separate from health strategy	→	Digital health aspects included in the health strategy

Table continued...

Table 9 How Is Digital-in-Health Different from Digital Health (continued)

Digital health in the past and today		Digital-in-Health in the future
Alignment with wider e-government and digital transformation efforts is accidental	→	Strategic alignment between government-wide transformation efforts and digital-in-health efforts
Generative AI and AI in general are not part of the system	→	AI used in strategic ways in the cases that make the most sense and with regulations and safeguards firmly established
Value of digital technology and data is assumed	→	Value of digital health investments quantified and estimated prior to investments and established through proper metrics
Disparate and disconnected health datasphere	→	Connected and linked health data sphere enabling individuals to access health data and data about health
Health digisphere is conceptual, incomplete, and fragmented	→	Health digisphere is a connected and interoperable ecosystem that is trusted by persons to access and protect their health data, deliver seamless health services, and improve their health

What Digital-in-Health Means in Individual Contexts

In the following, the application of the digital in various parts of health system management is described: digital in health financing, digital in health service delivery, digital in pandemic preparedness and public health, digital in nutrition, digital in pharmaceuticals, digital in clinical care, digital in supply chain management, and digital in health research.

Digital in Health Financing

KEY CHALLENGES: Lower-middle-income countries typically struggle with chronic failures in the three core health financing functions (WHO 2021a, World Bank 2022c):

- **Resource mobilization:** the mobilization of financial resources to develop and operate a health system. Contributions are typically derived from individuals,

households, and firms, and, in some countries, from external sources, often in the form of development assistance for health.

- **Pooling:** the accumulation of prepaid resources (for instance, taxes and government charges and insurance contributions and premiums) to pay for health services, spreading the financial risks of illness and medical expenses and increasing access to needed services among people who are eligible for coverage from pooled funds.
- **Purchasing:** the allocation of funds to obtain individual and population-based health services and secure system governance and other cross-cutting essential public health functions. Purchasing can mean paying for required service inputs by paying providers for the delivery of services. Purchasing decisions determine the services that are available, where, for whom, at what quality, and delivered with what mix of inputs and at what costs.

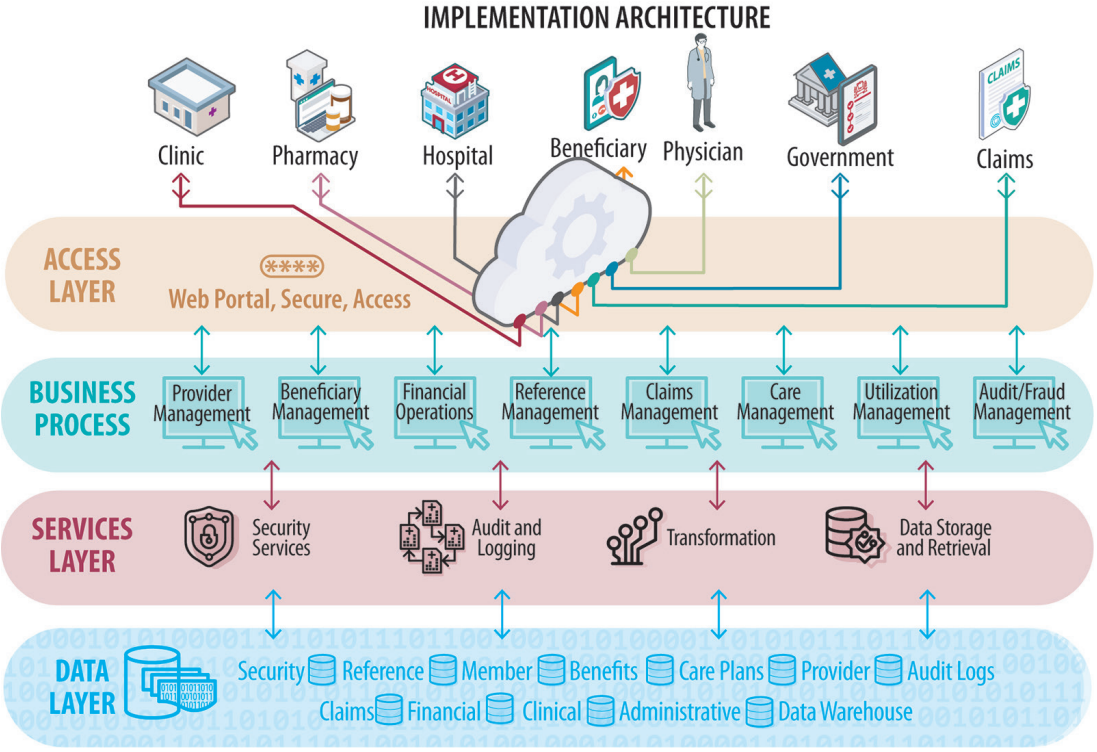
CURRENT STATE OF PLAY: Traditionally, siloed digital solutions are developed within each area to improve efficiency and effectiveness. Digital in health financing means deploying digital technologies to enhance the efficiency and effectiveness of health financing functions and contribute to the realization of UHC. A major struggle today involves how to provide relevant and accurate data for typical provider payment mechanisms, such as repositories of used resources for line-item budgets, clean lists of patients, and empanelment for capitation-based methods, diagnosis-related group case reporting, and so on. On the side of pooling and resource mobilization, lower-middle-income countries are investing in budget management systems and social insurance premium collection systems, making sure the registries of insurees are robust and the convenience of electronic payment creates opportunities for the improved collection of funds.

Current systems that provide data for various provider payment mechanisms are usually disconnected from clinical information systems requiring separated lines of reporting that not only lower data quality in terms of connecting administrative data to clinical data, but also create additional bureaucratic burdens among providers. In health financing reform, data (mis)management can be a decisive factor in reform failure. For example, in Kosovo, a major health financing reform in primary care was delayed for almost two years because of an underestimation of the capability of information systems to provide sufficient data for results-based indicators.

FUTURE USES: In the future, modern financial management information systems are envisaged that involve the real-time integration of transactional clinical data that can improve the capacity of payers to manage health financing resources by consolidating

the budget and monitoring expenditure flows across schemes, which are critical for balanced budgets, compliance, governance, transparency, and accountability (Hashim, Farooq, and Piatti-Fünfkirchen 2020) (Figure 22).

Figure 22 An Integrated Information System for Health Financing



Source: Wilson et al. 2013

In purchasing, analyzing health payment data provides opportunities to identify inefficient spending, such as payments for unnecessary care (referrals, visits, laboratory tests, and so on), failure to adhere to best practice, duplication of services, nonoptimized drug prescriptions (for instance, less use of generics than expected), nonoptimal use of infrastructure and medical equipment, low workforce productivity, detectable high-cost centers (for example, populations with high numbers of readmissions, overprescribing centers), errors (such as coding, claimed services not linkable to medical conditions), and fraud. In combination with clinical data, health financing data may also provide a foundation for evaluating provider performance and the quality of care, enabling new payment models based on the value of care.

In the future, payers may rely on digital solutions to optimize resource allocation, improve efficiency, and reduce waste. Digital technologies will allow payers to cut

administrative costs by streamlining legacy administration processes. Self-service tools, paperless communication, and automated sales support processes are examples of areas wherein administrative cost savings may be generated. They accounted for 35 percent–40 percent of the impact of digital transformation among payers in the United States. Furthermore, analyzing collected health data enables payers to identity opportunities for cost savings deriving from improved capacities in analytics and financial and risk management. From a population's perspective, innovative digital public infrastructure (DPI) approaches, such as the unified payment system in India or the M-PESA system in Kenya, could enable a population to pay for health services in new ways, allowing people to vote with their feet by showing their preference and willingness to pay for care at higher-quality facilities.

Digital in Health Service Delivery

KEY CHALLENGES: Governments and health care providers face a variety of challenges in the delivery of health care. In low- and middle-income countries, where 80 percent of the world's population lives, malnutrition and infectious diseases account for significant numbers of premature deaths. Many people in low- and middle-income countries do not receive even basic health care. Health facilities are often located in urban areas, far from rural areas and frequently difficult to access by public transportation. The care that is provided can be costly and substandard (Brandeau, Sainfort, and Pierskalla 2004). Most middle-income countries are faced with a double disease burden. As infectious diseases and infant and maternal mortality decrease in a nation, middle- and higher-income urban households suffer more from chronic illnesses, while lower-income households and the rural population continue to suffer primarily from infectious diseases (Hsiao and Heller 2007).

CURRENT STATE OF PLAY: The Lancet Global Health Commission on High-Quality Health Systems has documented the urgent need to improve quality at scale and to move from microlevel quality improvement to macrolevel reform (Kruk et al. 2018). Digital in service delivery enhances all these efforts. It utilizes technology as a foundational cross-cutting enabler for high-quality care and data for decision-making and optimized logistics to meet current and future challenges. The use of digital technology is already infused in many aspects of health and health care. In a future of digital in health for service delivery, this means the adoption and integration of digital health solutions that are fully embedded and integrated into every aspect of health service delivery (Snowden 2020).

Accelerated by the COVID-19 pandemic, the paradigm shift in health service delivery toward digitally enabled care is approaching (WHO 2020a). The COVID-19 pandemic

has demonstrated that digitally enabled care and health service delivery and remote care are increasingly important in achieving UHC (Walcott and Akinola 2021). Digitally enabled care requires substantial coordination among many types of care across many types of health workers in separate locations and at different times. The digitally enabled care model offers patients coordination of in-person and virtual visits, which are fully integrated with the care journeys of patients based on precise clinical needs and appropriateness. This high degree of coordination and integration demands not only significant interoperability among underlying electronic health records and digital health solutions used by the care teams, but also robust telehealth solutions that are able to support real-time connections seamlessly among patients and care teams. For example, health data created during virtual visits should be included in patient electronic records and be accessible to the primary care providers or at any entry point of contact with a health system.

While health care is historically delivered in person, improvements in connectivity and advances in IT, telehealth, and telemedicine programs have started to shift this traditional paradigm. Implementation in various health systems now occurs among targeted populations, such as populations in remote areas or in cases of specialized disease categories (Kimble 2015). Digitally enabled care also expands the narrowly focused clinical interventions of traditional telehealth programs to a holistic approach, including digital therapeutics, pharmacy management, and the remote monitoring of persons at home, thereby expanding the concept of a hospital from a physical building to a range of health services, some of which can be provided through remote monitoring. In addition, digitally enabled care expands health data collection beyond traditional health care facilities because data may also be supplied from home-based monitoring devices, static sensors, personal health records, and virtual visits.

FUTURE USES: In the post-pandemic era, continually improving the delivery of health care services and health outcomes requires reimagining and reforming the health system. The future of service delivery will evolve to become patient-centric, virtual, ambulatory, delivered in the home, value-based and risk bearing, driven by data and technology, transparent and interoperable, enabled by new medical technologies, and integrated, yet fragmented (Singhal, Radha, and Vinjamoori 2022). As with the vision of digital-in-health, technology and data are an organic foundational block supporting the ability and desire of individuals to manage and improve their health. The future of appropriate and effective health service delivery will apply digital health to ensure that health systems are characterized as follows:

- **Future-fit:** Resilient, anticipating and adapting to dynamic contexts, challenges, needs, and risks

- **Holistic:** Embodying a problem-solving approach that interrogates interlinked root-cause issues to identify leverage points for high-impact, quality interventions
- **People-centered:** Prioritizing the perspectives, preferences, and needs of people and communities and building trust
- Excellence in evidence and operations research: Filling evidence gaps, adopting an investment perspective, undertaking impact evaluations of digital transformation in health

In providing convenient, timely, and efficient access to health care, digitally enabled care offers the promise of transforming health care delivery. By becoming future-fit, holistic, and people-centered, digital in health service delivery will enable models and processes to adapt easily to changing health care needs and new methods in service delivery and become resilient in responding to emergencies. To realize the digital-in-health vision, health delivery networks will have to undergo a cultural and structural evolution in the way good health is achieved. This means that health systems must adapt to become holistic, future-fit, and people-centered, but also share the focus of providers and systems in supporting individuals while achieving personalized care and fostering citizen engagement in virtual and ambulatory care, that is, empowering patients.

Digital in Health Sector Supply Chain Management

KEY CHALLENGES: According to WHO, about one-third of the world population lacks access to medicines, vaccines, and other essential health products. Such products represent the second-largest expenditure item and the largest component of private health expenditure in low- and middle-income countries. The difficulty in accessing high-quality health products, the introduction of bogus medical products on the market, rising medicine prices, shortages of essential medicines, poor logistics, waste, and inappropriate use of medicines pose severe inefficiencies and high costs in heath care service delivery (WHO 2020b).

CURRENT STATE OF PLAY: Today's supply chain information systems play a critical role in access to quality medicines and health care products, but are often siloed, do not track, end-to-end, the delivery of good medical products, equipment, or drugs, and serve mainly inventory and reporting functions.

Many health care organizations have developed the practice of acquiring essential medical supplies and equipment, storing vital medications, meeting medical needs, and scheduling patient treatments without coordinating and synchronizing those

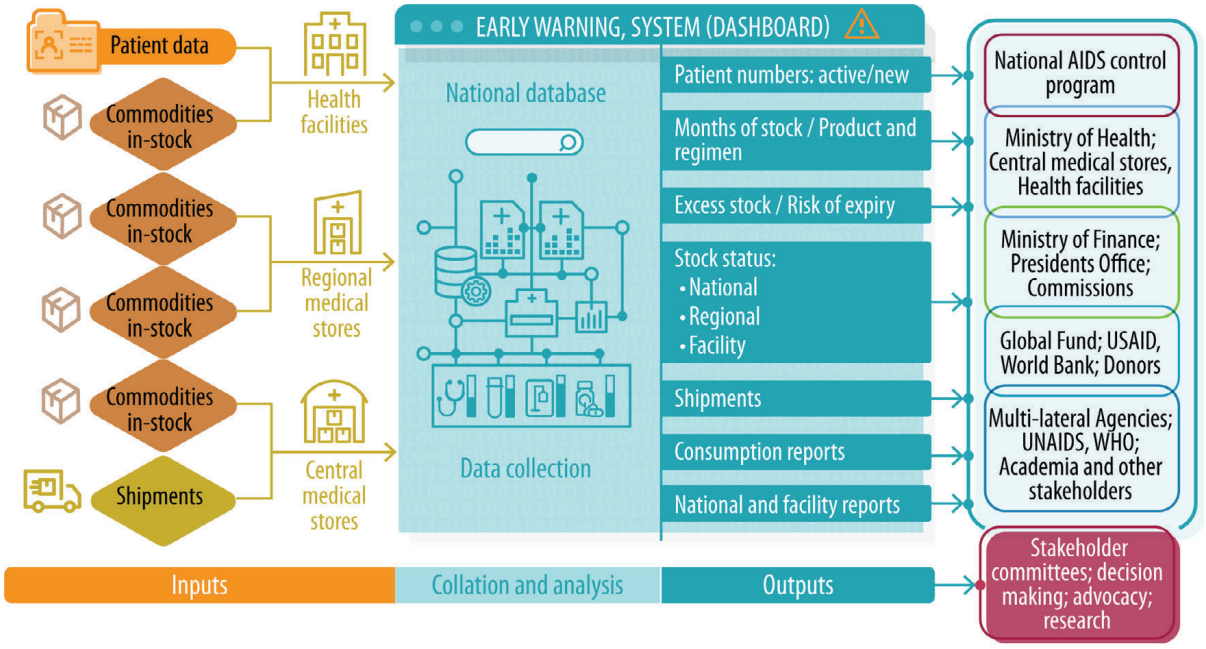
actions. Professionals in the supply chain are finding it difficult to keep up with the vast amounts of data that are needed to create an integrated, efficient, effective, and agile supply chain in today's complex, connected world (Painuly, Sharma, and Matta 2023, 569).

Given the high volumes of data , the potential for data connectivity, and the level of standardization that supply chain management typically entails, the area is ripe for an exponential rise in value through digital interventions.

FUTURE USES. The future role of digital in supply chain management is likely to focus on four main core areas of growth, as follows:

- **Greater integration of traditional supply chain data and other data** to help inform predictions of future needs: Instead of today's siloed systems, digital in supply chain management will involve end-to-end digital platforms that triangulate data from various sources, including nontraditional supply chain data on patients and products, geomapping, procurement, facility demand, and stockouts. In Mali, the Outil de Suivi des Produits de la Santé (health product monitoring tool) has been developed, conceptually, as an end-to-end solution to meet the needs of the context (Figure 23)

Figure 23 Conceptual Design of Mali's OPSANTE Supply Chain End-to-end Digital System



Information flow at the three levels would feed into the dashboard with the aim to serve as an early warning system for products at risk of stockouts. The various stakeholders shown at the right are consumers of aggregated data for appropriate decision making

Source: Adapted from Konduri et al. 2018.

- **More real-time information about supply and demand:** Data are more well integrated and available end to end, from demand to procurement to national traceable source and supply, storage, distribution, local supply, stock levels, and restocking requests. These data should enable more real-time information to be used to make supply-related decisions and generate savings.
- **More augmented decision-making:** With wider data availability, more predictive and augmented decisions about future supply needs become possible and lead to the development of supply chain decision support systems.
- **Better standardization and traceability:** End-to-end systems facilitate greater standardization and better traceability, from origin to use, in supplies and commodities and reduce substandard and counterfeit products and medicines. Digital technologies are game changing in this process. They include medicine authentication tools, such as mobile apps and messaging services, barcoding in drug safety alert systems, web-based drug safety alerts, radio frequency identification tags, databases to support visual inspection, digital aids to enhance the performance of quality evaluation kits, reference libraries for the identification of bogus or substandard medicines, and quality evaluation kits based on machine learning for field testing (Rasheed, Höllein, and Holzgrabe 2018).

Digital in Clinical Care and Health Research

KEY CHALLENGES: Several challenges stand in the way of delivering clinical care services, from timely and accurate diagnosis of health problems to the discovery of new treatments and to prevention. Two key areas in clinical care in which digital innovations hold great promise for transformation are drug development in the pharmaceutical industry and digital diagnostics.

Timely and accurate diagnosis is critical to providing effective patient care and enabling targeted pandemic preparedness and response. Digital diagnostic tools can improve equity in access to diagnostics by addressing health care gaps in low- and middle-income countries, where accessibility is poor (Fleming et al. 2021). Yet, significant gaps exist in access to diagnosis and imaging. It is estimated that close to half the world's population has little to no access to medical diagnostics. The gap is pronounced especially in primary health care. In 2020, the Global Diagnostics Alliance conducted an analysis across four countries to determine barriers to diagnostics access (FIND 2020), as follows:

- **Barriers among patients and other individuals.** Difficulties in navigating a fragmented health system; high out-of-pocket costs in the private sector after avoiding the public sector because of a perception (and often the reality) of poor

quality or lack of convenience in the public sector; low value (such as convenience, quality of service, certainty) for the patient despite their efforts (time and cost) in seeking diagnosis and care, which reduces their trust in the health system and discourages future care-seeking behavior

- **Barriers among health care workers.** Lack of knowledge on point-of-care diagnostic tools; long wait times for sample collection and receipt of test results; difficulties in navigating care-seeking steps (screening to treatment and monitoring); poor-quality diagnostic tests, equipment, or infrastructure; and paper-based tools that prevent the easy reporting and use of data
- **Barriers within health programs.** Lack of interoperability across systems; lack of guidance or evidence in the effort to select the most cost-effective digital diagnostic technologies for the specific context; and lack of visibility in supply chain data on diagnostics

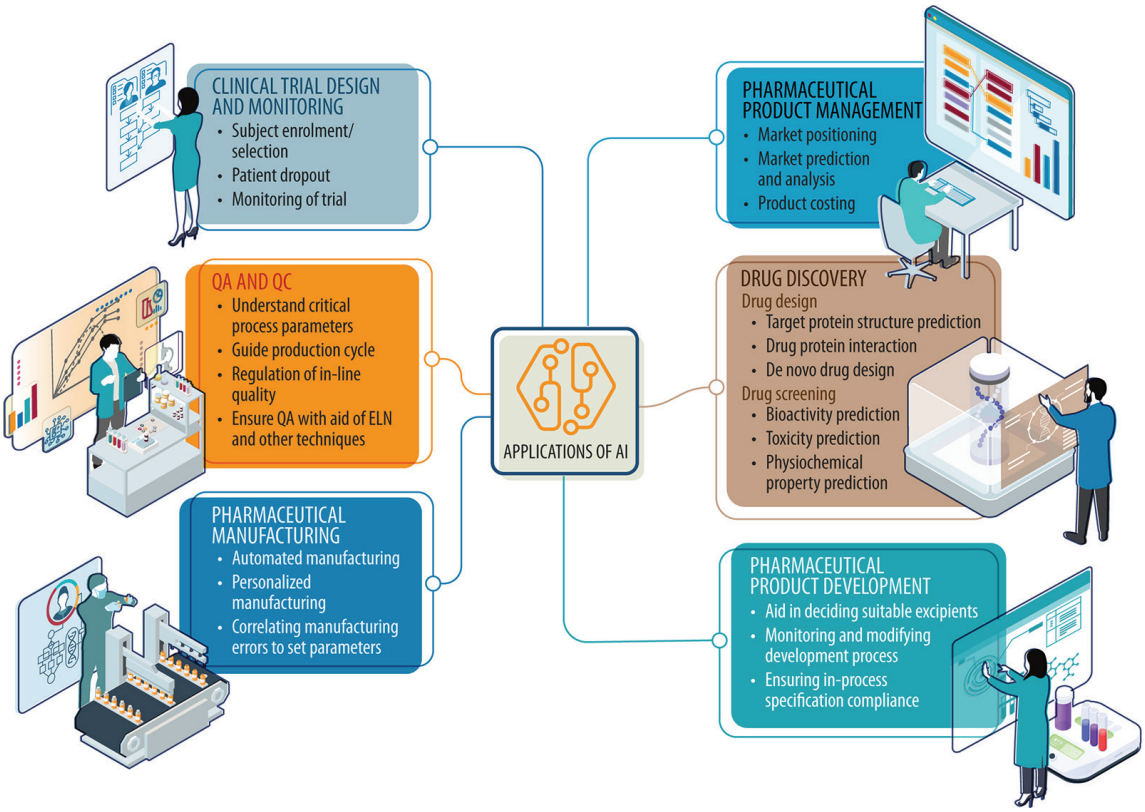
Digital diagnostics and imaging can help to address these gaps and barriers. Examples of digital innovations that have successfully addressed some of the gaps listed above include clinical decision support tools that guide health workers in administering appropriate tests and treatment, AI-powered portable chest X-rays that enable improved and faster diagnosis, connected diagnostic devices that automate data transmission to lab information systems and surveillance systems

Clinical research and drug development in the pharmaceutical industry. Despite billions of dollars spent on drug development and clinical research trials, as of 2015, drug development had a success rate (drugs to market) of slightly more than 8 percent. Careful study participant selection—using biomarkers or other data—will yield higher success rates (Wong, Siah, and Lo 2019). Conceptualization to bringing a new drug to the market takes, on average, 10 to 15 years with a US$2 billion price tag (per drug). If the success rate could be increased and the duration and cost shortened, it would bring immediate value to the sector. The last decade has seen significant developments in how digital technologies have become embedded as part of everything, from more deliberate study participant selection to poly-pharmaceutical interactions and managing clinical trials.

Frontier technologies will take center stage in drug development and clinical trials. Because of the high stakes and high volume of data to manage (from genomics data to quaternary protein folding structures), the next frontier is the use of AI (Figure 24) for building systems that are faster and adaptable in comparison with conventional methods (Kennedy 2023). These innovations will help discover potential new drugs, repurpose existing drugs, anticipate interactions with other drugs (polypharmacy), better screen suitable participants for clinical trials, and undertake quality assurance

and monitoring of adverse events (Paul et al. 2021). Recognizing these potential use cases, the US Food and Drug Administration has recently published a discussion paper with proposed future governance and guardrails to using AI and machine learning in drug development.[4]

Figure 24 Areas in Which Artificial Intelligence Is Being Used in the Drug Development Cycle



Source: Based on Paul et al. 2021.
Note: ELN = electronic laboratory notebook; QA = quality assurance.

Other forms of health research will also benefit from digital technologies: Being able to better screen study participants, use new forms of data to measure outcomes, or streamline intervention design because of rapid literature reviews are all ways in which health research, writ large, will benefit from the potential of digital integration into how health research is done.

[4] See Artificial Intelligence and Machine Learning (AI/ML) for Drug Development (dashboard), Food and Drug Administration, Silver Spring, MD, https://www.fda.gov/science-research/science-and-research-special-topics/artificial-intelligence-and-machine-learning-aiml-drug-development.

FUTURE FOCUS. Digital diagnostic tools and imaging can increasingly be used to optimize limited resources, improve equity of health care access, improve availability of quality diagnostics, and support targeted programmatic intervention. Beyond pharmaceutical drug development, AI also has a role in fostering a better understanding of (a) diseases from a molecular network and genomics perspective; (b) functional foods such as peptides and other nutraceuticals and their impact on health, as adjunct therapy to pharmaceuticals, and on each other (Doherty et al. 2021); and (c) how nutrient profiles and nutraceuticals can be used alongside pharmaceuticals to predict disease severity and personalized supplementation regimens. Digital in the pharmaceutical and nutraceutical space has the potential to result in higher discovery success rates, shorter times until drugs are brought to market, and lower costs in doing so, enabling lower drug costs. Governments have a critical role to play in regulating how genomics data of citizens—the code of life—are used if AI platforms are used as part of the drug development cycle.

Digital in Nutrition

KEY CHALLENGES IN NUTRITION: Malnutrition in all forms, ranging from undernutrition (stunting and wasting), micronutrient deficiencies, and overweight or obesity, impacts millions across the life cycle. Its current trends are worrying, and malnutrition is directly or indirectly associated with major causes of death and disability worldwide. Malnutrition is intrinsically connected to human capital: undernutrition contributes to 45 percent of child mortality; iodine deficient children lose up to 13 IQ points; and stunting (low height for age) is known to be associated with lost productivity and earnings in adulthood (Shekar et al. 2017). Furthermore, one adult death in five can be attributed to dietary risk factors. Key drivers of malnutrition are not only direct ones, but also include several underlying factors, such as food insecurity, high food prices, resulting in hunger, unhealthy food marketing, unhygienic environment, climate change shocks, social disparities, gender inequality, harmful traditions and cultural practices, limited resources, and policy inertia (Tufford et al. 2020). Addressing nutrition challenges requires interventions that need to be delivered at scale, utilize multisectoral approaches, and address the multifaceted aspects of nutrition, from policy to community-level actions. Some of the challenges in the scaling up of nutrition interventions are the need for innovative tools and development of capacities to reach communities and vulnerable families, the need for adequate and strategic nutrition financing, and the need for nutrition-related data for evidence-based policy decisions (Subandoro et al. 2022).

CURRENT STATE OF PLAY: Digital technologies offer innovative ways to address key nutrition service delivery challenges, and their use ranges from reaching individuals and communities with continuous and edutaining behavior change messages, targeting the poor and most vulnerable in difficult situations, and allowing systematic approaches and tools for d ata collection, especially in low-capacity settings (Ireen et al. 2018; UNSCN 2020; World Bank 2013). Digital solutions to address these challenges have focused mainly on the following:

- **Tools to strengthen service delivery.** Digital tools have been used to strengthen screening and assessments, counseling, treatment, and the management of malnutrition (USAID 2020; WHO 2022c). Telehealth has been used in virtual clinical nutrition services, including consultations to support breastfeeding, infant and young child feeding, and the management of severe and acute malnutrition (Ferraz Dos Santos, Borges, and de Azambuja 2020; Uscher-Pines, Lawrence, and Waymouth 2023). In Burkina Faso, a digital tool (the electronic register of consultations) is used for screening and the referral of cases of severe and acute malnutrition as part of a broader package for the integrated management of childhood illness activities (SUN 2021). Access to smartwatches and mobile apps support diet management, weight loss, and the management of noncommunicable diseases by offering personalized solutions and tracking options (Dobbie et al. 2022; Natalucci et al. 2023).
- **Job aids for community- and home-based services by community health workers.** Initiatives to equip front-line community health and nutrition workers with smartphones or phone-based applications to replace paper-based work and improving the work efficiency of nutrition programs. In India, a digital job aid and supervision tool—integrated child development services–common application software—has replaced paper-based registers and provides workers in Anganwadi centers with real-time information to monitor, focus, and improve nutrition service delivery (Patil et al. 2022). CMAM m-Health, the community-based management of acute malnutrition mobile app, is a decision support tool that provides response-triggered decision tree algorithms, text, voice, and picture prompts, and automated reminders and that has helped enhance protocol adherence, improve patient tracking, provide targeted counseling, generate real-time monitoring data, and send reminders to supervisors and supply chains in Afghanistan, Chad, Kenya, Mali, and Niger (Frank 2017). In Indonesia, the electronic human development worker app is being used to converge the delivery of front-line services across multiple sectors (health, water and sanitation, social protection, and education) through service mapping, job supervision, reporting, and training to ensure the colocation of key services that are critical to reducing stunting (Bosquet 2019).

- **Reaching families and individuals with behavioral nudges.** Improving day-to-day nutrition practices requires consistent behavior change communication to be delivered at scale to nudge communities and families, as well as tailored messages for specific audiences and individuals. Traditionally, these messages have been delivered by enhancing the capacities of front-line workers and volunteers as change agents to enable such processes. Emerging initiatives in low- and middle-income countries include a chatbot-based nutrition counseling service—Poshan Didi—that has been developed in India (Jayal 2021). Similar efforts are also being planned in Bangladesh and Indonesia.
- **Digital marketing.** Trials in some high-income countries, such as Saudi Arabia and Singapore, have found that digital marketing can influence healthy food consumption by encouraging and incentivizing consumers to purchase healthier options (Rodriguez 2023). Various digital media are also used to market cheap, nutrient-poor foods to children and teenagers, primarily by private sector entities (Boyland et al. 2020; Bragg et al. 2017; Tangcharoensathien et al. 2019). Advertisements for ultraprocessed foods high in fat, sodium, and sugar often targeted at children can cause overweight and obesity, thereby leading to noncommunicable diseases later in life (Obesity Evidence Hub 2022).

FUTURE USES. Wearables for better lifestyle choices. There has been a proliferation in the use of digital technologies in the form of wearable devices and tracking apps that allow users to track their daily food intake, record nutrient intake data, monitor progress in disease conditions, and track other lifestyle factors such as activity levels, heart rate variability, sleep patterns, and more. These data can all be used together with nutrition data to provide customized plans and recommendations for specific clients.

Digital for behavior change. Behavior change and communication are an integral part of a nutrition program. Technology is increasingly being used to disseminate general and personalized messages and in training nutrition workers. Prospects for remote learning should also include opportunities to enhance the digital literacy of nutrition workers. Such platforms have the potential to provide peer to peer support, facilitate knowledge exchange, and impact behaviors. Though these channels facilitate greater, faster, and cheaper audience reach, widely shared misinformation and disinformation over the internet are a concern and should be proactively addressed by governments.

Personalized recommendations. Use of digital solutions in nutrition can be applied across all sectors, ranging from the use of innovative software to optimize school feeding menus and software tools to calculate and optimize the nutrient content of school meals to the delivery and monitoring of essential nutrition services and to the use

of block chain technologies to track the nutrition quality of foods along the food supply chain (UNSCN 2020). The use of digital applications and tools generates immense data. With the efforts to integrate and harmonize data and linking and sharing information from heterogeneous data sources, along with capitalizing on advances in computational sciences for automated data processing and management, can help answer many of the complex policy and programmatic issues in the nutrition sector (Emara et al. 2022; UNICEF and WHO 2021).

Digital in Climate and Health

KEY CHALLENGES: Climate change exhibited as increasing temperatures, more extreme weather events, increased droughts, flooding, sea-level rise, and wildfires impacts human lives. A climate resilient health system can adapt to change, respond, and reduce vulnerabilities arising out of the myriad of health impacts and the rising toll of climate change-related deaths. Transformation of the current health system across the globe can occur if these challenges are addressed. The use of digital technologies that connect climate and health issues under one platform is limited (WHO 2021b).

CURRENT STATE OF PLAY: The use of infectious disease surveillance systems and related HISs is widespread in countries, but they are often not linked. There is a need to strengthen electronic integrated surveillance systems for climate-sensitive diseases, such as dengue, heat-related illnesses, air pollution–related diseases, and nutritional deficiencies. Further advances in managing human health in the era of climate change will require information systems that capture, process, and communicate combined data on human, animal, and plant health. Digital technologies and data also play a role in adaptive responses to both short-term shocks and long-term trends associated with climate change. Timely access to information—for instance, early warning, temperature and rainfall, agricultural advice through, for example, mobile devices, SMS, radio, social media—is crucial to responding to and mitigating the impact of emergencies, such as floods and drought, and to identifying pest and disease prevalence. Big data are being used to inform responses to humanitarian emergencies, as well as to generate new forms of citizen engagement and reporting (such as community-based maps of flood-prone areas) that can help inform coping and adaptive responses. During the pandemic, low-carbon and energy efficient contact tracing technologies were used in the form of smartphone apps. There are also examples of the use of mobile applications, including SMS messaging. For instance, the AirRater air pollution monitoring app supports individuals with asthma and draws upon the open data monitoring of wider air quality issues, such as traffic pollution and alerts to bush fire smoke incidents.

FUTURE USES: To address issues of climate and health, extensive adaptation and mitigation measures are needed; people—their health, connection, and well-being—should be put at the heart of climate investment and action. Digital technologies and data can be used to support these people-centered climate investment goals in three ways:

- **The role of the digital in reducing the climate and health knowledge gap:** Knowledge and analytics are fundamental to effective action and the digital enabling this advance in new ways. For example, global climate monitoring and other environmental monitoring models can increase the available information by orders of magnitude between generations. These global data can be combined with better availability within countries through the digitalization of written records and expanding data collection through mobile technologies, both actively collected data and metadata. This holds great promise of contributing to the use and availability of health data. Intelligent search and analytics can help more effectively scan environmental data and the related climate footprints or identify health trends caused by rising temperatures.
- **Digital applications to quantify health sector contributions to the climate crisis:** Carbon footprint assessments are fundamental to understanding where action needs to happen. The sparsity of data is currently hampering this process. Digital can provide information on data already available and on how different approaches to the carbon footprint utilize information and the challenges inherent in this initiative. Ultimately, the goal is to understand low carbon clinical pathways and public health services. This requires much better data. Digital health will also be key to reducing this impact—smart devices and so on—and improve efficiencies.
- **Digital in climate and health action:** This would cover the importance of digital in detecting risks (surveillance), warning people) (early warning systems), and evaluating health responses to climate shocks. Digital can support both behavior change efforts, combat mis- and dis-information, and play a role in risk communication. It can also support the use of data to integrate health and hydromet systems. Use of AI and sensing technologies based on machine learning can generate health-related data to predict vulnerabilities, for instance, smart sensors on wearable technology.

Digital technologies that minimize environmental damage and reduce the carbon footprint should be used as much as possible so that greenhouse gas emissions are not increased. There are many approaches to achieving this through renewable energy

sources (solar power), energy star–certified energy efficient hardware, data centers, technology recycling (for example, Recycle-Health collects used activity trackers and provides them to underserved populations), and e-cycling, digital temperance, green computing, use of repairable devices, and responsible disposal and resource pooling between partners and stakeholders. Such approaches can reduce the global impact of electronic waste through the circular economy, reduce electronic waste emissions and associated health risks, and reduce carbon emissions. Other innovations, such as direct-to-client digital health services using mobile messaging, chatbots (which may also be driven by AI), call centers, help desks, mobile applications, websites, and the remote monitoring of patients are also important enablers of UHC and can reduce the carbon footprint of health systems by requiring fewer health facilities and reducing greenhouse gas emissions caused by travel-related fuel consumption and physical footprints. The Green Guide for Health Care is an example of a sustainable design toolkit integrating environmental and health care principles and practices into facility planning, design, construction, operations, and maintenance (HCWH 2007). Additionally, new and emerging technologies, such as green cloud computing (carbon neutral data processing) and virtualization (reduces the physical number of services needed to store data by shifting the data to virtual servers), tiny machine learning and compact AI (that reduce software size and power), and greener IT solutions, represent more sustainable ways of using technologies and ensuring that digital-in-health does not add to global health burdens. Such transformational investments today have the potential to shape tomorrow's health care systems.

Digital in Supporting Healthy, Productive Longevity

KEY CHALLENGES: With large swaths of the world population aging, digital in healthy longevity entails efforts to ensure that aging populations live productive, healthy, and connected lives for as long as possible: focusing not only on life span, but on health span (years of life without chronic illness) and joy span (years of life socially connected to others and living with purpose). Populations aging today will be more technology-savvy than today's aging populations and may have different demands on the health care system as they age, but they are not a homogenous group (Kokorelias et al. 2022).

FUTURE USES: Digital aspects of healthy longevity will focus on these areas in the future:

- **Prevention of chronic illness and polypharmacy in predictive and personalized ways, thereby reducing health care costs for older populations:** Caring for aging populations can be costly, particularly as these populations often present

multimorbid chronic illnesses. Health care systems should strive not only to provide these services at the lowest cost, but also to reduce the need for these services. Increasing a person's health span and reducing the health span—the life span gap—can be accomplished through the proactive, personalized, preventive lifestyle- and environment-based services that digital technology can provide.

- **Supporting gerontolescence to maximize productivity:** Gerontolescence is the period ages 50–70 when individuals typically develop a second or new career and take up new interests to plan for a future after their current formal employment comes to an end. Digital technologies can help in this transition by helping people discover new careers and new types of jobs as they age.
- **Reducing and managing cognitive decline:** Digital technology can prevent and reduce cognitive decline (Wu, Lewis, and Rigaud 2019) and can also be used diagnostically to assess and track cognitive function over time.
- **Reducing loneliness and social isolation:** Social isolation is the lack of social contacts and the shortage of regular interaction with people, whereas loneliness is the feeling of isolation, regardless of the amount of social contact (Kroll 2022). In China, Europe, Latin America, and the United States, 20 percent to 34 percent of older individuals are lonely. Social isolation and loneliness are harmful. They not only shorten longevity, but negatively impact mental and physical health and the quality of life (PAHO and ITU 2023). It has even been shown in a 12-year follow-up study in the United Kingdom that social isolation and loneliness have the negative health effects akin to smoking 15 cigarettes a day (Kroll 2022; Phillip et al. 2022). Digital technologies can help reduce social isolation and loneliness.
- **Making independence at home possible:** With technology and at-home monitoring tools, it is possible to keep older people at home for longer and help them transition from vulnerable to valuable (PAHO and ITU 2023).

Critical success factors include the need for human-centered design and digital skills training to reduce negative attitudes about digital technologies and ageist attitudes about the likelihood of aging populations wanting to use technology (Mace, Mattos, and Vranceanu 2022).

Digital in Medical Education

KEY CHALLENGES: The process of medical education is struggling to keep up with the quickly evolving health care demands of populations around the globe and new evidence emerging on what it takes to live a healthy life. Challenges such as outdated curricula,

insufficient funding, slow uptake of new research evidence into medical curricula, and lackluster quality control and accreditation systems result in graduates who are not fully prepared for their roles. To tackle the health issues that the twenty-first century presents, a shift is needed toward newer, more streamlined, and more effective approaches in medical and public health education. Health care professional institutions must lead in forming evidence-based curricula, integrating the latest technology, and introducing innovative programs. It is crucial for primary stakeholders to participate actively in instigating the required transformations in medical and public health education. Among the significant challenges and shifts are the movement toward competency-centered education, an augmented focus on collaboration across various medical disciplines, the integration of technological advancements, and an emphasis on addressing the social factors that influence health within medical education (Majumder et al. 2023).

FUTURE USES: As medical education moves toward more competency-based approaches, digital technology can be used effectively. The use of technology in medical education represents a significant shift in the way health workers are trained. Here is an overview of how technology is impacting and enhancing the field of medical education:

- **Simulation and virtual reality:** Medical students can practice surgeries and diagnostic procedures in a virtual environment. This provides a risk-free platform to learn, make mistakes, and improve skills before contact with real patients.
- **E-Learning and online platforms:** Online courses and platforms offer flexibility and accessibility, allowing students to learn at their own pace. They can access lectures and notes and even interact with professors and fellow students remotely.
- **AI and machine learning:** These technologies help in personalized learning by analyzing the performance of individual students and adapting the educational content accordingly. AI can also assist in complex research and diagnosis training.
- **Augmented reality:** Augmented reality can provide interactive 3D demonstrations of anatomy and complex medical procedures, enhancing the understanding of spatial relationships and functional processes within the body.
- **Telemedicine training:** With the growth of telemedicine, students can be trained in remote patient care, enhancing their ability to diagnose and treat patients from a distance.
- **Mobile applications:** Apps that provide quick access to medical journals, drug information, and interactive case studies help in continuous learning and staying updated with the latest medical advances.

- **Big data and analytics:** Technology helps in the collection and analysis of large volumes of medical data. This information can be used for research, understanding patterns, predicting outcomes, and creating evidence-based practices within medical education.
- **3D printing:** Used to create accurate models of organs or specific medical conditions, 3D printing provides tangible resources for learning complex anatomical structures.
- **Collaborative platforms:** Technology enables better collaboration among medical institutions, allowing the sharing of resources, research, and expertise.
- **Ethics and digital literacy training:** As technology becomes an integral part of health care, training in digital literacy and ethical considerations related to data privacy and security becomes crucial.
- **Continuous assessment and feedback:** Technology allows for real-time assessment and feedback, providing students with immediate insight into their performance and areas for improvement.

The integration of technology in medical education is not merely a trend, but a necessity. It brings about more interactive, personalized, and effective learning, preparing medical students and professionals for a rapidly changing health care landscape. The challenge lies in ensuring equitable access to these technologies and in continuously evaluating and updating them to align with the ever-evolving field of medicine.

Digital in Public Health and in Health Emergencies

KEY CHALLENGES: Public health promotes and protects the health of people and the communities where they live, learn, work, and play. While a doctor treats people who are sick, public health tries to prevent people from becoming sick or injured in the first place. It also promotes wellness by encouraging healthy behaviors.

The US Centers for Disease Control and Prevention clearly identifies the integral role of public health systems in preparing communities to respond to and recover from threats and emergencies. The public health consequences of disasters and emergencies initially affect local jurisdictions. During the initial response, the people and communities that are impacted must rely on local community resources. As a result, all state, local, tribal, and territorial emergency response stakeholders must be prepared to coordinate, cooperate, and collaborate with cross-sector partners and organizations at all governmental levels if emergencies occur, regardless of the type, scale, or severity (CDC 2018).

CURRENT STATE OF PLAY: Information management is at the heart of all public health functions. From assessing and monitoring population health to improvement and innovation and evaluation, research, and quality improvement, digital solutions play an ever-increasing role in the massive data collection and processing required and, by extension, in health emergencies and pandemic preparedness. The COVID pandemic was a catalyst, shedding light on the blind spots that even some of the most advanced economies could not address because of a previous lack of investment in digital infrastructure for public health.

Digital tools are an essential part of a dynamic and interconnected public health surveillance system with the capacity to gather and analyze multiple sources of data in real time. Public health information management steadily moves from static, descriptive statistics to dynamic, diagnostic, predictive, and prescriptive analytics. It helps in the shift from a reactive response to health systems that are equipped to detect and even predict future health emergencies proactively. Public health surveillance is the continuous, systematic collection, analysis, and interpretation of health-related data (Khoury and Dotson 2021) by way of multiple sources, such as syndromic surveillance (Henning 2004), laboratory surveillance (Cheng et al. 2022), sentinel, genomic surveillance (WHO 2022a), antimicrobial resistance surveillance, and wastewater surveillance (Diamond et al. 2022), but also extends to social and behavioral data collected from internet-based platforms and social media.[5] Future enhanced applications of machine learning (CDC 2023) and AI for better forecasting (Brownstein et al. 2023) to this set of integrated and interconnected data set will help not only improve the speed at which the surveillance system can detect anomalies, but also, through predictive models, forecast health emergencies and their impact on specific population groups. Public health surveillance information should be part of the wider health data ecosystem in a country.

FUTURE USES: Noncommunicable diseases now account for almost three-quarters of all deaths globally.[6] The potential impact of a digital public health surveillance system linked to primary health care and other information systems goes well beyond emergency response and can help monitor, predict, and target the response to noncommunicable disease. Such a system can help identify the emergence of

[5] For antimicrobial resistance surveillance, see GLASS (Global Antimicrobial Resistance and Use Surveillance System) (dashboard), World Health Organization, Geneva. https://www.who.int/initiatives/glass.

[6] "The Role of the Health Community in Climate Action: Taking Stock and Moving Forward," 76th World Health Assembly, Session 3, World Health Organization, Geneva, May 24, 2023, https://www.who.int/news-room/events/detail/2023/05/24/default-calendar/the-role-of-the-health-community-in-climate-action-taking-stock-and-moving-forward.

environmental impacts on noncommunicable diseases or facilitate population-based clustering of modifiable risk behaviors, such as smoking, diet, alcohol consumption, substance use, physical activity, and sleep (Khoury and Dotson 2021). This highlights another promising source of digital data for public health: gathering personal data from telemedicine, wearable devices, and other health care devices connected to internet to collect patient information (Manteghinejad and Javanmard 2021). The amount of data collected and integrated with AI will enable public health authorities to target their interventions more effectively, reaching a new level of prediction and proactivity to reduce the incidence of chronic diseases.

The future of digital in public health points toward an ever-increasing leverage of individual data and services that can be integrated in surveillance systems. With its wearables, implants, and sensors, the internet of things can constantly feed individual data and potential digital biomarkers relevant for public health as well as other early warning systems that can detect potential disease outbreaks earlier (Sahu et al. 2021). Digital therapeutics for chronic disease diagnostics and management, mental health screening and treatment, and lifestyle preventative (behavior change) interventions represent another range of interventions that can be used for public health and service delivery (Wang, Lee, and Shin 2023). Virtual and augmented reality to facilitate health care worker training can be used for therapies or patient education. The future of public health will involve using this interconnected individual data to predict, detect, modify, treat, and intervene beforehand, thereby expanding the field of personalized precision medicine to include applications in public health—precision public health—and using AI and machine learning to target public health efforts more effectively within populations (Bilkey et al. 2019).

CHAPTER 5

Country Readiness *for and* Determinants of Digital-in-Health Success

"Digital health interventions are not just limited to individual health care delivery programs, but are spread across multiple health outcomes, catering to both communicable and noncommunicable diseases across the health and disease burden spectrum."

Mansukh Mandaviya,
Union Minister for Health and Family Welfare, India (PIB 2023)

Key Messages in This Chapter

- Countries are at different stages of maturity in their digital health infrastructure, systems, and governance. A country's maturity will influence its ability to make progress with digital-in-health. Countries are also at different stages of maturity in government-wide technology, systems, policies, and approaches (GovTech).

- The digital health maturity of some countries is on par with their wider GovTech maturity. The digital health maturity of many countries is greater than their GovTech maturity, suggesting sector-exclusive approaches. And other countries have made progress with their GovTech maturity, but their digital health maturity is low. For most countries, the correlation between the two is weak to moderate. Regardless of which one is more mature, the lack of correlation between them suggests a lack of coordination among these efforts.

- From these maturity assessments and from reviews of more than 80 country case studies of digital health implementation efforts, three key challenges emerge in relation to the digital aspects of country health systems, regardless of the context: (a) opportunistic, short-term, and provider-focused approaches that do not put people or health system problems first; (b) leadership gaps and disjointed, siloed digital solutions; and (c) piecemeal efforts with challenges in financing, capacity, and trust. The case studies also reveal the factors that will determine the extent to which countries will be able to address these challenges.

Challenge in growing digital aspects of health systems	What will determine the extent to which the hindrance can be addressed
Opportunistic, short-term, and provider-focused approaches that do not put people first	1. Whether evidence of what works is available and used, together with a deliberate focus on technologies that reduce disparities in health, to prioritize digital solutions 2. Whether providers, patients, and underserved communities are involved in choosing, designing, and evaluating digital solutions
Leadership gaps and disjointed, siloed digital solutions that make it difficult to generate, link or use data	3. How functional digital health leadership and governance are at national, regional, and global levels 4. How comprehensively data about health are governed and shared 5. The extent to which digital infrastructure is available and is used 6. How widely digital health records are created, updated, and used during every encounter with the health system 7. Number and types of health information systems and digital solutions and the ease with which they exchange data
Piecemeal efforts with challenges in financing, capacity, and trust in digital technology	8. The extent to which digital solutions are trusted and people are comfortable with and have the capacity to use them 9. How well the public and private sectors work together in delivering technology for health care 10. The extent to which the planning and implementation of digital-in-health are linked to wider digital transformation 11. How digital technologies are financed, monitored, and implemented

This chapter considers how well prepared low- and middle-income countries are for a digital-in-health future by looking at the maturity of the digital aspects of their health systems, the challenges that most countries face in maturing the digital aspects of their health systems, and the factors that will determine the extent to which countries will be able to address these challenges.

Country Readiness Measured through Maturity Metrics

What is digital health maturity? Digital health maturity refers to the notion that the various aspects of a country's digital health technologies, tools, data, governance, and capacity may be at different stages of development, financing, implementation, and use. Identifying areas of greater or less maturity is useful as countries embark on prioritizing the investments most relevant to them.

Approaches to assessing digital health maturity. Stakeholders have developed various approaches to assessing the maturity of HISs and digital health systems. One of these approaches adopts a comprehensive view by considering the maturity of each of the seven digital health building blocks defined in the 2012 WHO and International Telecommunication Union e-health toolkit: leadership and governance; strategy and investment; legislation, policy, and compliance; workforce; standards and interoperability; infrastructure; and services and applications (WHO and ITU 2012). The toolkit is called the Global Digital Health Monitor (GDHM) (see annex D for a detailed list of indicators that the tool uses).[1]

Digital health maturity in the context of digital transformation. Digital health transformation rarely occurs in a vacuum. In Latin American and Caribbean countries, many do not have a digital health strategy, but, rather, a digital transformation strategy for all of government.

Box 2 The Four Subindexes of the GTMI

1. **Core government systems index** (17 indicators) captures the key aspects of a whole-of-government approach
2. **Public service delivery index** (9 indicators) presents the state of online portals, e-filing services, e-payment capabilities, and more
3. **Digital citizen engagement index** (6 indicators) measures aspects of public participation platforms, citizen feedback, and open government and data portals
4. **GovTech enablers index** (16 indicators) captures strategy, institutions, and regulations, as well as digital skills and innovation programs

Source: GTMI (GovTech Maturity Index) (dashboard), World Bank, Washington, DC, https://www.worldbank.org/en/data/interactive/2022/10/21/govtech-maturity-index-gtmi-data-dashboard.

[1] GDHM (Global Digital Health Monitor) (dashboard), GDHM, Washington, DC, https://digitalhealth-monitor.org/.

Thus, in interpreting digital health maturity, digital maturity across all of government is relevant, too. The World Bank has developed an index for government-wide digital transformation maturity, the GovTech maturity index (GTMI). It was first launched in 2020 and is updated annually. The GTMI consists of four subindexes and 48 indicators (Box 2).

The Maturity of Digital Health Building Blocks around the World

The 2023 GDHM maturity assessment shows that countries have made progress with the digital aspects of their health systems, but that significant gaps remain. Overall, countries were in stage 2 (of five stages) of digital health maturity (Table 10), with significant variation among digital health building blocks and across countries. By country income group, countries vary widely in the areas on which they have focused in digital health. High-income countries and regions with the largest shares of high-income countries exhibit higher levels of maturity (Figure 25 and Figure 26). The data also show that, across the board, interoperability and standardization, legal and regulatory issues, digital skills (among the health workforce), levels of investment in digital technology and data, and financing the infrastructure related to digital health are the most challenging aspects.

Table 10 Maturity of Aspects of Digital Health, 76 Countries, 2023

Aspect of digital health maturity	GDHM phase	What this means
Leadership and governance	Phase 3	A governance structure is in place and a plan for emerging technology exists
Legislation, policy, and compliance	Phase 3	Some data governance legislation and cybersecurity legislation exist, but are not yet fully implemented
Digitally skilled health workforce	Phase 1	Virtually no curricula on digital health exist at preservice or in-service levels. There is low maturity across most countries. Greater investment and standardization are needed in preservice and in-service training for health professionals, the professionalization of digital health and career paths within the public sector, and gender representation within the digital health workforce and governance.
Infrastructure	Phase 4	"A plan for supporting digital health infrastructure (including equipment computers/ tablets/ phones, supplies, software, devices, and so on) provision and maintenance has been implemented partially and consistently with estimated 25 percent–50 percent of necessary digital health infrastructure needed in public health care service sector available and in use." Thus, 50 percent–75 percent of the infrastructure is still inadequate. Most countries have a plan for supporting digital health infrastructure, but greater investment is needed to support implementation at scale.

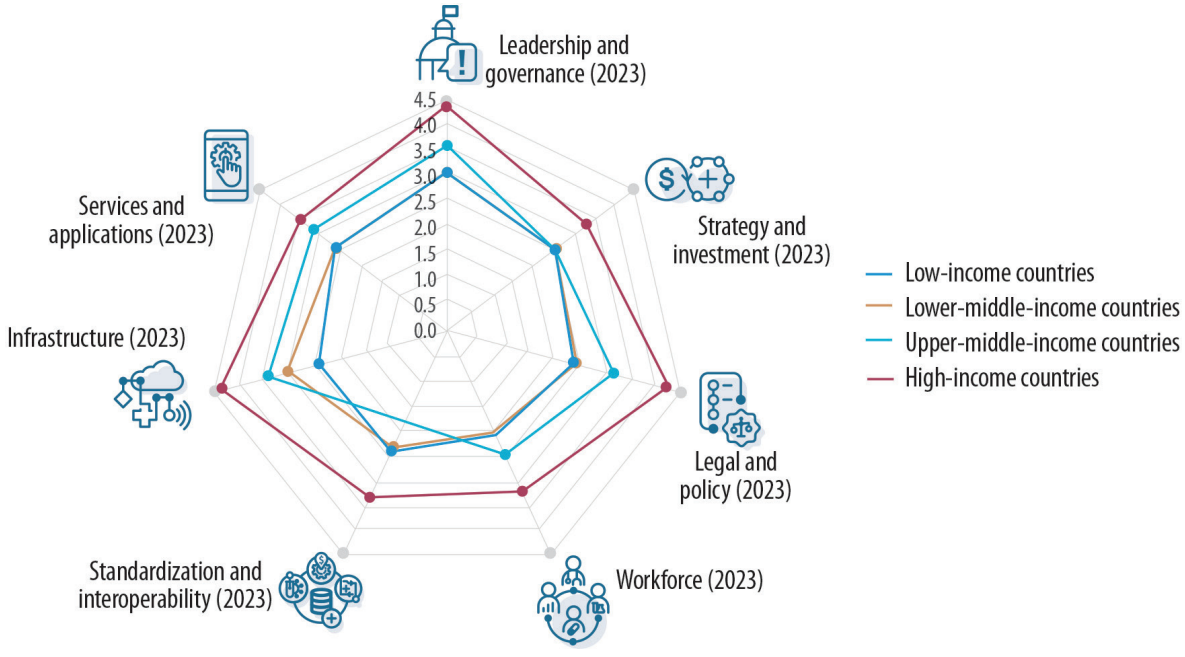
Table continued..

Table 10 Maturity of Aspects of Digital Health, 76 Countries, 2023 (continued)

Aspect of digital health maturity	GDHM phase	What this means
Standards and interoperability	Phase 1	In many countries, there is no national digital health (e-health) architecture framework or health information exchange that is operational.
Strategy and investment	Phase 1	Approved digital health strategies exist in a minority share of countries. Investments in digital health are woefully inadequate, and there is no separate budget line for digital health.
Services and applications	Phase 1	National priority areas are not (yet) supported by digital health at any scale, and digital health interventions are not scaled up. There is a need to invest in digital civil registration and vital statistics, patient feedback systems, and preparations for emerging technologies such as AI.

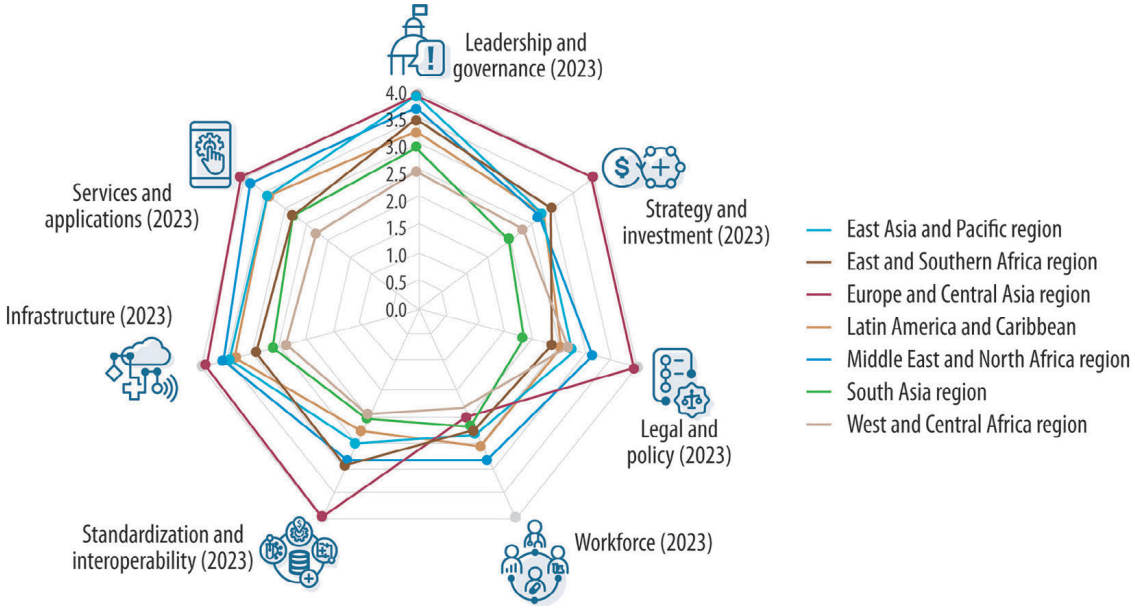
Source: Global Digital Health Monitor Launch Event, World Health Organization, Geneva, May 7, 2023; State of Digital Health around the World Today, Global Digital Health Monitor, Health Enabled and Global Development Incubator, https://monitor.digitalhealthmonitor.org/map.

Figure 25 Global Digital Health Monitor Index Results, by Country Income Level, May 2023



Source: Elaborated from data of State of Digital Health around the World Today, Global Digital Health Monitor, Health Enabled and Global Development Incubator, https://monitor.digitalhealthmonitor.org/country_list.

Figure 26 Global Digital Health Monitor Index Results, by Region, May 2023



Source: Elaborated from data of State of Digital Health around the World Today, Global Digital Health Monitor, HealthEnabled and Global Development Incubator, https://monitor.digitalhealthmonitor.org/country_list.

Digital Health Maturity in Relation to Digital Transformation Maturity

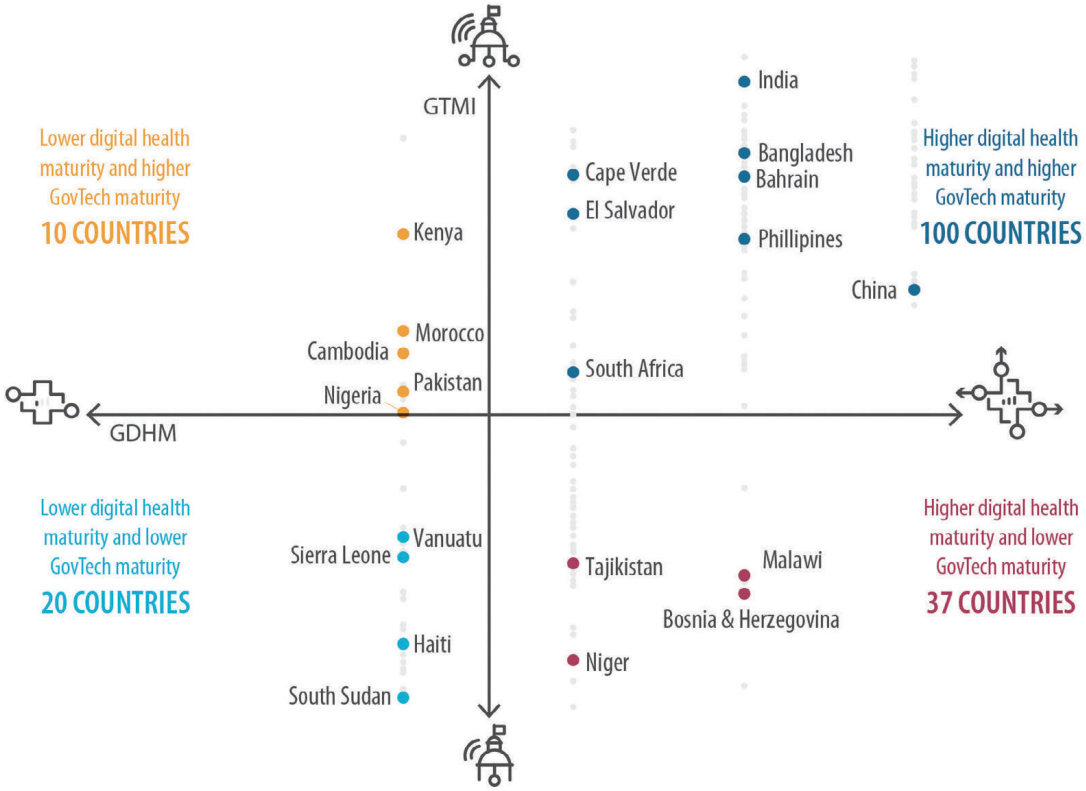
The correlation between digital health maturity and the wider digital transformation agenda in a country is important because not all the investments needed for the digital aspects of health systems to work well will be made by the health sector.

Comparing the GDHM and GTMI scores of countries, a mixed picture emerges. Figure 27 shows that, in some countries, digital health maturity is on par with the wider GovTech maturity. In most countries, the digital health maturity is higher than the GovTech maturity, suggesting sector-exclusive approaches. Other countries have made progress in GovTech maturity, but digital health maturity is low.

With an overall correlation coefficient of 0.4156 (that is, the correlation between the 2022 GTMI index value and the 2023 GDHM index value for the same country), it is fair to say that the correlation between digital health maturity and GovTech maturity is weak to moderate. Regardless of which one is more mature, it suggests a lack of

coordination between these efforts. Because many digital health solutions will require investments beyond the health sector, improving the coordination and links among digital transformation efforts for health and digital transformation across government, writ large, should be strengthened.

Figure 27 Correlation between GovTech Maturity Index 2022 and Global Digital Health Monitor Index 2023

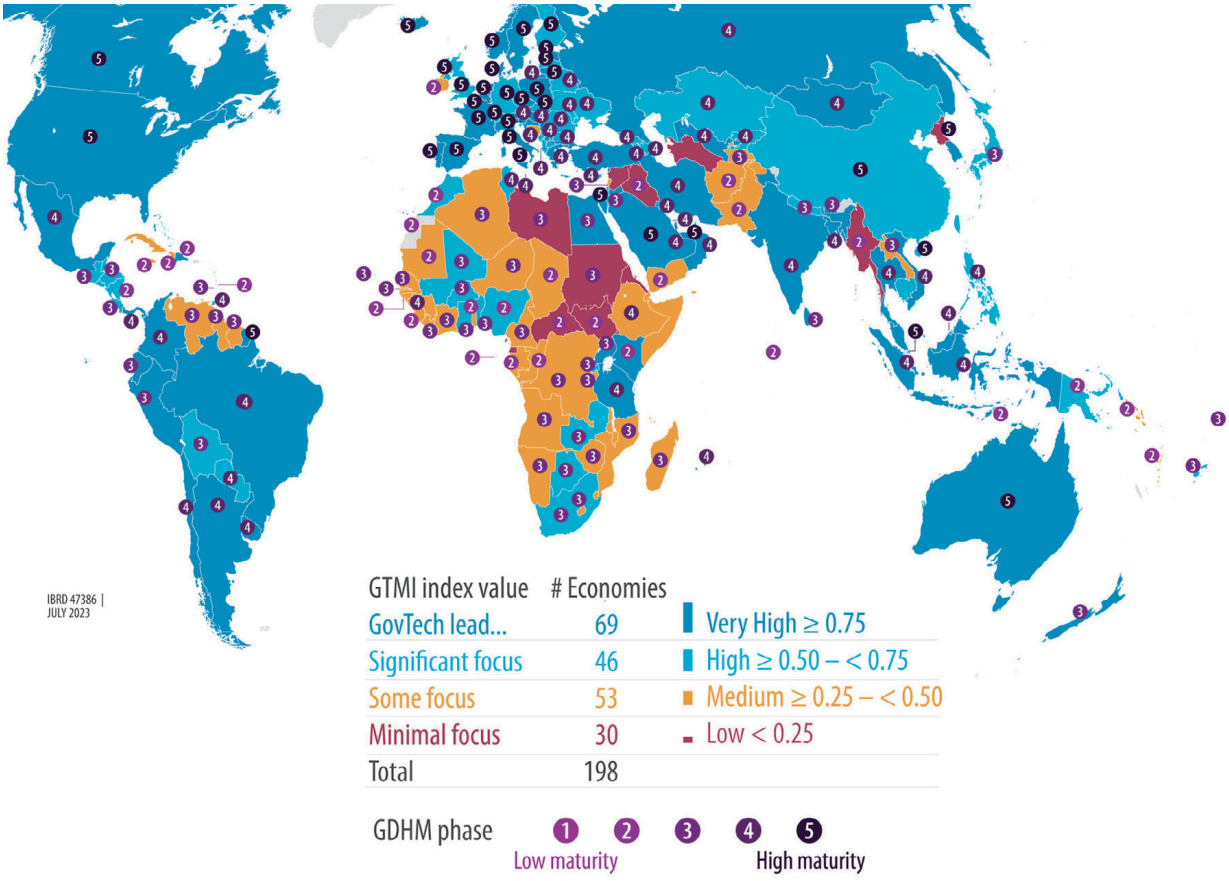


Sources: Elaborated from data of GTMI (GovTech Maturity Index), 2022 Update (dashboard), World Bank, Washington, DC, https://www.worldbank.org/en/programs/govtech/2022-gtmi; State of Digital Health around the World Today (dashboard), Global Digital Health Monitor, Washington, DC, https://monitor.digitalhealthmonitor.org/map.

A comparison of GDHM and GTMI scores among countries in different regions reveals trends (Map 2). In Sub-Saharan Africa, the GTMI and GDHM scores both tend to be low. The GTMI and GDHM scores are similar in East Asia and Pacific, Eastern Europe and Central Asia, and South Asia. In Latin America and the Caribbean, the GTMI scores are higher than the GDHM index values, which reflects the all-of-government approach that the countries in this region have adopted toward digital transformation.

The GTMI / GDHM comparison shows that digital maturity differs across countries and regions, that countries take separate paths toward maturity, and that government-wide digital transformation efforts and digital health maturity are not necessarily planned in an integrated way (countries with higher levels of digital transformation maturity do not necessarily have better digital health maturity).

Map 2 Comparison of GDHM Index Values and GTMI Values around the World



Source: Elaborated from data of State of Digital Health around the World Today, Global Digital Health Monitor, Health Enabled and Global Development Incubator, https://monitor.digitalhealthmonitor.org/map; World Bank 2022 https://www.worldbank.org/en/programs/govtech/2022-gtmi.

Determinants of Digital-in-Health Success

Achieving such an all-encompassing vision will require a concerted effort and will be challenging. Several sources—(a) the GTMI and GDHM results, (b) Chowdbury and Pick's (2019) assessment of digital health in low- and middle-income countries, (c) Transform Health's 2022 report on what it will take to move digital health forward, (d)

the World Bank's 2023 report on accelerating digital technology take-up in the European Union, (e) the experiences of other development partners and the private sector, and (f) experiences from over 80 digital health case studies—were consulted. They provided a rich library of challenges that countries face in growing the digital aspects of their health systems, and what it will take to address them.

Three challenges emerge as the most prevalent in maturing the digital aspects of country health systems: (a) opportunistic, short-term, and provider-focused approaches that do not put people or health system problems first; (b) leadership gaps, and disjointed and siloed digital solutions; and (c) piecemeal efforts with gaps in financing, capacity, and trust. Field experiences validate these three challenges: A review by Muinga et al. (2020) find that, across 58 hospitals in Kenya, most of the investments in digital health interventions were aimed at digitalizing administrative system processes and data, as well as radiology and laboratory management systems, that these systems were stand-alone with limited interoperability, and that virtually no electronic health record modules were being used. So, the focus was on the digitalization of data and siloed systems, not yet digital-in-health.

From the review of all these sources and the feedback from stakeholders (chapter 3), **11 factors emerge that determine the extent to which countries are able to address the challenges** and grow toward a digital-in-health future (Table 11).

Table 11 Challenges for and Determinants of Digital-in-Health Growth

Challenges for growing digital aspects of health systems	Factors that will determine the extent to which the challenges can be addressed
Opportunistic, short-term, and provider-focused approaches that do not put people first	1. Whether evidence of what works is available and used— together with a deliberate focus on technologies that reduce disparities in health—to prioritize digital solutions 2. Whether providers, patients, and underserved communities, are involved in choosing, designing, and evaluating digital solutions
Leadership gaps and disjointed, siloed digital solutions that makes it difficult to generate, link or use data	3. How functional digital health leadership and governance are at national, regional, and global levels 4. How comprehensively data about health are governed and shared 5. Extent to which digital infrastructure is available and is used 6. How widely digital health records are created, updated, and used during every encounter with the health system 7. Number and types of health information systems (HISs) and digital solutions, and the ease with which they exchange data among them

Table continued...

Table 11 Challenges for and Determinants of Digital-in-Health Growth (continued)

Challenges for growing digital aspects of health systems	Factors that will determine the extent to which the challenges can be addressed
Piecemeal efforts with minimal country leadership, financing, capacity, and trust in digital technology	8. Extent to which digital solutions are trusted, people are comfortable with and have the capacity to use them 9. How well the public and private sectors work together in delivering technology for health care 10. Extent to which planning and implementation of digital-in-health are linked to wider digital transformation 11. How digital technologies are financed, monitored, and implemented

These 11 determinants of digital-in-health success are described in the rest of this chapter.

Determinant 1: Evidence to Choose Wisely

Because the opportunity cost of investing in digital health interventions can be large, countries must be selective about where to invest. Over the last two decades, Ethiopia's health sector has introduced a broad set of digital tools, and the Ministry of Health has decided to move ahead with the digitalization of data to improve services and evidence-based decision-making. However, much can be done beyond digitalizing health data. The challenge is how to choose. Although digital technologies bring huge and countless opportunities for transforming health care, not all possible opportunities can (or should) be implemented at the same time. This is because of the financial and human capacity constraints.

To make good investment decisions about where to invest in digital technology and data, investments need to (a) respond to the most important health system challenges; (b) at the system level, focus on the areas where there is the most value to be gained in improvements in health and improvements in health care; (c) at the individual digital health intervention level, use a variety of rigorous evaluation evidence that shows whether and how digital health interventions work; and (d) benefit underserved populations to improve equity.

> On one hand, we have seen solutions change lives, but, on the other, we have seen innovations make advancements in science and engineering but lack clinical utility. Sometimes these are true "hammers in search of nails," where an innovation is

> inadequately applied to health care; other times, they are misguided attempts at innovation, lacking proper understanding of clinical context (Buis and Huh-Yoo 2020, 45).

Choosing the appropriate intervention will require different kinds of evidence and information about how an intervention reduces disparities. Several reviews have concluded that significant evidence gaps exist and that substantial effort will be needed to deepen and widen the evidence base for digital health interventions. For example, Xiong et al. (2023) classify the evidence base for digital health interventions for noncommunicable diseases as follows: clinical (mixed), behavioral (positively inclined), and service implementation outcomes (clear effectiveness). Thus, the service delivery benefits may be clear, but there are less clear links to health outcomes. This is also the case in many other areas where digital health interventions are deployed.

An area of particular importance is the use of digital health interventions (or data) for clinical purposes, such as diagnostics, treatment, or the management of chronic illness. Perakslis and Ginsburg (2021, 127) find that, "digital health has potential to improve health management, but the current state of technology development and deployment requires a buyer beware cautionary note." The reason for the caution is that the evidence base on digital health interventions is still insufficient at a time of significant commercial and global pressure to scale up digital health interventions in low- and middle-income

Box 3 The State of Evidence on Digital Health

The World Bank and the International Initiative for Impact Evaluation have developed an evidence gap map to investigate the published literature on impact evaluations of digital health interventions (Görgens et al. 2021). The resulting evidence on the effects of digital health interventions highlights the following:

- The evidence base for digital health interventions is skewed toward evidence on high-income countries (75 percent of studies); 66 percent of the studies are on Europe and North America alone.
- Almost all studies evaluated interventions for clients and health care providers, and few looked at health care management applications (that is, digital for back office functions such as health worker allocations or claims management) even though the experience of high-income countries has shown that this is where the earliest value can be found.
- There was a dense focus on digital health interventions concerned with service delivery (such as telemedicine). In contrast, interventions that support providers in the planning or coordination of health services (for example, referral or activity scheduling) have received relatively little attention.
- Reflecting the newness of the technology, evidence for AI-based interventions was limited.
- The review also found a preponderance of evidence focused on interventions on noncommunicable diseases (88 percent of the evidence base).
- The focus of most studies concerns short-term outputs (for instance, number of clinic visits), and there was a significant gap in the number of studies that report intermediate or ultimate health outcomes, such as morbidity, mortality, and quality of life.

Source: Wilkinson et al. 2023

countries. It is easy to use hype and hyperbole to convince countries to use unproven technologies. For this reason, evidence and regulation must be high on the priority list of countries as they grow their digital-in-health focus.

The evidence base for digital health interventions is growing, but has started from a low base, and it is skewed today toward specific geographical areas and specific digital interventions (Box 3). Additional and new kinds of evidence of what works, how it works, and who it reaches will be needed to make the best possible investment choices in the future. Such evaluation is needed during implementation as well. By continuously evaluating digital health tools, health care providers can build a body of evidence on what works and what does not work. This evidence can then inform decisions, both by individual health care providers and at the policy level.

Determinant 2: Who is Involved in Planning and Implementation

Who is involved in the decision about which digital technology to use and how it is planned and designed has a critical impact on the extent to which the technologies are trusted and applied in the short and long term. The perspectives of people who will use and benefit from digital technology are foundational to what is designed and how it operates. A focus on user-centered design can help avoid instances where an innovation is incorrectly applied to health care and where it does not serve a clear health-related purpose. Akram, Augustin, and Koepsell (2022) show that there is a disconnect between those who design digital health interventions and those who use them day to day. User-centered design or human-centered design may help overcome this disconnect (De Vito Dabbs et al. 2009; Dominguez-Rodriguez and De La Rosa-Gómez 2022; Ledel Solem et al. 2020). The extent to which interventions are designed with a view on the current work flows of the health workforce and the extent to which this workforce is involved in deciding what an intervention will look like have been key to anticipating the level of use of applications (De Vito Dabbs et al. 2009; Rudin et al. 2021). But care should be taken in how user-centered design is implemented, and practical challenges need to be overcome (Cornet et al. 2020).

Determinant 3: Leadership in Countries, and at Regional and Global Levels, for Digital Health

Building an enabling environment for a digital-in-health mindset and vision requires **strong government leadership** to establish solid partnerships; avoid an array of siloed systems; maintain a balance among maintaining, growing, linking, and maturing existing information systems and digital health interventions and creating

new ones; support and enable required changes; and oversee the implementation of recommendations and monitoring results for the delivery of expected benefits.

> In light of "digital health," we see multiplying numbers of web platforms and mobile health applications, often brought by new unconventional players who produce and offer services in nonlinear and nonhierarchic ways, this by multiplying access points to services for people. Some speak of an "uberization" of health care. New realities and challenges have emerged from this paradigm, which question the abilities of health systems to cope with new business and economic models, governance of data, and regulation (Alami, Gagnon, and Fortin 2017, 1).

Strong coordination is needed. Previous experience has shown that, if many different organizations deploy digital health interventions and HISs in an uncoordinated fashion without adequate local leadership and strategy, the result is endless pilots and fragmentation. In these cases, digital health interventions can have the opposite of their intended effect, negatively influencing health service delivery instead of enhancing it. Without strong leadership, ineffective or problematic legacy systems may be maintained at the expense of new systems, and, inversely, new digital health interventions or information systems may be implemented without understanding how they would link within the wider ecosystem. The migration of data from legacy systems to new systems should be carefully managed.

Global and regional coordination, with strong country leadership. Coordination is needed in countries, but also at the regional and global levels, with a strong focus on all partners working together under the leadership of countries.

Donors tend to focus on supporting innovation, often at the expense of support for maintaining the effective running of routine systems. This significantly compromises the crucial national routine systems and creates fragmented systems that typically die as pilots (UNICEF 2019).

Beyond leadership and coordination, regulation is needed. Regulation typically lags innovation. The rapid pace of innovation has made keeping up a challenge even among significant regulatory authorities, such as the European Medicines Authority, the UK National Institute for Health and Care Excellence, and the US Food and Drug Administration. The strength of regulatory processes will influence the extent to which a country embraces digital technologies with clinical benefit. A patient reminder system, for example, would arguably need less regulatory approval than a digital therapeutics software that provides virtual reality–based daily pain management services to patients suffering from chronic pain.

Unlike pharmaceutical products, medical device regulation and medical product regulation for digital health solutions require special regulatory consideration that is currently lacking in many countries. This is the case during the testing phase and implementation phase when digital solutions could be tweaked on an ongoing basis. Both medical device regulation (for AI-based medical devices) and medical product regulation (for digital health interventions that offer clinical benefit) are needed (Colloud et al. 2023). Private sector technology companies that supply digital health solutions have been vociferous about the need for clarity around what requires regulatory approval, as well as the regulatory process itself.

Determinant 4: Data Governance and Sharing

What is health data governance and why is it important? Health data governance refers to the overall management of the availability, usability, integrity, protection, and security of health-related data. It is a system of decision rights and accountabilities for information-related processes executed according to agreed models that describe who can take what actions with what information when, under what circumstances, and using what methods. In essence, health data governance provides a framework that helps organizations manage their health data responsibly and effectively, ensuring that the data are trustworthy and that they are used in ways that benefit individuals and communities, while maintaining individual rights. The aim of data governance is to shift the focus from data collection to using data more effectively to improve development outcomes, particularly among the poor and in low- and lower-middle-income countries (World Bank 2021). Health data governance is crucial for several reasons, as follows:

- **Data rights.** Health data contain sensitive information that must be protected and that individuals have the right to use and share. This includes medical histories, genetic data, and other private information. Effective health data governance preserves rights and helps protect against data breaches, identity theft, and unauthorized access to sensitive information.
- **Quality and accuracy.** Accurate health data are essential for effective patient care, research, and public health initiatives. Effective data governance ensures the quality and accuracy of health data by implementing standards, policies, and procedures for data entry, maintenance, and use.
- **Interoperability.** Health data are often shared across health care systems and providers. Effective health data governance can help promote interoperability or the ability of various information systems, devices, and applications to access, exchange, interpret, and use data in a coordinated manner.

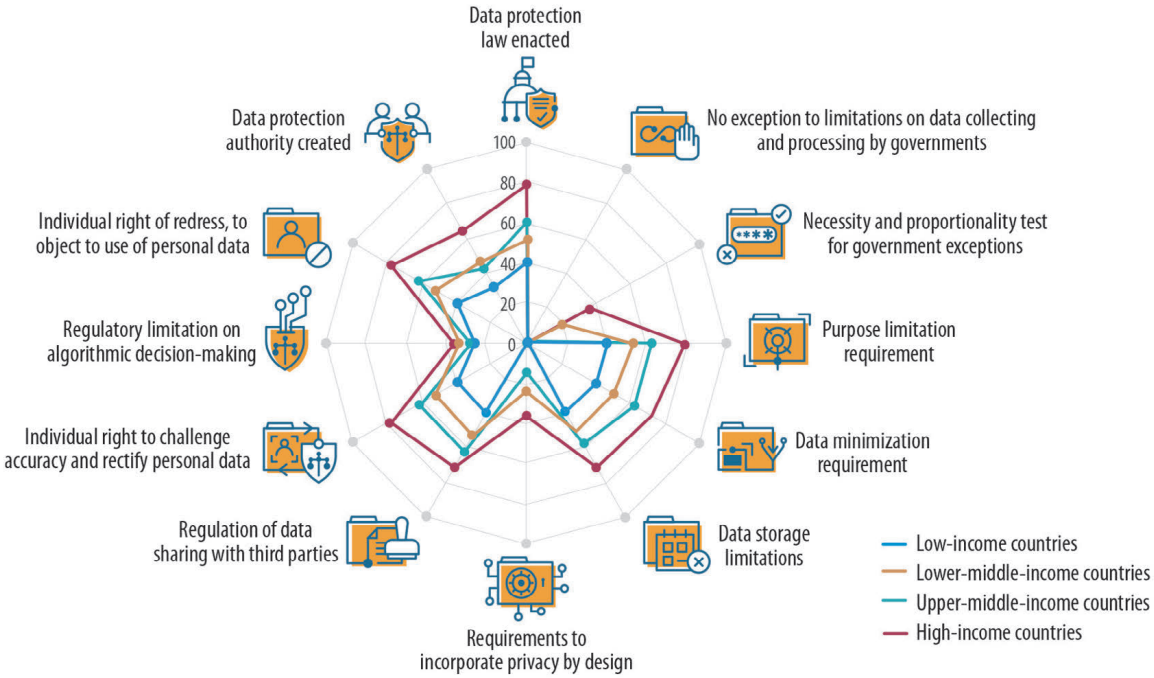
- **Regulatory compliance**. There are numerous laws and regulations related to health data, including the general data protection regulation in the European Union and the Health Insurance Portability and Accountability Act in the United States. Effective health data governance helps organizations comply with these laws and regulations.
- **Trust.** Patients and the public need to trust that their health data are used appropriately and protected adequately. Effective health data governance can help build this trust by promoting transparency, accountability, and responsible data stewardship.
- **Efficiency and effectiveness.** Proper governance of health data can lead to greater efficiency and effectiveness in health care services by reducing errors, improving data flows, and providing a clearer picture of patient health for better decision-making.
- **Research and innovation.** Well-governed health data can be a valuable resource for scientific research and innovation, leading to new insights, treatments, and interventions in health care.
- **Equity.** Health data governance can also play a role in ensuring health equity by setting rules and guidelines that ensure data are collected and used in ways that do not discriminate against or disadvantage certain groups.

Data governance writ large and health data governance are weak. World Development Report 2021 shows that the legal and policy environment for data governance, writ large, is in its infancy in many countries and that it often interacts in a complex multidimensional legal and regulatory space (Figure 28). The underlying type of data does not necessarily determine how the data might be treated legally across the data value chain. This depends on how such data are used or processed. Safeguards on personal data need to be grounded in a rights-based approach whereby data subjects are adequately protected before data can be used for any purpose. In addition, current regulatory approaches, especially relating to crossborder personal data flows, are diverse, might not enable data transfers among countries, and restrict data flows because of data protection and national security concerns. While data governance is becoming a matter of pressing national policy, the global nature of the data landscape also calls for closer regional and international cooperation to harmonize regulations and coordinate policies.

A fully integrated national health datasphere built on the principles of value, trust, and equity allows the flow of data among a wide array of users in a way that facilitates the

safe use and reuse of data (World Bank 2021). Such an integrated national data system aided by good digital and data governance can unlock untapped value through creative data reuses, data analytics, and AI techniques for improved health outcomes.

Figure 28 Personal Data Protection Legislation Differs Markedly by Country Income Status



Source: World Bank 2021.

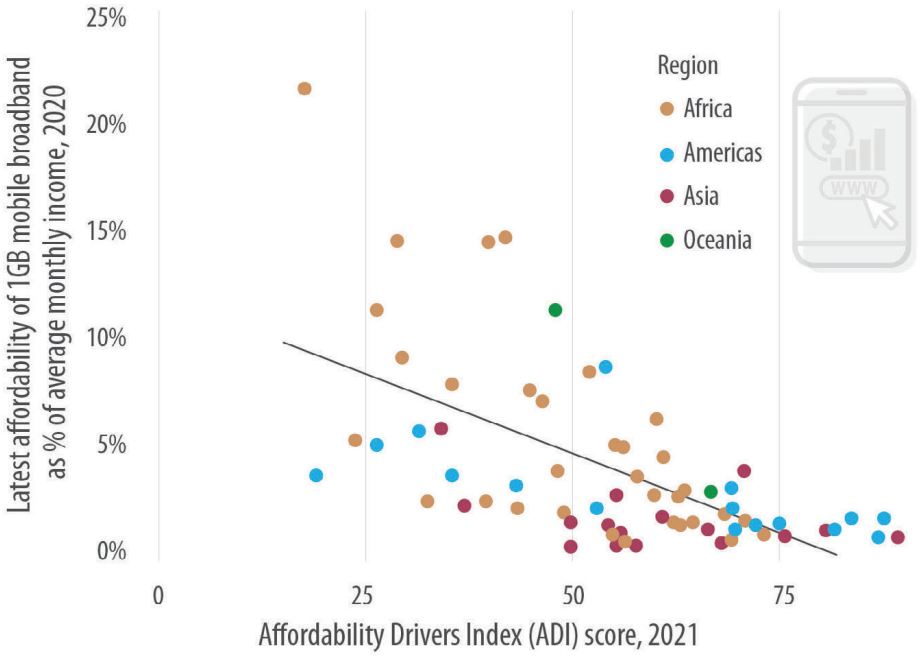
Determinant 5: Digital Infrastructure Availability and Accessibility

Digital technologies do not work without digital infrastructure. In a world where technology is ubiquitously used as part of health systems, the extent of the use of the technology will depend, in part, on whether the location where it is used, includes access to the internet. Wherever health care is delivered, it will become dependent on meaningful and appropriate mobile or fixed internet connectivity, and a minimum internet bandwidth that is adequate for the synchronous and asynchronous functioning of devices that use the internet of things and other digital-based medical technologies. For example, a digital X-ray that uses machine learning to distinguish negative chest

X-rays from X-rays that a radiologist must review requires minimum bandwidth, speed and reliable internet connections to work as designed.

The community—people seeking to improve their health—need to be able to connect to digital technology and data using the internet in ways that are affordable and do not exclude the most vulnerable. Unequal access to technology and connectivity can hinder the adoption and utilization of digital health solutions, especially in underserved or remote communities. In addition, bring-your-own device approaches (which assume that people already have access to a smart phone) can perpetuate inequality if the poorest and most vulnerable do not have their own devices. While mobile connectivity has dramatically increased during the past decade (95 percent of the world's population is now covered by a mobile broadband network; Delaporte and Bahia 2022), 40 percent of the connected do not use the internet, mainly because of challenges in the reliability of the connections, the cost of data, and the availability of hardware (Figure 29). In some countries, a cell phone is often shared among many persons. Usage and affordability therefore still need to be addressed.

Figure 29 Internet Affordability as a Share of Monthly Income



Source: A4AI 2022.

Note: % = percentage; GB = gigabyte.

Determinant 6: Extent to Which Digital Records Exist and Are Used

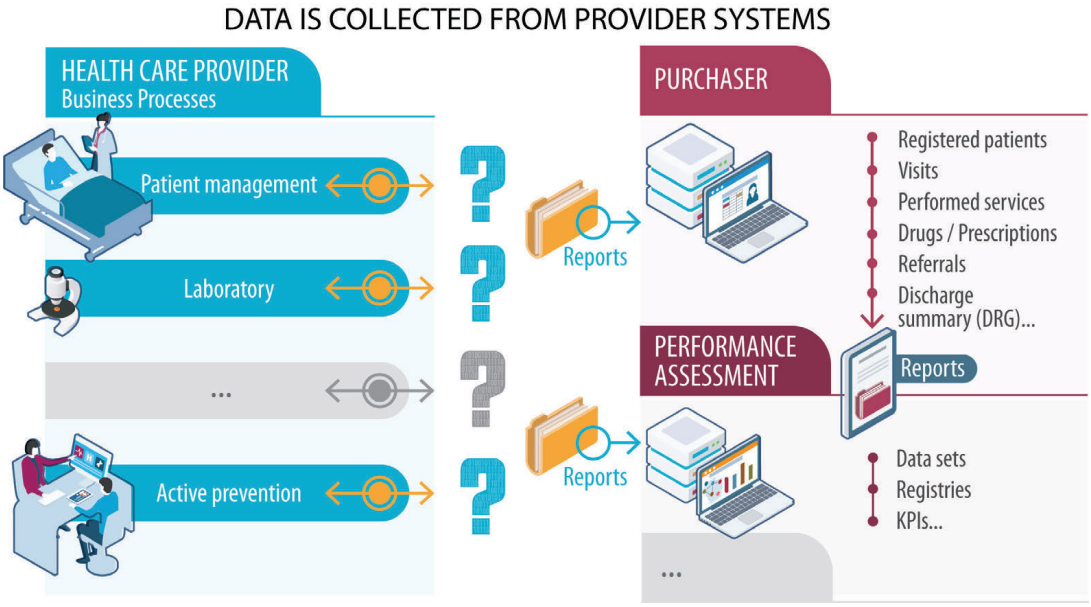
In many low- and middle-income countries, patient data are still stored on paper registers and patient cards. If such data are digitalized, serve clear purposes, are widely available, are utilized appropriately by health providers and managers, and if their contents are both timely and accurate, they can transform health care planning, financing, delivery, and even public health.

In the last 10 years, digital health record adoption has rapidly increased (see Figure 10). Once digital health records are created, paper-based records are sometimes not eliminated, thereby doubling the required effort. According to Bagnoli, Kapoor, and Mullane (2022), "when new digital systems are implemented, it is common for CHWs [community health workers] to continue maintaining paper forms in parallel. We should treat this double data entry as a failure of the digital system. Digital implementers should be proactive in understanding whether paper systems are still in use and work toward a digital system."

Health data usage and quality are compromised because of missing point-of-care primary health care and hospital information systems. Static paper records are often difficult to maintain in health care delivery, particularly in longitudinal information settings, such as the continuity of care among individual patients in care at multiple points of service and across separate providers. By using data collection systems at the point of care, health care professionals become passive health data users. While it is expected that they use the collected real-time data as much as possible for clinical and administrative decision-making processes, the way in which the data are collected at specific points in time does not provide them the access to the data resources they need to manage these processes.

A key reason for this situation is digital discontinuity. If health records are paper-based or if digital health record systems are disconnected from each other, data need to be manually aggregated and collected from these separate sources. These periodic, non–real-time data collection efforts are at the root of most troublesome data quality issues (Figure 30). Data at the source (for example, in patient medical records) are typically correct, complete, and captured when the service is delivered. If the data are not digitalized at the source, they need to be collected later, usually through aggregate reporting forms. This results in weak data quality and use. Updates may be delayed; reported data may be incomplete; summary reports leave out more detailed information; and mistakes are possible. Even if such inefficient and inaccurate data collation processes are digitalized (for instance, by capturing monthly aggregate health service delivery data), the compromises in quality and use persist.

Figure 30 Digital Discontinuity Resulting in Data Collection Efforts and Compromises in Data Quality



Determinant 7: Number of Health Information Systems and How They Exchange Data

To curate health data, many countries use multiple HISs, each serving a different purpose. A multitude of disconnected HISs have a detrimental effect on the functioning of health systems because they create siloes of unconnected data in systems that cannot exchange data seamlessly. The approach of investing in one specific information system without paying attention to whether it can talk to other systems in the region makes data both expensive and limited in utility. Sri Lanka, for example, has 29 HISs that are not interconnected.

Some countries continue to use multiple data management systems, for example, systems for specific diseases and covering community workers, with unclear complementarity and that do not feed into the HIS. Also, health management information systems are often not connected to other relevant management information systems, such as laboratory information systems or logistics information systems (UNICEF 2019).

These HISs are often disconnected from each other. Linking systems can provide significant benefits in the coordination of resources and the reduction of response times during an outbreak or for pandemic preparedness, as well as the routine delivery of reliable, high-quality health services. If these data about health that are housed in

multiple HISs are not connected, inefficiencies and inaccuracies are the result. Figure 31 illustrates a disconnected approach (currently commonplace in many countries).

Figure 31 Disconnected, and Unlinked Information Systems

Information System 1	Information System 2	Information System 3
		
Primary Healthcare EMR	**Laboratory Information System**	**Logistics management information system**
Patient visit data	Laboratory test results	Primary Healthcare sites and locations
Patient name and details	Patient name and details	Medicine list
Primary healthcare sites and locations	Laboratory test types	Medicines at PHC site
Healthcare workers and PHC site	Healthcare workers who ordered the test	Medicines at hospitals
Diagnosis codes and descriptions	Diagnosis codes and descriptions	Transport routes
Medicines list	Supplies needed for laboratory tests	Transport drivers
Medicines at PHC site	Health workers at laboratories	Health workers at warehouse and health facilities

Health workers often only have access to one or a limited number of HISs that do not link with regional or national information infrastructure, thus limiting the ability to piece together a person's health data puzzle and to communicate critical information in a timely and reliable manner. Without sufficient data sharing and integration, critical activities suffer because of a lack of access to or accuracy in real-time information. The lack of interoperability also affects the use of data to improve health and deliver consistent, quality care outcomes during service delivery (Al-Adwan and Berger 2015; Yi 2018).

These data collection systems remain fragmented and lacking in adequate assurance of data quality, which serves as the major bottleneck to effective data use for decision-making and actions for improving health care delivery. This challenge of fragmentation and proliferation of systems is expected to escalate soon, given the policy thrust to

include data from urban health and the private sectors, which represent virgin initiatives (UNICEF 2019).[2]

Determinant 8: Capacity For and Trust in Digital Technology

Health workers may be hesitant to adopt new technologies because of concerns about disruption to established work flows, potential job displacement, a perceived lack of adequate training and support, or a fear of showing weakness in providing medical care. Several studies make the point that there is disproportionately low use of electronic medical records by physicians. It seems that the proliferation of digital tools to implement digital health records does not correspond to the full adoption of electronic medical records in health care delivery, despite the clear benefits (Al-Adwan and Berger 2015; Dutta and Hwang 2020; Sines and Griffin 2017; Yi 2018). Dutta and Hwang (2020) show that the potential barriers behind the comparatively low adoption rate of electronic medical records by physicians include privacy and security concerns, high start-up costs, work flow changes, system complexity, lack of reliability, and challenges in interoperability.

Patients might have unrealistic expectations in technology, be distrustful of technology use in health care, or not want their health information records to be maintained electronically. Digital literacy and skills (knowledge, attitudes, and practices) among patients and providers are often low, as is confidence in data and in how the data will be protected and used.

Determinant 9: Extent to Which Public and Private Sectors Work Together

The extent to which the private sector contributes to digital-in-health growth as a user of digital health interventions, a provider of data, an innovator, or a technology implementor is critical since many of the innovations in health care derive from the private sector. The lack of adequate business models for engaging in a sustainable way with the private sector is an area of concern that limits investment. In health systems in which insurance schemes are the main mechanisms of health financing, the lack of clear reimbursement models for digital health services can create uncertainty among health care providers and organizations, making them less likely to adopt new technologies. Traditional contracting models may require a review and update to align more closely

[2] See DHIS2 (dashboard), HISP Center, University of Oslo, Oslo, https://dhis2.org/.

with digital health. The extent to which the private sector is engaged in digital health depends on the following:

- **Does government look for homegrown solutions, and is it prepared to support local private sector solutions after the pilot phase?** Governments may not be aware of the digital solutions and services available, including many homegrown ones. In some countries, health system actors have supported pilot schemes to test and validate digital solutions. Others may work with development partners to develop or test solutions. A risk for the private sector occurs after the pilot phase. Will the government provide sustainable funding to support continued or expanded rollout? Are there options for working with banks and funding entities to support projects?
- **Are expectations and developments in sync?** It is critical that the digital health space continue to mature hand in hand with the public and private sectors. They must be in lockstep because, if not, parallel care delivery will occur, wasting resources and reducing the overall efficiency of the system. The public sector must embrace the digital health innovations created by private companies and integrate them into the broader care ecosystem.
- **Was sustainability beyond the pilot phase considered during design?** If these adopted solutions are to be sustainable long term, they must be well planned. Governments need to decide what parts of a system will be replaced by digital health services and how these services will be provided. Once this is determined, the government needs to seek to understand how the private sector providers will cooperate and become integrated within the private health care system. This is most important from a data sharing and security standpoint. How can private and public providers share digital health records as completely as possible while still respecting the privacy and other rights of each individual patient.
- **Is contracting appropriate for the type of service being provided?** For public-private partnerships (PPPs) in digital health, it is essential to understand and clarify the various modalities that are appropriate for digital-in-health investments. Traditional PPPs and private finance initiative models lend themselves more to capital expenditure–intensive projects, while digital health does not. Currently, there are few examples of pure digital health PPP initiatives. Indeed, in the past, the rapid pace of digital health and the technology underpinning it has made medium- and long-term PPPs difficult to structure, and the value for money is difficult to demonstrate. Some PPPs may include digital components, such as building a hospital, providing equipment, and establishing a hospital information system. At a minimum, any future PPP project should involve feasibility studies and assessments of the digital requirements, including the IT infrastructure. Digital health may lend itself to services, but not capital expenditure–oriented PPPs. Furthermore, digital

health may not necessarily suit PPP structures and could be oriented toward more traditional procurement if country-specific policy allows. Even then, enhancements to conventional procurement and contracting models may be required. Thus, for example, one-year contracts do not align with a digital health solution rollout.

- **Are regulations in place; do they work as intended; and should they be amended?** As the public sector begins to regulate the digital health space, it must be cautious. The frameworks that are developed must allow the private sector to participate in the development of the digital health space. Some countries in Sub-Saharan Africa, for instance, require that all data be stored on local data servers within the countries. However, the countries do not have servers with the proper security measures to store health data, resulting in storage of the data in other countries. This is a prime example of good intentions in the development of a regulatory framework without considering the implications on the ground. Other common regulatory issues that will require attention include teleconsultation, e-prescriptions, and AI-based diagnostics. In addition, there is a need to consider whether the scope of the practice of health care workers could be expanded using digital technology.
- **Is the private sector prepared to consider reciprocal transformation and adaptation?** Technology companies may need to adjust their products to suit the needs and circumstances of low- and middle-income countries, for example, internet of things devices that require less bandwidth, the ability to work in online and offline environments, and so on. Also, technologies themselves will need to be transformed to meet health care norms, standards, perceptions, and practices.

Determinant 10: Extent to Which Digital Health Progress is Linked to Wider Digital Transformation

The World Bank's five pillars of digital transformation (See Figure 13) are not sector-specific and are all crosscutting. Digital health efforts need to be linked to government-wide efforts in digital transformation. As the GTMI and GDHM comparison shows, government-wide transformation and health sector digital health efforts do not seem to be synchronized in many countries. This is limiting because it does not allow for capitalizing on economies of scale or on the uniform implementation of cross-sectoral aspects of digital technology. In many countries, the lack of coordination between ministries of health, ministries of ICT, ministries of digital development, and other relevant agencies responsible for government-wide digital transformation serves as a critical barrier to scaling digital health interventions and leads to the wastage of resources. For example, the implementation of foundational digital infrastructure requires collaboration with ministries responsible for ICT and broadband,

telecommunication regulators, telecommunication companies, and government agencies responsible for energy. In addition, other foundational aspects, such as data governance, enterprise architecture approaches, digital IDs, procurement and financial management systems, and shared digital services, are led increasingly by new agencies or consolidated under existing agencies that sit outside health.

One of the components of government-wide digital transformation is a focus on DPI. DPI describes platforms (and the governance and institutional frameworks around them) for digital identity, data exchange, and digital payments, as well as for any other functions that are necessary for economy-wide public and private sector service delivery within and across borders (Box 4). These components are not new. What is new is the act of combining them into an umbrella category and linking sectoral efforts in a government-wide effort. The rationale for combining them is that almost all digital transactions require some form of authentication (digital identity), information (data exchange), and funds (digital payments). The infrastructure in DPI is aimed at capturing these foundational and enabling dimensions for sectors to use for their purposes (for example, a digital health information exchange using unique patient identifiers). Thus, countries that can build DPIs are much more easily able to harness digital technologies across sectors. For instance, the government and stakeholders in Thailand have used the DPI as the basis for the much-heralded UHC insurance scheme. In India, the concept has been pioneered through the India Stack, which brings together the DPI and, through public-private collaboration, connects the DPI through open application programming interfaces and common standards.

Determinant 11: How Digital Technologies Are Financed, Implemented, and Monitored

The fiscal space for health remains precarious after the COVID-19 pandemic. Kurowski, Evans, Schmidt, et al. (2022) show that many more countries face the prospect of lower per capita government spending in 2027 than in 2019 (pre-pandemic), tantamount to a lost decade in public investment. In other countries, government spending per capita will exceed 2019 levels through 2027, but spending growth will be weak, restricting the capacities of governments to boost public investment in critical areas, such as health. In only 61 of the 177 countries analyzed will the capacity of governments to spend increase robustly up to 2027. And of great concern are four low-income countries and 14 lower-middle-income countries that are expected to see government spending capacity lag below pre-COVID-19 levels through 2027. In addition, another 10 lower-income countries and 19 lower-middle-income countries will see slow growth in government capacity to spend, including on health. Financing digital health in these markedly diverse fiscal contexts will require customized solutions in individual countries.

Box 4 Digital Public Infrastructure

The word public in DPI does not necessarily denote public ownership or implementation. Instead, this captures the fact that the government has the primary role in and responsibility for deciding on whether and how DPI is provided in the interests of the broader economy and society (Poole, Toohey, and Harriset al. 2014). Exercising tThis role can be exercised by done through managing implementation, through supervision and regulations, or through standard-setting and market-making. There are many different approaches to digital identity, for instance, from centralized systems implemented by governments (for example, Japan's MyNumber) to federations of public or private sector ID providers (for example, the Pan Canadian Trust Framework and FranceConnect). Similarly, there are many different ownership and implementation models for digital payments, but, typically, these are governed by central banks. Data exchange involves many stakeholders because as it entails legal frameworks, technical standards, and digital infrastructure. DPI emerged in 2022 as countries and the international community reflected on lessons from the COVID-19 pandemic demonstrating that digital solutions are critical for resilience. The countries that had DPI in place could more easily keep education, health care, and commerce going through digital and online channels.

- As government agencies, businesses, health care providers, and other service providers relied on the app to allow Singaporeans and residents to transact fully online, the use of Singpass, Singapore's national digital identity app, rose from 25 percent of the population in March 2020 to 97 percent by October 2022 (World Bank 2022b). Similarly, the use of India's Unified Payment Interface, the digital payment system, increased from over one billion monthly transactions in January 2020 to eight billion in January 2023.[a]
- Research has found that countries with DPI in place could deliver social assistance payments to nearly three times more of the population (51 percent versus 16 percent) in less than half the time (11 days versus 26 days) (World Bank 2022a). Togo offers an illustrative example. There, the Novissi Cash Transfer Program was rapidly built in March 2020 using mobile money and innovatively leveraged various data sources to cross-check eligibility (Gentilini et al. 2022)..

Note: a = UPI Product Statistics (dashboard), National Payments Corporation of India, New Delhi, https://www.npci.org.in/what-we-do/upi/product-statistics.

The perceived high costs associated with implementing and maintaining digital health technologies can be a significant barrier to investment, particularly in times of challenging fiscal space. In resource-constrained settings, it is challenging to allocate funds to digital technologies if the value of the technology is unclear or if the focus is simply the data itself. More domestic and international investment in digital technologies that are well aligned and linked within the country's national data ecosystem are needed. Incentives for private sector investment are also relevant.

Beyond the source of financing, the **mechanisms of financing digital technologies warrant consideration.** Ensuring that digital technology and data service providers are

reliably reimbursed in value-based ways—regardless of the financing system for health in a country—is crucial to the sustainable use of digital technologies. This is because the ongoing maintenance costs can be significant. It is critical to consider whether long-term cost drivers, such as maintenance and the total cost of operation, are considered in digital health investment choices.

Monitoring and evaluating digital health efforts act as a multifaceted safety net, ensuring that technology is used in a way that is safe, effective, ethical, and efficient. Here is a breakdown of the importance:

- **Quality of care:** By monitoring and evaluating digital health efforts, health care providers can ensure that the quality of care is maintained. They can identify areas where improvements are needed and implement changes accordingly.
- **Cost-effectiveness:** Digital health tools and interventions can be expensive. Evaluation helps in assessing the value and cost-effectiveness of these tools. Understanding which tools provide the best value for the cost allows for more strategic allocation of resources.
- **Equity and accessibility:** Evaluation helps ensure that digital health efforts are reaching all population segments equally, including those who may have limited access to technology or health care. This helps in promoting equity in health care delivery.
- **Compliance, regulation, and patient safety:** Digital health tools must often comply with various regulations and standards. Monitoring ensures that these tools are operating within legal and ethical boundaries, reducing the risk of legal issues. Monitoring can help identify any potential issues that could affect patient safety, such as software bugs or errors in algorithms. Early detection of these issues is crucial to avoiding any potential harm to patients.
- **Data security, privacy, and ethics:** With digital health efforts, there is a substantial amount of sensitive patient data that need to be handled securely. Digital health tools may raise ethical considerations, especially AI and machine learning. Monitoring and evaluation ensure that patient information is kept confidential and secure.
- **Technology performance:** Evaluating the performance of a technology ensures that the technology is operating correctly and efficiently. If there are any performance issues, they can be identified and resolved quickly.
- **User acceptance and satisfaction:** Understanding how end-users (both health care providers and patients) perceive and use digital health tools is vital. If the tools are not user-friendly or do not meet the needs of users, they may not be applied to their full potential.

CHAPTER 6

Unlocking the **Value: Ten Recommendations** *for* **Action**

"We have reached a stage in the digital health journey where we need to think beyond enhancing health systems through the introduction of individual digital technologies and to instead consider the digital transformation of health systems in its broader sense."

Transform Health

Key Messages in This Chapter

- Shifting to a digital-in-health mindset requires that countries prioritize specific digital health investments for people, problems, and the planet in unison with the private sector, that they connect the disparate leadership, regulatory, information, and infrastructure dots, and that they scale digital health in sustainable, replicable, and equitable ways for the long run. To support the efforts of countries' to address the determinants of digital-in-health progress, the following 10 recommendations are presented:

Prioritize digital health interventions to solve health challenges

1. *People- and problem-centered choices:* Choose digital technology that responds to people's health needs and is evidence-based
2. *Reaching the underserved:* Choose digital health solutions that improve the access and availability of health care services to vulnerable and marginalized groups

Connect to deliver new, more, better and seamless health services that a changing world requires

3. *Leadership and partnership:* Drive digital health action within and across sectors through strong country leadership
4. *Data governance:* Increase data use and reuse to realize greater value while reinforcing ethical standards and regulatory systems for equitable and trustworthy digital solutions
5. *Digital infrastructure and health information gaps:* Connect facilities, services, information, and people, and fill health information gaps by connecting siloed information systems
6. *Global and regional collaboration:* Global and regional solidarity to support countries as they lead digital health investments in their countries

Scale to ensure equitable access to health care for everyone and leave no one behind

7. *Digital skills and literacy:* Help patients and providers understand, trust, and confidently use new technology and data
8. *Nimble public-private and private-private partnerships:* Innovate how the private and public sectors work together in designing, delivering, and funding digital health solutions
9. *Wider digital transformation:* Create synergy between the health system's efforts and the wider digital transformation agenda in a country
10. *Financing and implementation:* Finance enough at the right time, monitor implementation progress, and track outcomes

In line with the World Bank's agreed framework on supporting digitalization and development and considering the 11 determinants of success described in the previous chapter, one needs to help countries prioritize, connect, and scale. This chapter outlines 10 recommendations to accomplish this.

Getting Digital-in-Health Right: Prioritize, Connect, and Scale

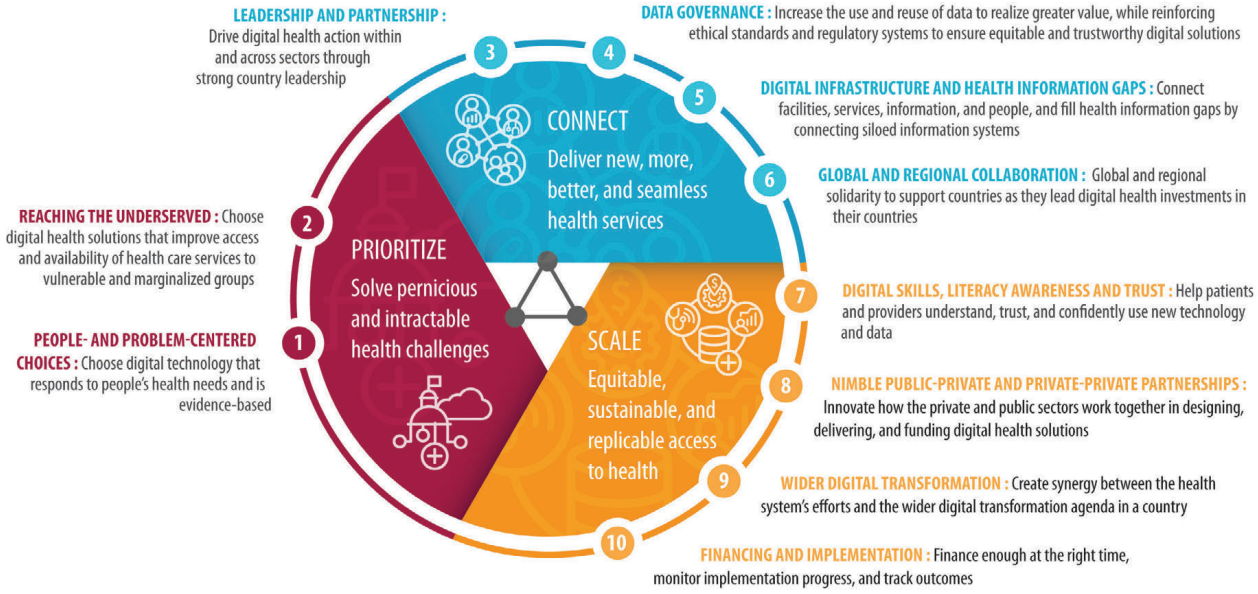
In addressing the challenges to digital-in-health growth in ways that are equitable, three areas of action are essential as governments invest in digital and data: prioritize, connect, and scale. While there is no linear path to progress, these areas are interrelated. (a) **Prioritize** evidence based digital investments that tackle the biggest problems and focus on the needs of patients and providers, such as addressing the disconnect and gaps in health information and telemedicine. (b) **Connect** the regulatory, governance, information, and infrastructure dots so data flows across diverse stakeholders, patients know their data are connected and safe, and health workers can use digital solutions transparently to deliver better care. For example, the accessibility of medical records across health facilities or providers improves the ability of health workers to know a patient's history and provide better care. (c) **Scale** digital health for the long run with sustainable financing for partnerships with and among the private sector and by building capacity and skills for digital solutions that serve all people. Trust in digital technology by people and health workers increases the adoption of the technology and leads to better health care (Table 12).

Table 12 Addressing Challenges to Create Solutions to Grow Digital-in-Health Mindsets

Challenges for growing the digital aspects of health systems	Solutions	
Opportunistic, short-term, and provider-focused approaches that do not put people first		**PRIORITIZE** to solve intractable and growing health challenges with digital solutions
Leadership gaps, and disjointed, siloed digital solutions that makes it difficult to generate, link, or use data		**CONNECT** to deliver new, more, better, and seamless health services that a changing world requires
Piecemeal efforts with inadequate financing, capacity, and trust in digital technology		**SCALE** to ensure equitable access to health care for everyone and leave no one behind

For each of these solutions, there are specific steps governments and stakeholders can take to implement them. Ten recommendations for action have been developed (Figure 32). These recommendations respond to the determinants highlighted in the previous chapter.

Figure 32 Three Areas Needed for Digital-in-Health to Add Value



Prioritize to Solve Intractable and Growing Health Challenges

Recommendation 1. People- and problem-centered choices: Choose digital solutions that respond to people's health needs and are evidence based

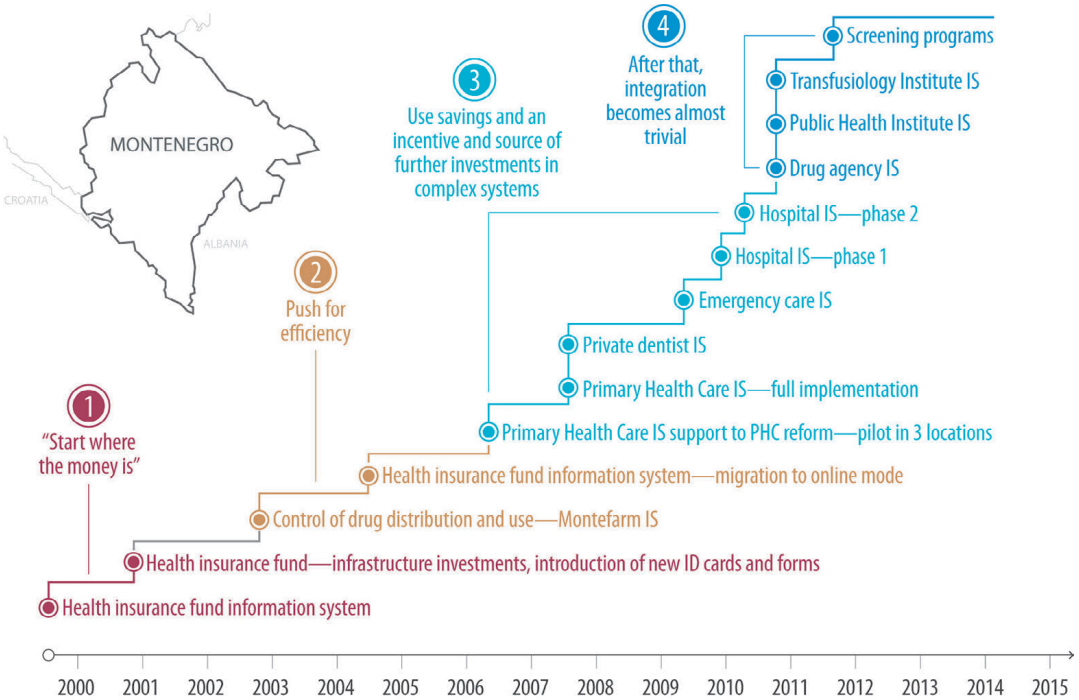
One of the four functions that successful health systems have carried out more effectively involves making patients and others the preeminent players in health system transformation processes (Braithwaite et al. 2017). The same is true of digital health solutions. For the actors in digital solution choices, digital solutions should be codesigned with all stakeholders, starting with users. Such a codesign process will involve setting shared goals and working to understand the process and desired outcome from the perspective of stakeholders. The value of having persons at the center of all digital solution designs should be balanced with health system–driven goals, such as reducing health disparities, ensuring a worthwhile return on investment, demonstrating a clear clinical or health system value, identifying or collecting the minimum

data required for functionality, aligning solutions with institutional priorities, and implementing requirements for long-term priorities (Marwaha et al. 2022).

Choose digital technology and data that respond to specific and most pressing health system challenges. Digitalization is not beneficial only because it responds to a desire for modernity. As a complex adaptive system, health system reform occurs incrementally, iteratively, adaptively, and on a rolling basis. The health system reforms that are considered a priority at a given time should drive digital health solutions, and the reforms should be prioritized as well. Figure 33 illustrates the path to strengthening the e-health system in Montenegro and how the process focused at the start on where the money is, then pushed for efficiency, and used cost-savings to incentivize more digitalization and, finally, full-scale integration.

Work flow mapping or business process mining is useful as part of the process to ensure that the digital solution or technology is best suited for all who will use it. Work flow mapping has the added benefit of helping ensure that the process is understood and that the digital solution improves a particular service or process. Otherwise, the digital solution or information system is simply a digital version of an inefficient manual process.

Figure 33 Sequencing in e-Health Development, Montenegro



Source: World Bank 2016b.
Note: PHC = primary health care; IS = information system.

Prioritize based on a master plan. Many historical and current digital health investments by various development partners have followed this approach, that is, tying the digital transformation to health system transformation. However, doing so in isolation, one reform at a time and therefore one digital health solution at a time, could inadvertently result in siloed, disconnected, and isolated information systems (for example, a logistics management information system that does not draw its data on health facility locations from the same database as the primary health care information system). Such siloed information systems result in immense duplication of effort (needing to recapture a patient's address in many places, for instance) and is, today, the reality in many countries. Care should be taken to avoid this siloed approach in future digital investments. It is vitally important that specific digital investments prioritized at given points in time are designed and implemented with an overall digital ecosystem master plan in mind. If such a plan does not exist, it should be developed before an individual digital health solution is scoped and designed. The overall puzzle matters, as do the pieces that fit into it and the order in which they are put in place. Value can be either created or diminished depending on these decisions.

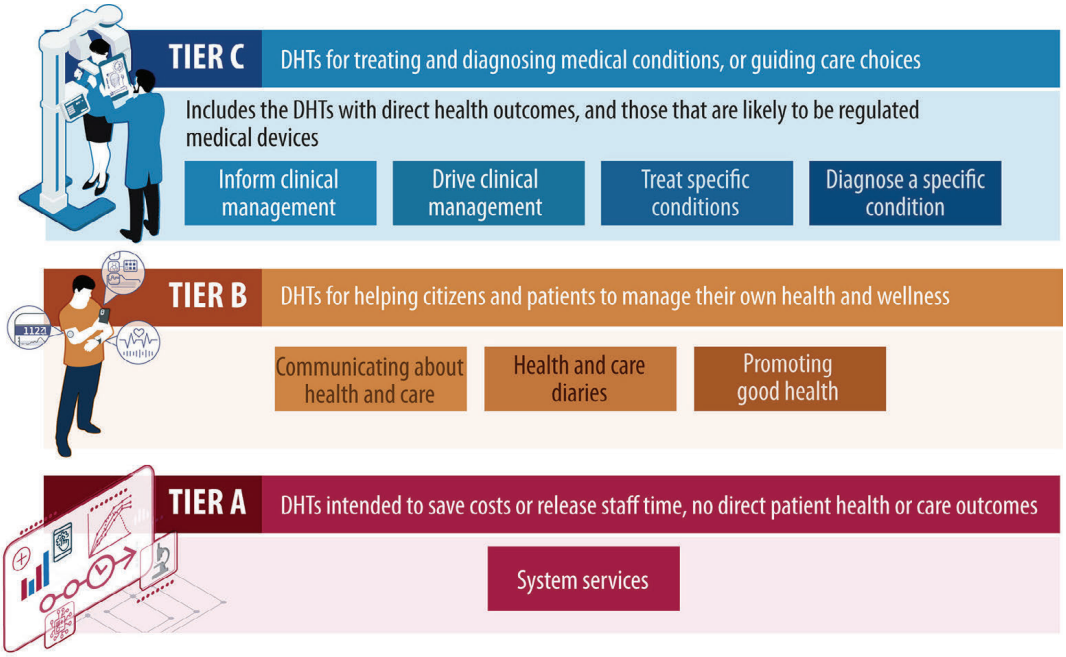
Prioritize based on the defined value that a set of digital solutions brings to a health system. Digital solutions can help facilitate health system outcomes related to financial protection, effective coverage, quality, utilization, efficiency, and equity. Digital solutions can also support the administrative and managerial parts of health system management, such as streamlining payroll, billing, and insurance reimbursement efforts. In considering the digital solutions or information systems to be prioritized in a country, the value they will generate in health care in terms of outputs and outcomes warrants careful consideration. This is a complex undertaking because the associated standardized metrics—akin to a disability-adjusted life year for health outcomes—do not yet exist. For better comparisons on how various digital solutions generate individual and collective value in health systems, such standardized metrics for intermediate health system outcomes will need to be developed.

Prioritize based on evidence that a digital intervention works. Various types of evidence can be used to make decisions about what to prioritize. People-centered approaches reflect a recognition of and build on what others have learned (with firm evidence of such a claim), thereby reusing expertise. There are already pilot projects, blueprints, including operational recommendations, literature, and case studies that can be applied in designing, implementing, and maintaining digital health interventions.

Digital solutions focusing on patients and providers must show, fundamentally, that they are clinically safe and do no harm. Beyond that, evidence of their benefit in terms of patient or provider benefits or preferences is warranted. Digital health solutions

that make clinical claims (either medical devices with digital components, or medical products that are digital, such as digital therapeutics) merit special consideration (see recommendation 3). The UK example shows that evidence standards will differ depending on the purpose of the digital health solution or the benefit the solution provides. The evidence standards for Tier C (digital solutions that make clinical claims) will be much more rigorous than the evidence standards for interventions in Tier A (Figure 34).

Figure 34 Tiers of Evidence from the UK Evidence Standards Framework for Digital Health Technologies



Source: NICE 2023.
Note: DHTs = digital health technologies.

Regulatory frameworks and systems. Countries' regulatory frameworks (for information management, clinical regulations, regulations for medical devices, and regulations for medical products) will need to be revised to accommodate digital solutions. Specific regulatory areas that governments and stakeholders may need to focus on include the following:

- Methodological regulations for HIS development and implementation; requirements for the initial implementation, administration, and maintenance.

- Minimal functional requirements of administrative business processes in health systems
- Clinical regulations for digital-driven medical devices and medical products.
- General technical standards for digital health system development and implementation, such as system platform requirements (hardware, system software, and communication systems), ease of use of software, and ergonomic requirements.
- Regulations to protect human rights and equal opportunities for citizens.
- Regulatory frameworks for medical devices and medical products need to be expanded to include AI-based medical devices and digital health interventions with clinical benefit, including digital therapeutics. Given the pace of technology development and release, the regulatory environment for digital and data interventions is an ongoing catch-up and rapidly evolving process, but several regulatory authorities have made headway.

Context-dependent economic evaluations might also be necessary. The World Bank has developed a framework to support efforts to expand the knowledge base of what works in digital health, the framework for the Economic Evaluation of Digital Health Interventions. (Wilkinson et al. 2023)

Based on the available evidence, four areas stand out for priority investment according to current country and patient need, as well as the value that they can bring, as follows: (a) patient-facing applications to support scheduling and access to health data; (b) digital technology for noncommunicable disease prevention, diagnoses, and management; (c) virtual interactions, such as telemedicine; and (d) electronic health records and health information exchanges.[1]

Considering the current gaps in the evidence base, not all digital health innovations have evidence-based precedents, creating a paradox, “no evidence, no implementation, and no implementation, no evidence” (World Bank 2023, 49). In these cases, rapid evaluations with a theory of change with several layers of ministeps might be needed to adjust rapidly on the ground as new lessons about implementation are learned and before any health claims are made. Investments should introduce small-scale, concrete

[1] These are not exclusive areas of focus, but rather ones where the World Bank anticipates the greatest demand based on the assessment that this is where the most value can be found. However, recognizing this, great care should be taken especially in terms of setting up electronic health records and health information exchanges and avoiding the costly mistakes that governments and stakeholders that have already gone down this path have made.

changes to processes in ways that minimize technical debt and that maximize quick wins.

The World Bank will support governments in the following:

- In implementing a priority set of digital health interventions that the government has determined will bring the most value for the country
- In transitioning from siloed, unconnected HISs or digital health interventions where the value is not defined
- In building the evidence base for digital health, including economic evaluations

Recommendation 2. Reaching the underserved: Choose digital health solutions that improve access to and availability of health care services among vulnerable and marginalized groups

Digital health technologies have significant potential to improve equity by making health care more accessible, affordable, and tailored to individual needs. While digital health holds promise in improving equity, the digital divide can also exacerbate health inequities if these are not addressed. Efforts to use digital health to improve equity should therefore be paired with efforts to bridge the digital divide. Ways in which the digital-in-health mindset can improve equity and reduce health disparities include the following:

- **Access:** One of the primary ways digital health can improve equity is by increasing access to health services. For instance, telemedicine can connect patients in rural or remote areas—where health care resources might be scarce—with doctors and specialists in urban centers.
- **Language and cultural barriers:** Digital health platforms can incorporate translation services, culturally appropriate content, and tools to make health information more accessible and understandable to diverse populations, breaking down language and cultural barriers.
- **Health literacy:** Digital health can provide educational materials and resources to individuals who may not have received adequate health education. Interactive health apps can also promote understanding and engagement with one's own health.

- **Chronic disease management:** Digital health technologies, such as wearables or mobile health apps, can help monitor chronic diseases and provide real-time feedback, which is particularly beneficial for marginalized populations that may exhibit a higher prevalence of chronic conditions because of the social determinants of good or poor health.
- **Tailored interventions:** Digital health technologies can be used to personalize health care to the specific needs of each patient. This includes the ability to customize interventions for marginalized communities that may have unique health care needs.
- **Data collection and analysis:** Digital health tools can capture data to identify and address health disparities. They can provide information about population health trends, enabling targeted interventions in areas where health disparities are most pronounced, including through geospatial analyses.
- **Mental health support:** Digital mental health services, such as therapy apps and online support groups, can make mental health care more accessible and less stigmatizing, particularly in communities where such services are lacking or taboo.

Connect to Deliver New, More, Better, and Seamless Services

Recommendation 3. Leadership and partnership: Drive digital health action within and across sectors through strong country leadership

Country leadership for digital-in-health is vital. Such leadership would define the rights, standards, responsibilities, and risks pertaining to digital health technology and the use of health data. This needs to be carried out in ways that address the disparities in access to digital technologies and that reduce inequities in health outcomes among vulnerable populations.

> This transformation requires governance that addresses rights, regulations, responsibilities, and risks in areas such as internet and health, using health data, and information systems. The aim of digital health governance is to improve the quality, efficiency, and effectiveness of the health system (Carnicero and Serra 2020, 5).

Leadership teams and processes. As the system matures, increasingly complex governance and dedicated teams are needed to lead and govern digital health

investments, with clear process management procedures. A critical dimension is how to manage all processes. Who will do what and what is the institutional framework? The level of maturity of digital health in a country determines the complexity of governance needed. Typically, governance structures grow incrementally. Early-stage implementation does not require overly complex governance levels and structures. Indeed, too much governance can slow development. Once implementation accelerates, demand and supply become more mature, and more systematic governance efforts are required to guide the development, regulate the market, manage health data, and so on. (Annex E details the various layers of management that countries should consider.)

Strategy for the health sector that includes digital health. A key component of better digital health governance is to have a strategy. Typically, this is either a digital transformation strategy for the country, a digital health strategy, or a health sector strategy that includes digital technology and data components (or a combination of these). Developing such strategies is also one of the four goals of the WHO global digital health strategy. Developing and publishing a national strategy that includes digital health, alongside a costed road map for the implementation of the digital aspects of health system strengthening, represent a key step in the establishment of the foundations for digital health to deliver benefits for all. A digital health strategy provides a common vision and direction, identifies the roles and responsibilities of all stakeholders, links digital health interventions to health system challenges, and determines the resources that are needed.

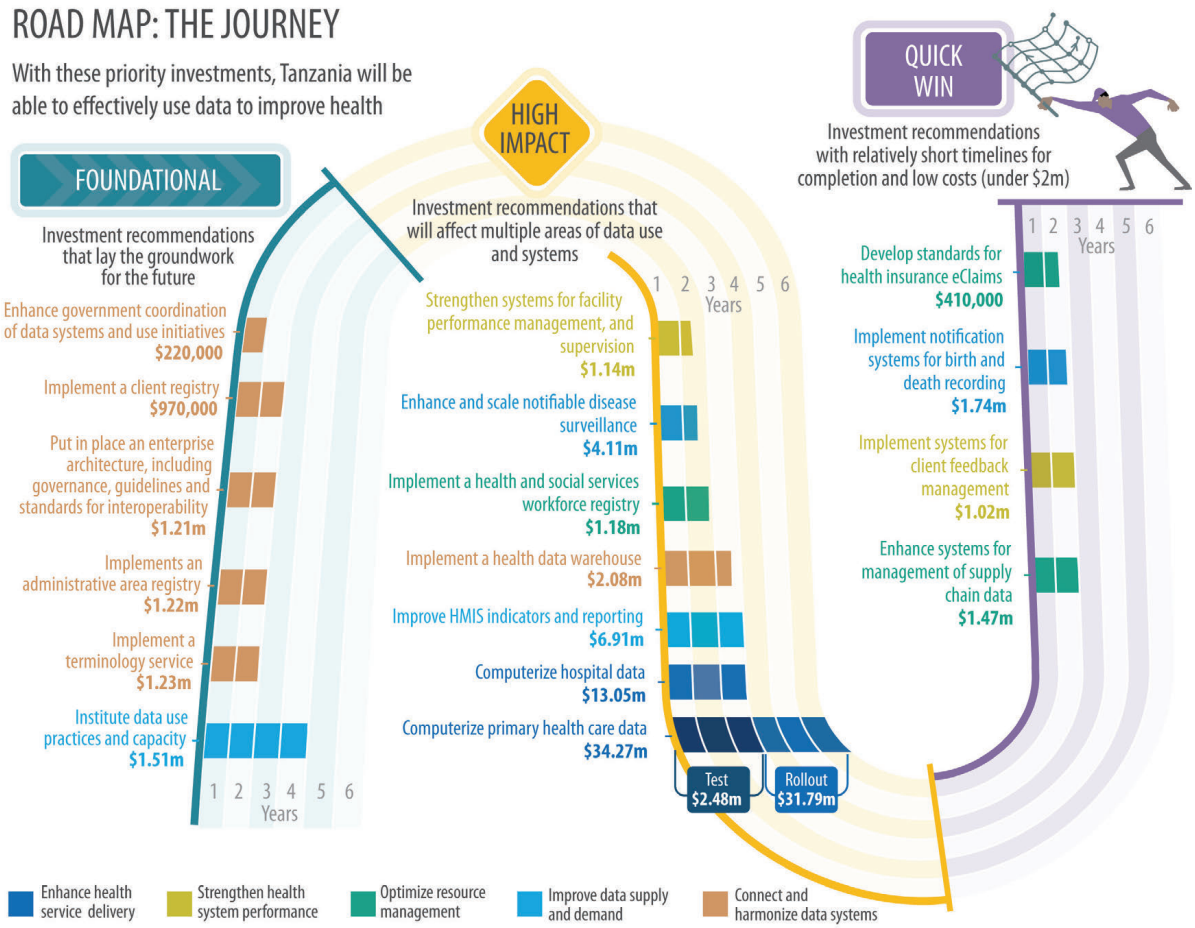
The strategy and, in some cases, its related action plan establish the roles and responsibilities of all stakeholders. The strategy thereby highlights the location of institutional and human capacity gaps. The strategy and action plan also provide a blueprint for horizontal elements (that is, those elements that apply across all applications and services), such as enterprise architecture, interoperability, data governance, cybersecurity, standards, certification, private sector engagement, innovation, skills, and education. The strategy can also prioritize or refer to specific services and applications based on health system objectives (for example, digital health records, telemedicine, and claims management).

Beyond the strategy document, a successful strategy entails a deal among stakeholders. In this sense, stakeholders need not only to be actively involved, but must also to co-own the strategy in the sense that they will use their energies and funds to help implement it. This is essential to realizing a strategic plan, from document to execution. Investment cases and sectorwide approaches are practical tools to help in this process.

Costed and phased road maps linked to a wider digital transformation agenda—particularly sectorwide approaches for digital health investment at the country level—are

an essential tool in breaking the investment fragmentation impasse that has existed globally and in countries. The road maps need to be phased and costed, taking country realities and incentives into account. Figure 35 shows the phased investment road map for digital technology in the health sector in Tanzania. It shows the five objectives of digital health investments and the kinds of investment choices, with associated costs and timelines to implement. Such a prioritized menu of options, clearly linked to health system transformation objectives, with costs and durations, will help the government select a set of investments that are a combination of long-term developments and quick wins, expensive and less expensive options.

Figure 35 A Road Map for Digital Health Investments, Tanzania, 2017–23



Source: Government of Tanzania 2017.

Note: m = millions.

It is also critical that countries track expenditures in digital technology in the health sector. Whether the national health accounts system or other approaches are used to track health expenditures, expenditures on digital technology and data systems should be part of the reporting. This will ensure that actual expenditures are tracked against digital health road maps and plans and in planning future investments and determining the cost of digital solutions, which is useful for economic evaluations, including cost benefit and cost-effectiveness analyses.

The World Bank will work in partnership with other development partners and regional organizations to support countries in accomplishing the following:

- Strengthening country leadership and partnership for digital-in-health
- Developing and using investment case experiences and sector-wide approaches to country digital health planning and prioritization considering the evidence and successful Global Financing Facility model
- Track domestic and international development investments in digital health as part of health expenditure tracking systems and processes

Recommendation 4. Data governance and regulations: Reinforce ethical standards and regulatory systems for equitable and trustworthy digital solutions

Regulating the use of data that are growing at an unprecedented rate is a vital part of digital health governance. This requires significantly strengthening health data governance and building an innovative and agile regulatory environment to keep pace with digital innovations and ethical standards that protects against unbiased and unfair use of data.

Health data governance. National strategies should emphasize the creation of a healthy digital environment for future generations. Without a precautionary, mission-oriented, and value-based approach to governance, digital transformation will fail to produce improvements in health for all (Kickbusch et al. 2021). This is especially urgent given the rise of AI technologies and the way they use data. As digital technologies continue to impact health care and are accelerated by the rapid development of novel solutions such as AI, governance and legislative frameworks must be developed and evolve quickly to keep up, especially a legislative environment that stimulates the growth of evidence-based solutions and data sharing, while protecting the privacy and data of citizens (World Bank 2023). The publication and dissemination of trustworthy, accurate high-

quality data in a timely manner by governments, health authorities, and researchers is crucial to combating mis- or disinformation campaigns.

World Development Report 2021 (World Bank, 2021b) advocates for governance arrangements that support the generation and use of data in a safe, ethical, and secure way, while also delivering value equitably. This requires a balanced mix of enablers and safeguards that promote data generation and use while protecting against harmful misuse. Creative novel methods for reusing and repurposing data are opening doors to new business models that can bring equitable benefits to all of society. For example, the Ministry of Social Affairs and Health in Finland introduced the Act on Secondary Use of Health and Social Data to facilitate the effective, safe processing and access to personal social and health data for steering, supervision, research, statistics, and development in the health and social sectors.

Ethical standards for health data and AI governance. *World Development Report 2021* highlights that the scope for discrimination based on ethnicity, religion, race, gender, disability status, or sexual orientation may be exacerbated by the growing use of algorithms (World Bank 2021). The report advocates for addressing these concerns through the regulation of personal data grounded in a human rights framework and supported by policies that secure both people and the data systems on which they depend. The growing use of algorithms, including recent developments in generative AI and their dependence on high-quality data, has put a spotlight on the ethical implications of using personal data. Several reports raise serious concerns regarding algorithmic bias, surveillance capitalism, and, in some cases, faulty predictions. For innovations in AI to generate equitable benefits, ethical standards that promote trust, inclusiveness, and fairness need to be embedded in health data and AI governance.

The crossborder exchange of health data and information not only allows patients to receive health care using new business models abroad, but also promotes research and development by increasing the scope and volume of the available data. Regulatory improvements at national and international levels that enable personal data transfers across borders with data protection and security safeguards are critical to harnessing the potential of crossborder digital health innovations. In addition, crossborder activities need to address other challenges, such as frameworks for medical device regulations, portable medical licensure, or mutual recognition of license issues to keep pace with the increasingly crossborder nature of digital health solutions. Crossborder data flows are especially helpful for research on rare diseases. Initiatives such as the Global Digital Health Partnership and the European Health Data Space are promoting international agreements on semantic and technical digital interoperability. Others, such as the United Nations System Chief Executives Board for Coordination, are seeking to create global principles and mechanisms as a universal framework for regulating data flows.

Cybersecurity, digital security, and business continuity. Cybersecurity incidents in health care facilities can restrict access to critical health data and disrupt work flows. The rising number of cyberattacks threatens the health and lives of citizens. The scale of the data breaches in health care is increasing (CyberPeace Institute 2021) and requires concerted action, as part of data governance efforts. Cybersecurity relates to the security of technical assets (for example, HISs and networks), while digital security refers to the measures taken to manage the security of the economic and social activities and prosperity that rely on those technical assets (for instance, the delivery of emergency health services) (OECD 2022). Thus, a cyberattack on a health care facility may subvert the security of technical assets (for example, by causing the facility to shut down its IT systems) and the security of economic and social activities (such as by causing the facility to divert urgent care to other facilities). As digital technologies become increasingly embedded in health systems, governments and stakeholders also need to consider the offline business continuity considerations of ensuring that services remain functional even if the digital aspects do not work.

The World Bank will work in unison with other development partners, regional organizations, and the private sector to support governments in strengthening all aspects of health data governance within and across countries.

In support of global health data governance and donor alignment principles, the World Bank will aim to ensure that its investments in information systems and digital health interventions adhere to (a) a country's digital health data governance framework and (b) a country's digital health regulations and interoperability standards. If such regulations, standards, and data governance frameworks do not exist, the World Bank will support governments in developing them.

The World Bank will continue to collaborate with development partners and countries in the design and development of global standards, norms, and governance mechanisms for health data governance.

Recommendation 5. Digital infrastructure and health information gaps: Connect facilities, services, information, and people, fill in health information gaps, and connect siloed HISs

Connectivity to the digital world is essential today. One of the most telling explanations for this high priority is that lack of affordable and functional connectivity (speed and bandwidth) is often cited as a reason vulnerable communities and individuals are not linked to the digital economy (Connect Humanity 2023) or to the digital aspects of health care. Few international comparative data are available about the status of the active

connectivity of health facilities, health workers, or the populations that they serve, except that the GDHM index on infrastructure estimates that 50 percent to 75 percent of health facilities are not yet connected.

Ensuring that health facilities and populations have access to meaningful connectivity (connectivity that is adequate for the needs of technology and patients and affordable, reliable, and commercially viable) is a priority as one of the aspects of the foundation that needs to be completed to grow digital-in-health.

With 95 percent of the world covered by mobile broadband, few places are not connected. But there may be impediments, such as prohibitive costs, gaps in digital literacy and digital skills, and internet of things devices that do not operate on mobile broadband (Box 5). Where internet connectivity is not yet feasible (for example, too expensive), suitable offline solutions must be built into a country's health digisphere.

Box 5 Giga for Education: A Global Initiative to Focus on Connectivity in Education

Launched in 2019, Giga aims to connect every school in the world to the internet. Giga is a United Nations Children's Fund and International Telecommunication Union initiative to connect every school to the internet by 2030.

A similar initiative for the health sector might be needed to ensure good quality (affordable, reliable, and sufficient) internet connectivity at every health facility.

A similar United Nations Children's Fund initiative to connect health facilities has recently been launched.

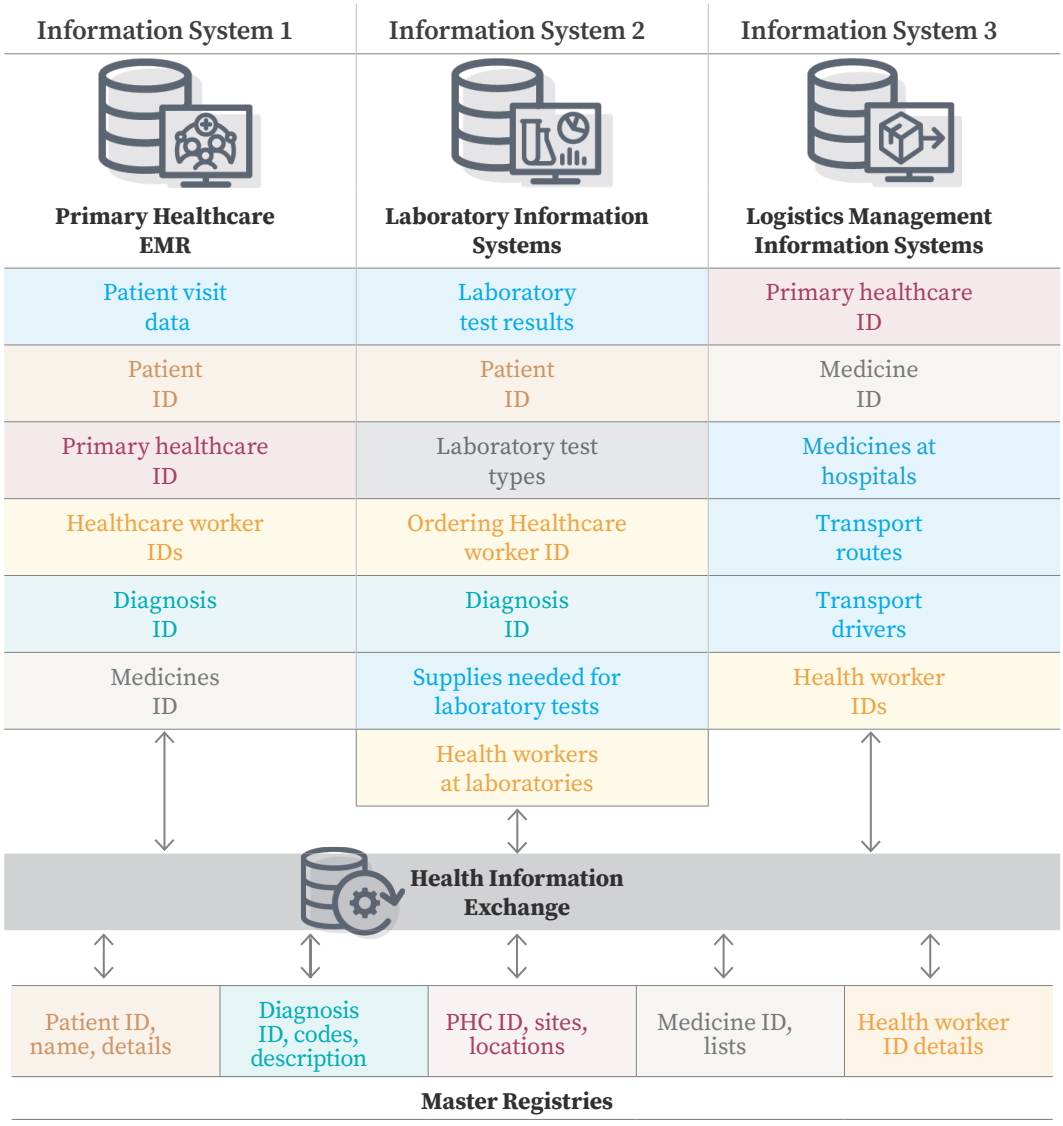
In support of Sustainable Development Goal 9, target 9.c (significantly increase access to information and communications technology and strive to provide universal and affordable access to the internet in least developed countries by 2020), the World Bank will work with other development partners, regional entities, and countries to support the following:

- Meaningful connectivity of health facilities and health workers to the internet and to each other
- Efforts to expand internet access to populations in affordable and equitable ways
- Measurement of progress by assisting governments in including relevant metrics of connectivity in health-related surveys and routine data collection efforts

Filling in health information gaps, is paramount. The Global Strategy on Digital Health (WHO 2021c) recognizes the importance of integration and harmony within the digital and data aspects of health systems. For the next phase of the digital technology evolution in health to take hold, the remaining health information gaps need to be filled, and disparate, disconnected, and siloed information systems need to be connected and

exchange health information with each other (Figure 36). Doing so will help ensure that every country creates health-focused DPI that will go a long way in reducing the small islands of health data challenge, that is, the proliferation of siloed and disconnected health information.

Figure 36 Connected, Linked, and Distributed Information Systems with Core Central Registries



Source: Authors.

Note: EMR = electronic medical record; ID = identity, PHC = primary health care.

Data gaps exist either because data that should be recorded and processed are not, or because data are recorded using paper records that have no portability and that one cannot directly connect with another set of information. One of the main gaps are in digital health records, which is the data about a person and the health care that they receive every time that they interact with the health system.

Digital health records, stored in different HISs, are the bedrock of health care delivery. Yet, not all countries use them, and, where they are in place, a patchwork of disconnected and fragmented HISs, without a central or organized structure, often exists. Many low- and middle-income countries still use paper-based patient cards, medical records, and registers at the facility level. These data are often digitalized at aggregate, facility levels, perhaps only monthly. This leaves significant gaps in digital health records, duplication where they do exist, and a real difficulty in transferring records from one location or one service provider to another.

HISs are also fragmented and disconnected with separate unlinked digital health record systems often existing for the same persons at different timepoints and for different health services; for example, pregnancy data, malaria data, and vaccination data on the same individual may be stored in different places and at different times.

Reducing paper recordkeeping and replacing it with digital health records that are linked and that enables one to track a person from birth to death, through all life events, regardless of whether their location or other attribute change in status, are what every country should strive for as a major area of digital-in-health growth. Jousset et al. (2023) estimate that going paperless could bring around 30 percent of efficiency gains to health systems. To support health care service delivery, electronic health data should be accessible to providers and people over time and across locations where health care is delivered and used. Properly implemented HISs allow patients and health care professionals to use the data from operational databases at the point of care (Figure 37). This not only improves health care service delivery, but also incentivizes data providers to capture data in a timely and consistent way.

Reducing paper recordkeeping also improves data quality. The implementation of operational HISs at the point of care eliminates the problem of digital discontinuity and allows data to be extracted, not collected (Figure 38). Data from operational databases can be automatically extracted to secondary data analysis tools and systems, based on agreed rules and without cumbersome manual intervention. The process improves efficiency and all aspects of data quality.

Figure 37 Use of Collected Data at the Operational Level

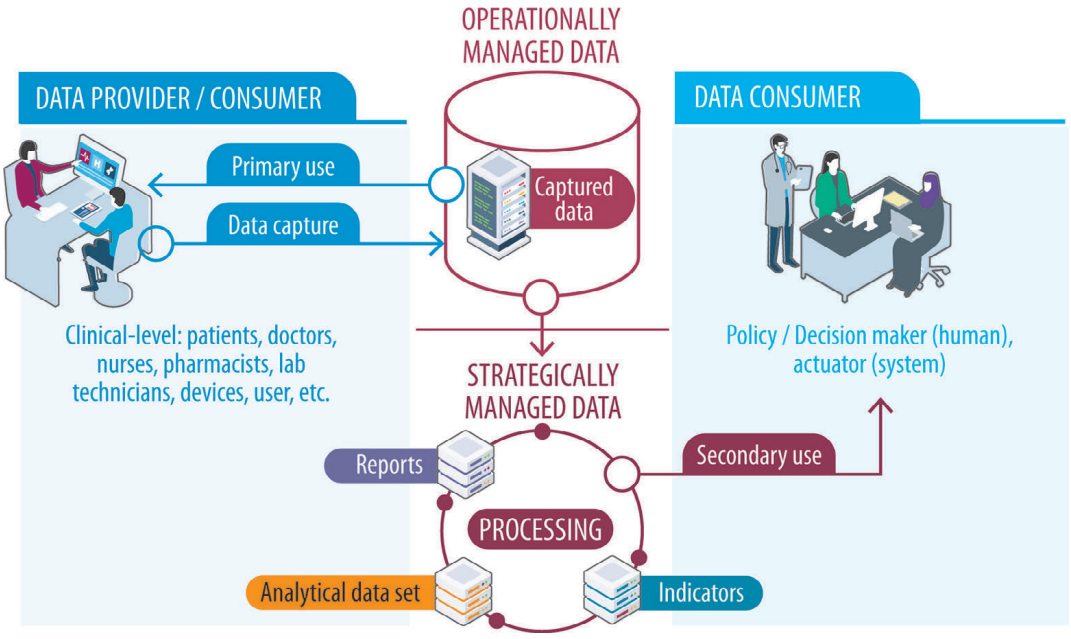
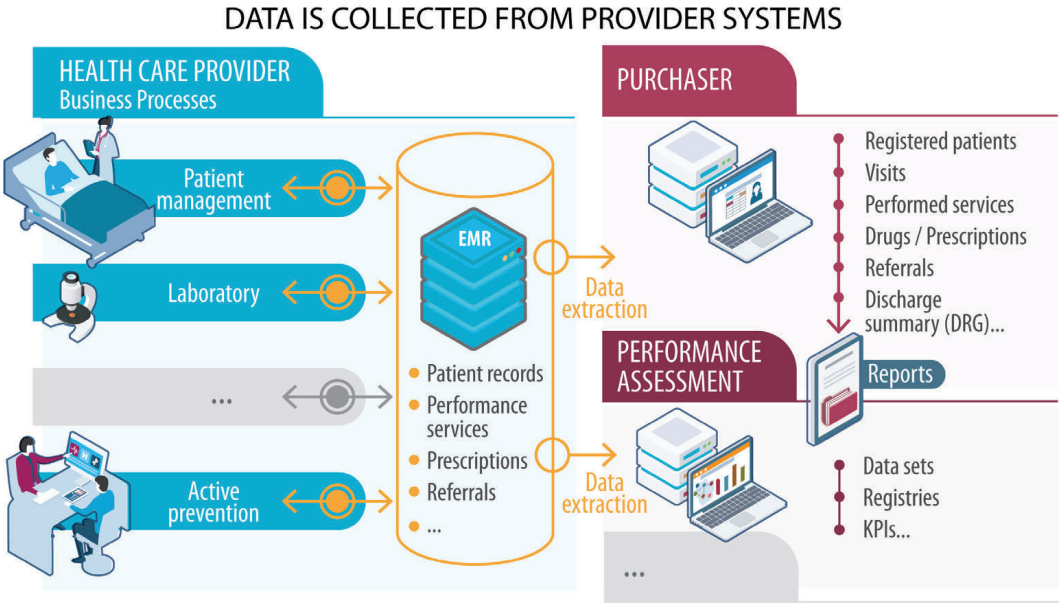


Figure 38 Eliminating Digital Discontinuity through Electronic Health Record Approaches



Over and above filling the gaps, the other gap that needs to be addressed is the siloed and fragmented HISs. Because a patchwork of HISs already exists in many countries, some digital and some not, bringing different systems together will require focusing on the following aspects.

Enterprise planning and platform approaches. Graduating data systems into a more well organized and integrated data and information system architecture is foundational. Platform approaches to digital-in-health begin with defining business objectives and evaluating data-related policies, rules, and standards. This includes consolidating information from appropriate business domains or registry services and may accelerate innovation in new digital health applications through the use of common shared functions with reduced risk. This is not an expensive or time-consuming endeavor and is a step most governments should be able to accomplish. Rwanda and Tanzania were, early on, making considerable headway in integrating these standards into a health enterprise architecture at a national scale. Several other countries in Africa have since followed suit (Mamuye et al. 2022, 1). "Results revealed that African countries have paid attention to the development, improvement, adoption, and implementation of the HIE [health information exchange] architecture for interoperability and standards."

Strategies on how to bring data about health together. Information systems should be linked, particularly as virtually all countries in the world today already have some form of digital HIS that digitalizes at least one aspect of health data. Different options exist as to how to bring data together, each with its own benefits and risks. A government may decide to pool all its health data together in a data lake, or, at the other extreme, maintain entirely separate systems. An interim and balanced option is to create a health information exchange, which separates the core and common aspects of health data into a central set of registries that then exchanges this with the individual health applications (see Figure 34). In adopting this option, one should take care to ensure that duplicate paper systems are removed and that a duplicate paper system is not maintained alongside a paper system.

Integration, interoperability, and standardization. Beyond infrastructure and sound governance practices, foundational information building blocks may include client, facility, and provider registries, national data dictionaries, and clinical guidelines. This enables digital health platforms and their subsequent interventions to be not only technically compliant, but also guideline adherent in supporting patients, providers, or health sector managers in delivering the best care. An enterprise or platform approach steers toward interoperability, which serves users and their respective work flows in the health care ecosystem: patients, providers, health system managers. It enables the work flows (including data) that they need to ensure accountable, high-quality, guideline-adherent care.

With a health enterprise architecture approach, individual information systems and digital health interventions need to abide by interoperability standards and other technical standards (for instance, cybersecurity and minimum data exchange standards). With the health sector increasingly reliant on digital technologies and assets, HIS interoperability is important. The interoperability of health information needs to be ensured in the context of the integration of health services. It typically entails (a) agreement on standard ways and formats (a common data transfer language) for exchanging health information (Box 6), (b) a set of rules about what is exchanged, and (c) how the data can be accessed and used (that is, the data governance aspect, discussed under recommendation 2).

Box 6 Range of Open Standards for Exchanging Health Information

Governments are encouraged to use standards for health data exchange that are open. Standard means that there is a common scheme for health data, calculations, and information exchange, and open means that various governments and providers can access and use them, instead of each government developing its own. Open standards that have emerged in the health sector include the following:

Digital Imaging and Communications in Medicine is the international standard for transmitting, storing, retrieving, printing, processing, and displaying medical imaging information.

Fast Health Care Interoperability Resource, based on Health Level Seven (see next), is an interoperability standard intended to facilitate the exchange of health care information among health care providers, patients, caregivers, payers, researchers, and anyone else involved in the health care ecosystem. It consists of two main parts: a content model in the form of resources and a specification for the exchange of these resources.

Health Level Seven is a comprehensive framework and related standards for the exchange, integration, sharing, and retrieval of electronic health information that supports clinical practice and the management, delivery, and evaluation of health services. Level seven refers to the seventh level of the International Organization for Standardization's seven-layer communications model for open systems interconnection.

International Classification of Diseases is the international standard for the systematic recording, reporting, analysis, interpretation, and comparison of mortality and morbidity data (WHO 2022c).

Box continued...

Box 6 Range of Open Standards for Exchanging Health Information (continued)

International Classification of Health Interventions is a common tool for reporting and analyzing health interventions for clinical and statistical purposes. It covers interventions carried out by a broad range of providers across the full scope of health systems.

Logical Observation Identifiers Names and Codes is an international standard for identifying health measurements, observations, and documents.

Systematized Nomenclature of Medicine Clinical Terms is a set of standards for a codified language that represents groups of clinical terms. This enables health care information to be exchanged globally for the benefit of patients and other stakeholders

Interoperability extends beyond the interoperability of data. It also encompasses the interoperability of content and of process, that is, technology and health services working seamlessly together to deliver the best care in the right way to everyone who needs it. The interoperability of the content of clinical work flows and the ways in which health services are being delivered is also key. WHO's SMART Guidelines effort—the ultimate digital public goods approach—aims to improve the content of digital technology applications in health care.[2] It achieves this through a comprehensive set of reusable digital health components (for instance, interoperability standards, code libraries, algorithms, and technical and operational specifications) that transform the guideline adaptation and implementation process to preserve fidelity and accelerate take-up. Based on the SMART guidelines definition of the content of, for example, a diabetes app and a country's data interoperability standards definition of how the app exchanges information with other HISs, any app developer can derive a digital health solution that meets not only WHO standards in terms of what constitutes good health care, but that also meets country requirements in health information exchange and protection.

Certification in the context of integration and interoperability. Because most countries already have some information systems and digital health interventions, certification is important. Certification can be used to bring existing information systems and digital health interventions into the fold of a national interoperability framework and enterprise architecture approach. Certification is merely a way for ministries of health to verify that an individual digital health intervention or HIS meets a country's minimum requirements and that it may therefore interact (or operate together) with other parts

[2] See SMART Guidelines (dashboard), World Health Organization, Geneva, https://www.who.int/teams/digital-health-and-innovation/smart-guidelines. SMART = standards-based, machine-readable, adaptive, requirements-based, and testable.

of the health information ecosystem in the enterprise architecture. This allows multiple apps to be used, and governments and stakeholders do not need to make difficult decisions about choosing only one app for front-line health workers. To do certification well, one approach that has been extensively used with great success in the Fintech sector is regulatory sandboxes. This use in the fragmented and unregulated digital health intervention space is being tested by a few pioneering country actors, including in India, Indonesia, and Kenya.

> The concept of the regulatory sandbox—a safe space for testing new regulatory processes—was first used within the financial technologies (FinTech) sector, but has since expanded into other sectors, including health care. HTA [health technology agencies] should consider this approach to facilitate developing policies, methods, and processes for innovative and disruptive health technologies (Leckenby et al. 2021, 857).

The World Bank's experience with regulatory sandboxes in the FinTech sector shows the potential of this approach for reducing fragmentation and creating an open marketplace (World Bank 2020). It makes the standards transparent that digital solutions must meet to be part of the national health digisphere in a country. Any app developers who meet the country's interoperability standards and obtain the relevant content and work flow information from the SMART Guidelines effort can be confident that their solutions will become part of a growing corpus of digital public goods (Box 7).

Box 7 An Inclusive Approach to Public Digital Health Goods

Public goods in the digital space are digital solutions that can be linked with other solutions, typically reflect extensive experience in their use, and are available for easy adaptation. In the digital health space, several digital health applications have been deemed digital public goods. The discussion often centers on the software and whether it is open source or proprietary. With the rapidly changing digital landscape, what works in a particular country context cannot be based only on the software or the nature of the software, but must encompass the approach.

Indeed, it may be argued that, in an era in which connectivity among solutions is a big gap, open access (that is, access to the software in an application through an application programming interface) is as important as open source.

Keeping the focus on an approach that supports communities of practice, open development, interoperability, standard and guideline-adherent care, and training courses will play a critical role in the successful implementation of a digital intervention, regardless of whether it is labeled a digital health public good.

A careful balance is needed to ensure that a digital public goods approach does not exclude new entrants or local players from developing digital solutions, for fear that those solutions may not instantly become so widespread that they are public goods. Digital public goods approaches should not stifle or crowd out local innovation. By adopting open interoperability standards and open access and by following the WHO SMART Guidelines for content, the digital public goods space can be expanded to accommodate a wide(r) range of stakeholders, including homegrown innovators.

Unique identifiers. The last of the five aspects to consider in bringing health data together is unique identifiers. Unique identifiers are a way to identify every patient across space and time.

An example of a concerted effort to fill in health information gaps and connecting health information dots can be found in India's Ayushman Bharat Digital Health Mission. The case study In Annex F shows the journey on which the government and stakeholders in India have embarked to change the fragmented, disconnected, and isolated health data landscape to a much more integrated one. The Ayushman Bharat Digital Mission seeks to realize a digital health ecosystem by promoting an enterprise approach. The approach relies on a platform based on open application programming interfaces, whereby the building blocks and components of the initiative are designed to be interoperable to facilitate the safe exchange of data among information systems that are not inherently interoperable. Under the initiative, as of August 2023, nearly 442 million ABHA numbers (unique identifiers for participants in ABDM) were generated, and 293 million patient health records were linked to the individuals' ABHA accounts. In addition, a total of 110 digital health services/applications have been integrated with ABDM. Annex G illustrates the challenges in Indonesia's health system and how the digital health vision in Indonesia—moving from data for reporting to digital in services—is being realized through enterprise approaches and strong regulatory standards.

The World Bank will work with other development partners and regional entities to support governments in their efforts to accomplish the following:

- Fill in health information gaps
- Ensure that interoperability standards are in place and used
- Connect the fragmented HIS landscape
- Create systems to certify existing and new HISs and digital health interventions
- Implement rights-based approaches to health data and encourage efforts to ensure that persons have access to their own electronic health records

Recommendation 6: Global and regional collaboration: Global and regional solidarity to support countries as they lead in digital health investments

The need for global collaboration in digital health is well recognized. Typically, many development partners are involved in digital health technology and data investments

in a country. One partner might finance a logistics information system, while another partner might finance a community health worker app in a district HIS rollout. During the past decade, laudable efforts have been made by these development partners to come together, to recognize that possible duplication and gaps exist in what they are financing individually, and to discuss how they can work together more effectively. In support of this goal, many development partners—including the World Bank—signed the Donor Alignment Principles on Digital Health. Other efforts, such as the Global Digital Health Atlas, have also represented attempts to coordinate digital health investments, reduce fragmentation, enhance interoperability, and foster better alignment at country level. But these efforts are driven by development partners, not countries.

Increasingly, regional institutions have also recognized that they have a role to play in digital health efforts. The Africa Union, for example, is in the process of developing an Africa-wide digital health strategy and data regulations, and the Africa Centers for Disease Control and Prevention has supported efforts to coordinate health data during the COVID pandemic and beyond.

None of these global or regional collaboration efforts can substitute for the essential role that governments have to play in directing and leading digital health efforts at the country level. Stakeholders in countries expressed the idea this way: "There is a need for a value set, decentering, sharing, of togetherness, of collaboration at the right level. Not like the former concepts of collaboration where the North brings things to the South and the South executes them under the North's direction" (van Stam 2022, 665)

The World Bank will work with other development partners and regional institutions to strengthen global and regional collaboration that puts governments in the driver's seat.

Scale to Ensure Equitable, Replicable and Sustainable Access to Health Care

Recommendation 7. Digital skills, literacy and trust: Help patients and providers understand, trust, and confidently use new technology and data

With the growth of digital health, the capacity to implement more digital health also grows. Insufficient capacity is one of the reasons for the slow progress in digital health implementation, but also one of the outcomes of digital health growth. Instead of looking at capacity as a barrier, governments should focus on creating stable

mechanisms, such as preservice and in-service training and creating new cadres of technicians. They will gradually improve organizational and individual capacity to deliver and use the digital health services.

Without skilled human resources to design and maintain digital technologies and systems and without users of the system who are able to do so effectively, digital solutions will not be implemented, used, or maintained as intended. Digital literacy and skills encompass focusing on seven types of skills: (a) digital literacy among the general population to use and trust technology and also be aware of the limitations; (b) digital skills for patients to interact with, use, and understand specific digital technology; (c) health care providers and health system managers who are able to use and interpret results from specific digital technologies; (d) education among patients and users of technology to accept, trust, and use technology for the intended purposes; (e) a new cadre of specialist medical technicians certified or accredited to support the deployment and maintenance of these new technologies; (f) technical skills to design, evaluate, and monitor the implementation of digital technologies; and (g) research skills to evaluate effectively the use of technology in health.

Change management processes and efforts to improve trust in technology and data are also needed. Digital health innovation is part of a broader connected health ecosystem. Robust business models must therefore include the highest ethical standards. This is especially true for data-based solutions deployed on the market. Ethical considerations about these solutions should include transparency in data acquisition and exchange and the ability of users to control their own health data. This is vital if innovation is to become part of a trusted health care system (World Bank 2023).

Gender and social inclusion and equity should also be carefully considered. With the increasing ubiquity of AI algorithms and the risk of widening in the digital gap in health care, it is necessary to address the ethical challenges of digital health innovation. Individuals should be able to manage and control their health data easily after all digital health innovations. Digital health should be inclusive, accessible, and affordable to avoid creating growing divides between those who have access to digital health and those who do not. This is true especially because digital health disparities are likely to mirror disparities among socioeconomic groups and those with varying levels of digital health literacy (World Bank 2023).

The World Bank will work with other development partners and regional organizations to support governments as they seek to accomplish the following:

- Build digital skills and literacy
- Expand medical education preservice and in-service curricula to include digital skills
- Build cadres of medical technicians who can support digital technologies in the health sector
- Build trust in digital solutions and increase the demand for their widespread use

Recommendation 8. Nimble public-private and private-private partnerships: Innovate in how the private and public sectors work together to design, deliver, and fund digital health solutions

The public and private sectors working together. The private sector is a producer and user of solutions that offer the public sector many options for supporting the strengthening of systems and service delivery. Given the gaps in demand and supply facing many health systems and with the intent to realize UHC ambitions, the opportunity for the public and private sectors to work more closely together is a potential growth area. However, in many or perhaps most markets, the private and public sectors in digital health will need to find new ways of collaboration and adopt innovative partnership and contracting models. Failure to adopt change will undermine the benefits to be derived from a digital-in-health strategy and could, in a worst case scenario, lead to questionable financial decisions and motives in the selection of solutions.

If private developers of digital health are to grow quickly and sustainably, they will require the support of investors. Investors who support the development of digital health solutions will be looking not only at basic market growth indicators, such as the total addressable market and company performance, including some demonstration of an ability to scale, but also at a regulatory environment that ensures a predictable ability to operate and a level playing field.[3] From an individual business perspective, investors often feel more comfortable investing in companies that apply a commercial or business

[3] Uncertain regulatory environments have often been a point of concern for many investors. A prime example is the uncertainty of telehealth regulation in Brazil.

model that is replicable and scalable and that has achieved at least some initial traction as measured by sales, but that has also demonstrated market fit. Most business models can be categorized as business-to-consumer, business-to-business, or business-to-business-to-consumer.

Government as a customer may be comfortable with a business-to-government business model. However, investors may shy away from companies that generate most of their revenue from government, particularly if these are based in less stable markets and if there are concerns about procurement and contracting robustness. There are several challenges in working with governments, including the contracting process, which may be time-consuming and lack transparency, and the reliability of a government contract, as well as the timeliness of payment. There are many examples of lengthy contracting cycles with governments, unexpected contract terminations by governments, and lengthy delays in payment, adding significant accounts receivable days to the balance sheets of the private company. The impact of these challenges in working with governments is amplified in the case of digital health solution innovators, which are often earlier stage companies that may still not be profitable and may not have access to adequate working capital financing. For example, one IFC health care portfolio company was generating around 80 percent of its revenue from a government contract. Following an election that brought in a new government, the contract was cancelled overnight. The young company had to scramble to change its business model to survive and now largely generates its revenue on a business-to-consumer basis. Even today, the longest accounts receivable days the company carries remain associated with the contracts it makes with the government.

Many digital health innovators secure pilot contracts directly with the government or through donor funding. However, there is no long-term guarantee of continued funding even if the project is proving successful. While it is important and an imperative for governments to make clean, transparent procurement decisions, private sector players (for profit and not for profit) and their investors will be anxious to understand the requirements for longer-term contacting.

To increase this payment resiliency in public-private collaboration, industry leaders in the investment community, such as IFC, can and should encourage new methods of contracting to help embed these providers into the fabric of public provisioning. IFC and others may, for example, apply resources to help evaluate appropriate models for supporting public and private digital-in-health collaboration. To solve this contracting problem on the public side, there must be more detailed needs assessments and greater understanding of the digital health landscape by governments, plus a willingness to work with the private sector if appropriate. Many governments will require help in identifying their digital-in-health needs clearly and in determining when and how to engage with

the private sector. In embarking on digital-in-health strategies, it is advisable from the outset for governments to consider how they source and sustainably fund solutions in the longer term. Entities such as IFC that understand the private sector can provide governments with support and insight.

Innovations in public-private collaboration. The opportunities for public-private collaboration are wide-ranging, but require careful evaluation (for example, contracting for specific solutions or a service that includes a digital option). The structure and oversight of the health system by government vary by country. Innovative thinking in the public and private perspective is required to establish the most appropriate partnerships. Innovation occurs quickly in digital health, and solutions can become stale if they are not updated in a timely fashion. Ideally, governments should therefore identify innovative models of collaboration that involve support for rolling wave development and that maximize value for money (best cost for best outcome and long-term benefit).

Contracting methods should be considered following an upfront assessment of the needs and best fit for the country context and any technology-specific requirements. The contracting method should allow for innovation and reflect a recognition that digital health is moving forward at a rapid pace. The providers of solutions must be incentivized through contracting that allows for rolling wave updates and changes. The public sector must not become locked in to contracts that do not allow for change, such as through vendor or contract lock-in. Contracting must involve two-way risk sharing whereby the public and private sectors are true partners. It is also feasible to develop contracting models that incentivize the private sector through measurement targets to ensure the government is the recipient of the solution it requires, rather than one the private sector considers appropriate.

Among the contracting model options governments might consider are the following:

- **Traditional PPPs:** The provision of a service or technology for a given longer period using innovative financing. These may not be appropriate for digital-in-health solutions and require careful assessment for suitability.
- **Traditional procurement:** A standard tender option for the direct procurement of solutions or services. Traditional procurement may be narrow in time frame and short on outcome measurement and benefit realization. Digital-in-health requires continued innovative thinking from the initial contract award through to the final deliverable and then the supporting process. The digital solution is only part of the overall solution. There is a requirement for process realignment and change management. Traditional procurement models may not be appropriate for integrated people, process, and technology solutions because they may be based on solutions at low, inadequate investment.

- **Innovative contracting:** Contracting for a defined period for the provision of a specific solution, service, or both. Ideally for the private sector, the minimum contracting period should be five years. This option is often not financially or commercially viable. The private sector would have to undertake year-long contracts given the period required for the return on investment. Longer contracts enable the private sector to appropriately factor risk into their pricing, and they facilitate true collaboration by ensuring that the government receives the desired service and implementation support. Innovative contracting might, for example, include capacity building to enable the government, in the longer term, to be in a position to manage the future development of solutions or enhancements.
- **Contacting through social health insurance:** Social health insurance pays for selected solutions or services that are directly digital or digitally enabled in the private sector and utilize agreed tariff programs. As many markets shift toward new or revised social health insurance mechanisms, they will need to be flexible in the contracting and payment for digital health solutions. To accomplish this, social health insurance entities must be able to evaluate the care benefit offered by digital health and organize suitable payment structures that will need to be audited and reviewed to ensure benefit realization among the insured population.

Performance measurement: The contracting recommendations above highlight that the government must be able to monitor and measure contract delivery and solution performance against expectations. There are many global examples of cases in which governments have not received the expected benefit from their IT or technology decisions. Alongside the increased focus on digital health, governments must expand their capacity to measure contract performance. Otherwise, there is a greater risk that poor contracting, plus limited performance oversight, will result in wrong solution selection or poor delivery, and it then becomes more likely that the full benefit will not be realized. The need for performance measurement confirms the importance of effective public and private collaboration through new and enhanced initiatives.

Private-private partnerships: A key focus should also be on private-private partnerships, facilitated by the government or private sector incubators. Through these partnerships, homegrown solution providers (who often have a strong incentive to contribute to their country's health system) and larger-scale digital health companies (who often have a profit incentive) can partner to ensure that the incentives of all parties are aligned and that the parties are invested in the solutions.

The World Bank will support the efforts of governments and other stakeholders to work with the private sector—as both a user and a provider of digital health technology—in meaningful and sustainable ways and in consideration of the costs after the piloting phase.

Recommendation 9. Wider digital transformation: Create synergy between the health system's efforts and a country's wider digital ecosystem and digital transformation agenda

Linking the digital health efforts in a country with the country's wider digital ecosystem and the government's transformation agenda is key. The report of the United Nations Secretary-General's High-Level Panel on Digital Cooperation addresses the topic of digital interdependence, highlighting that "our aspirations and vulnerabilities are deeply interconnected and interdependent; that no one individual, institution, corporation, or government alone can or should manage digital developments; and that it is essential that we work through our differences in order to shape our common digital future" (United Nations 2019, 8). In alignment with this statement, the World Bank has recommended that all digital health efforts should be linked with the broader digital ecosystem of a country. This implies designing digital health interventions in light of digital governance, access to electricity, the status of connectivity even outside the health system, the digital education of health personnel and patients, and so on.

In addition to considering the broader digital ecosystem beyond the health sector, governments are encouraged to progress toward a digital transformation agenda through a multisectoral approach. Such multisectoral digital transformation efforts, including designing or choosing interventions specifically with this in mind, are a strategic choice that will ensure better political economy and the commitment of champions of reform not only within the health sector. As the World Bank portfolio review revealed, 49 percent of digital health–related investments were not health sector investments (Bashir et al. 2021). This, plus the moderate correlation between a country's digital health maturity and digital transformation (a GDHM index and GTMI correlation of 0.4126), shows the importance of the area for continued investment.

The World Bank will work with other development partners and regional and local organizations, to help governments accomplish the following:

- Understand the wider digital transformation agenda in the country, including DPI
- Codesign digital health efforts and digital ecosystem conceptualization and rollouts
- Encourage citizen engagement and feedback through mechanisms such as patient-reported experience and patient-reported outcome measures
- Adopt a coordinated and holistic approach that links with foundational infrastructure and government-wide digitalization efforts

Recommendation 10. Financing and implementation: Finance incrementally at the proper time, monitor implementation progress, and track outcomes

Digital health investments should be aligned with a country's digital health maturity: demand and supply grow together, incrementally. The functionality and geographic scale of digital solutions and information systems will depend on the maturity of the demand and supply of digital health services in a country. Large functional and physical coverage and better governance does not automatically mean that digital systems are delivering intended value and substantially transforming health care systems. This can be because the demand for such services is immature (clients do not know how to use these systems, do not see the value in them, do not trust digital systems, or simply do not articulate their expectations for such systems), or it can be because the supply is immature. Supply and demand grow incrementally, in sync. To be effective, investments in digital health need to be aligned with the country's stage of digital-in-health growth, as follows:

- *If investments are planned that are much lower in ambition than current digital-in-health readiness,* countries will not meet the level of ambition (because demand is more mature than supply) and might deliver incomplete, unambitious systems; the capacity to invest and govern will not be fully utilized.
- *If investments are planned that are too high in ambition relative to current digital-in-health readiness,* health care actors will not understand the potentially gained value (because demand is less mature than supply), the predominantly technical, usually expensive systems not fit-for-purpose, and there will be no capacity to navigate through the process. Failure in implementation is almost guaranteed.

Sustained and incremental investments in digital health are needed. Expanding functionality and scaling up geographic coverage require strong leadership and incremental approaches (Figure 39). Better governance and the use of a system's mature demand (people who use it experience the value and want more of it). As a result, supply reacts (internal teams and market provide solutions that are more sophisticated and more highly embedded in business needs). This leads to a virtuous cycle of scaling-up in both functionality and geographic coverage.

In addition to strategies to improve financing for health (and therefore for digital-in-health investments), it is also crucial that governments anticipate both the capital costs and the maintenance costs of using digital technologies in health care.

Because maintenance costs can be as high as 30 percent of capital costs, it is essential to plan for the ongoing maintenance at the outset. The total cost of operations should thus be considered.

Figure 39 Digital-in-Health Growth Is Incrementally Accelerated through Positive Feedback Loops

Digital health reimbursement strategies require careful consideration. Currently, most digital health interventions are financed through direct donor contracts (68 percent in the case of Ethiopia, for example) and are not embedded in a country's health financing payment mechanisms. As countries increase the use of technology and data in delivering and managing health care, the ways in which digital health is reimbursed and contracted becomes an important consideration. Whether through health insurance funds or social health insurance, through direct payment, or other financing and payment mechanisms, these have regulatory, design, and implementation implications that need to be part of the thinking from the get-go.

Economies of scope and scale should be investigated, perhaps even as World Bank–facilitated procurement to speed up and simplify what tends to be a highly technical procurement process. This, combined with careful design, will help ensure that every digital-in-health dollar is used as effectively and efficiently as possible.

Anticipated increases in financing for digital health. In the last decade, 6 percent of World Bank investments have been spent on digital health. Given the 10 recommendations outlined in this flagship report, the World Bank intends to maintain this as a minimum level of spending in digital health for the foreseeable future. It

plans to work with governments—as these increase their focus on digital and data as an integral part of every World Bank health system strengthening investment—to increase the level to at least 8 percent up to 2030. Because of changes to the investment coding system, the World Bank will be able to track across all global practices the digital health investments that are part of its investments among countries.

These investments need to be not only well designed, but also well monitored and evaluated. WHO has developed two guidelines on the most appropriate ways to monitor and evaluate digital health (Box 8). These tools and country monitoring and evaluation frameworks in the health sector will need to inform the understanding of governments of the progress made with specific digital health–related investments and of how these contribute to increases in the digital health maturity of a country. Using relevant metrics and GDHM indicators in World Bank investment results frameworks will support a clear link between digital health investments and the ways in which these support digital-in-health growth and progress in digital health maturity (see annex D for a list of the GDHM indicators).

Box 8 WHO Guidelines for Assessing, Monitoring, and Evaluating Digital Health Investments

2016 WHO Guideline: Monitoring and evaluating digital health interventions: a practical guide to conducting research and assessment (WHO 2016b)

2022 WHO Guideline: Monitoring the implementation of digital health: an overview of selected national and international methodologies (WHO 2022b)

The World Bank will continue to finance digital health investments as governments request such financing within the context of country partnership frameworks agreed to between the World Bank and governments. It is envisaged that the current investment level (6 percent of health sector investments) will at least be maintained and increased as governments shift to a digital-in-health mindset.

The World Bank will support governments as they seek to ensure that digital health investments are appropriately monitored and evaluated.

In supporting governments with their digital investment priorities, the World Bank will consider complementary investments outside the health sector and factor in maintenance costs, that is, the total cost of operations.

Financing the Implementation of the Digital-in-Health Recommendations

Following the COVID-19 pandemic, financing for health is currently fiscally constrained in many countries, especially the ones that most need to invest in digital solutions. The World Bank's Double Shocks, Double Recovery reports paint a stark picture of the fiscal reality that many countries are facing in the health sector (Kurowski et al. 2021a, 2021b, 2023; Kurowski, Evans, Tandon, et al. 2022). Recovery from the global recession has been slow and uneven. At one extreme are high-income countries with already-strong health financing and a government spending capacity that is poised for more aggressive investment in digital-in-health and in pandemic preparedness, recovery, and catch-up services. At the other extreme are low-income countries in which health spending is historically weak relative to wealthier countries and in which government spending capacity is expected to languish or lose ground. Many low- and middle-income countries, in particular, have struggled to return to pre-COVID economic growth and government spending trajectories (Kurowski, Evans, Tandon, et al. 2022).

In this challenging fiscal environment, the question arises: where will funding to implement these recommendations come from? Governments might want to consider the following approaches.

- *Adopt the mindset that every dollar for health is a partial digital dollar.* In an environment in which one considers digital as an embedded and integral part of whatever health system issue is being addressed, every dollar spent on health system strengthening is a partial digital dollar. Adopting such a digital-in-health approach to health financing will help governments weigh the low(er) cost and the efficient ways in which an aspect of digital technology and data could be strengthened as other services are delivered. For example, a new medical education program might be expanded to build digital skills, the vocational program in a country could include digital technicians for the health sector, or a new health strategy might include digital technology and data as an element, rather than spending on the development of a separate digital health strategy.
- *Follow the health system reform priority and embrace incremental change.* Reaching full maturity in all dimensions of a health system's digital and data dimensions is a long process. Countries that have made significant progress, such as Canada, Estonia, Israel, and the Republic of Korea, have done so over more than a 10-year period and built their systems incrementally. Such natural, incremental evolution will allow a country to focus on areas for which the political will and (some) financing already

exist, that is, not digital transformation of the health system, but health system transformation that involves the infusion of digital aspects.

- *Multisectoral funding:* not all financing required for digital-in-health needs to come from the health sector. As the World Bank's digital health portfolio review shows, 49 percent of digital health–related investments are outside the health sector and would not typically be funded from a health sector budget allocation. Proactively reaching out to other sectors to synchronize investments would ensure more efficiency and coordinated implementation.
- *Harness the financing that the private sector can offer.* Private sector financing can support digital-in-health investments, in particular, PPPs in digital health.
- *Applicable to the problem being addressed, consider digital health public goods.* One of the benefits of digital health public goods is that there is typically significant previous experience, examples, and other tools available to build on, and, so, the development costs should be lower. Even if a digital health public good is not a feasible option, choose interventions that adhere to a country's interoperability standards and that rely on the WHO SMART Guidelines, because this will ensure that the content is based on the latest guidance.
- *The total cost of operations and the maintenance cost.* Insist that development partners investing in digital technology and data systems in the health sector determine the total cost of operations and technical debt and commit to financing the maintenance costs for at least three years after product deployment.
- *Remain aware of generative AI–related leapfrogging opportunities for efficiency and scale.* Given all the regulatory and privacy caveats of AI, some of the early developments in health technology and data processing made possible by generative AI would have seemed impossible only a few months ago. Ministries of health should be aware of the cutting-edge technologies that may offer opportunities for efficiency gains, such as smart diagnostics, the ability to query instantly and analyze vast amounts of health data, and other developments.
- *Focus spending on the most cost-effective recommendations.* Depending on a country's digital maturity and most pressing health sector problems, different digital technology and investments in technology and data would be suitable. In Figure 40, the digital priorities of governments determine the figure quadrant in which a country is located.

Regardless of the quadrant in which a country is located (see Figure 40), growing digital-in-health is feasible. Table 13 shows the relative cost of implementing the 10 recommendations in this report, and the ones that countries with limited fiscal space can focus on first.

Figure 40 Comparing Fiscal Space for Health with Digital Health Maturity and GovTech Maturity

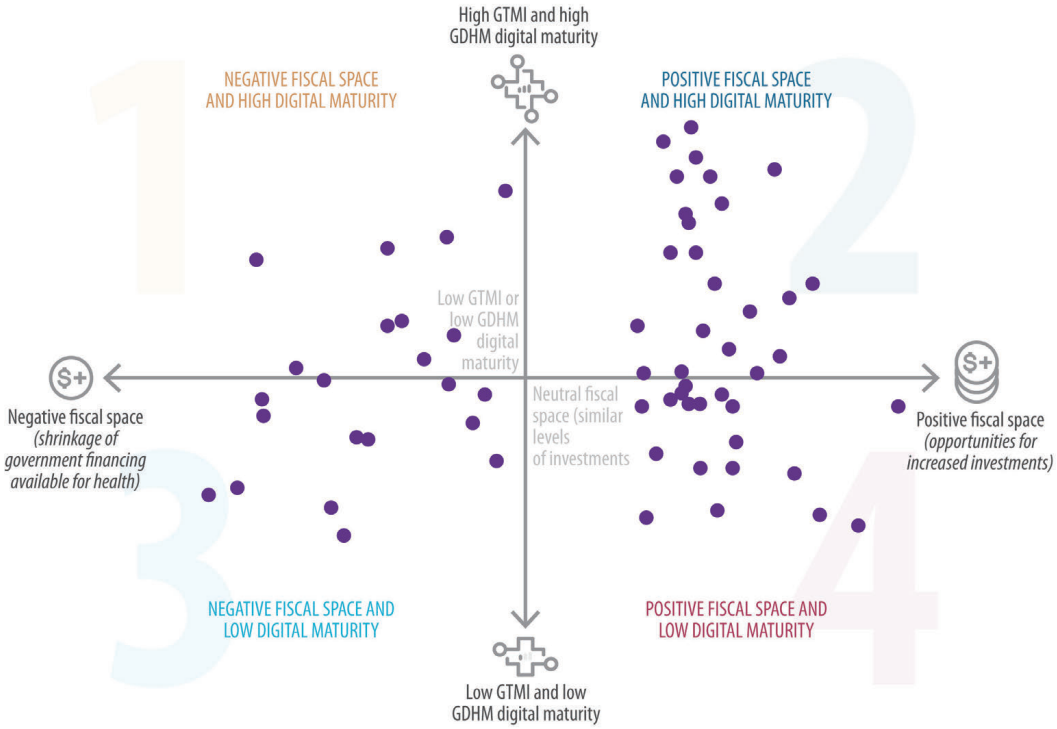


Table 13 Different Recommendations Are Prioritized Depending on a Country's Fiscal Space and Digital Maturity

Recommendations for action	Relative cost	Priority by country in this quadrant 1	2	3	4	If fiscally constrained, then
People-centered choices: Choose digital technology that responds to people's health needs and is evidence-based.	$$$		X		X	Consolidate digital health interventions already in place.
Reaching the underserved: Choose digital health solutions that improve the access and availability of health care services among vulnerable and marginalized groups.	$$		X	X	X	Choose the solutions with the most potential for reaching underserved populations.
Nimble partnerships with and within the private sector: Innovate how the private and public sectors work together in designing, delivering, and funding digital health solutions.	$	X	X	X	X	Nimble partnerships can help drive efficiencies if there are fiscal constraints.

Table continued..

Table 13 Different Recommendations Are Prioritized Depending on a Country's Fiscal Space and Digital Maturity (continued)

Recommendations for action	Relative cost	Priority by country in this quadrant				If fiscally constrained, then
		1	2	3	4	
Leadership and partnership: Drive digital health action within and across sectors through strong country leadership.	$	X	X	X	X	This is a matter of political will more than large sums of money, and is a priority in all countries .
Data governance: Reinforce ethical standards and regulatory systems for equitable and trustworthy digital solutions.	$	X	X	X	X	Establishing and maintaining strong data governance are important, but not an expensive endeavor.
Digital infrastructure gaps and health information gaps: Connect facilities, services, information, and people; connect disparate, disconnected, and siloed information systems, and fill in health information gaps.	$$$	X	X	X	X	Expanding connectivity if fiscally constrained, might be more challenging. Innovative PPPs might support this recommendation. Focus first on interoperability standards and certification and then on expanding the corpus of health information.
Global and regional partnerships: Global and regional solidarity to support governments as they lead digital health investments in their countries.	$$$	X	X	X	X	This is not a cost to countries, as partners need to converge on digital solutions.
Digital skills and literacy: Help patients and providers understand, trust, and confidently use new technology and data.	$$		X	X	X	Digital skills should be built into pre-service training and so the implementation cost, after curriculum design, should be minimal. The more expensive part will be the new generation of digital health technicians needed.
Wider digital transformation: Create synergy between the health system's efforts and a country's wider digital ecosystem and digital transformation agenda.	$	X	X	X	X	Because these wider digital transformation efforts are shared costs, synchronizing efforts should bring about efficiency gains.
Financing and implementation: Finance incrementally at the appropriate time, monitor implementation progress, and track outcomes.	$$	X	X	X	X	These are ongoing efforts and should be part of any health system reform agenda.

As suggested in Table 13, the following three types of investment choices are typically appropriate, despite the lack of empirical evidence on cost-effectiveness for some of them:

- **Lowest hanging fruit investments:** The recommendations and guidance that will bring about large changes at low cost, regardless of a country's stage of digital maturity, are leadership and partnership, interoperability standards, and data governance. These are the lowest hanging and low-cost fruit that will significantly help reduce the fragmentation that currently exists.
- **Go where the efficiency gains are:** Determine the areas where there is the greatest efficiency gains, and focus on them. Based on the Jousset et al. (2023) analysis, the evidence map of digital health interventions, and patient and provider areas of focus, these are the following:
    - *Virtual interactions (including telemedicine, remote monitoring, and e-triage).* The value assessment data and the post–COVID-19 experience in country demand make it clear that this is an immediate and urgent priority. The World Bank has already provided relevant resources and work is ongoing.
    - *Electronic health record and health information exchanges.* Given global and regional momentum (for example, a new digital health strategy of the Africa Centers for Disease Control and Prevention) and the value that electronic health records and health information exchanges can add, this should be another area of focus for countries and a clear priority for World Bank investments.
    - *Work flow optimization and simplification efforts* to help make aspects of health care delivery, ranging from billing systems and claims management to the allocation of health workers, or paying them, quicker and more efficient.
    - *Patient-focused applications* to help patients schedule appointments, access their medical records, and obtain health information to manage their health proactively.
- **Focus on technology and data efforts** that will address the most rapidly growing disease burden. In most countries, because of aging populations, this is noncommunicable disease, which already accounts for three-quarters of the world's morbidity and mortality. Because of their long lead times, lifestyle origins, and chronic nature, digital-first noncommunicable disease interventions (prevention, treatment, and long-term follow-up) lend themselves to being digital-first. In the evidence map for digital health of the International Initiative for Impact Evaluation and the World Bank, 88 percent of the evidence base is related to digital health interventions for noncommunicable diseases, suggesting that there is much

information and experience available for governments and stakeholders to use and tailor for their purposes (Görgens et al. 2021).

- **Prioritize for equity.** In making decisions about what to finance and the sequence in which to do it, consider those investments that would help the most to reduce health disparities.

Additional international financing will ultimately be needed to finance digital technology, especially in low-income countries with limited fiscal space. Unless governments can find savings or additional external financing becomes available, governments with limited fiscal space will have limited ability to spend additional health financing. Such additional financing should be part of existing health financing efforts. Every dollar for development assistance for health is a partial digital one. This is because almost all health interventions and reforms these days have some level of embedded digitalization. More and more, this will become the norm. If development assistance for health is designed base on a digital-embedded mindset, less fragmentation in development assistance for digital technology will result.

CHAPTER 7

Conclusion

“At the end of the day, it’s health that’s important, not e-health.”

Souheil Marine,
International Telecommunication Union

Technology and data are integral parts of health system strengthening. This report describes the ripe opportunity for moving from hype and hope to scaled solutions and from digitalization to a digital-in-health approach. As country health systems continue to mature in the twenty-first century, technology and data will become so embedded and assimilated into how health care is delivered and managed that, eventually, digital health as a concept distinct from health care will no longer exist. Populations seek to improve their own health (not their own digital health). The modality through which health care is delivered and the ways in which health data are governed are secondary to the value that a person receives from the health information and health care that they obtain and the ways they act on this information and services to take ownership of and improve their own health.

Digital determinants of health must be a central consideration in structuring health system strengthening efforts. While one should never lose sight of the fact that this is ultimately about health, governments—in their quest for the health and well-being of the populations that they serve—must consider wider perspectives than disease etiology in determining what health care to provide. In future, governments will need to focus their health system reforms on a consideration of the biological, behavioral, and social determinants of health, but also on the environmental determinants, commercial determinants (Friel et al. 2023), and digital determinants of health (Kickbusch et al. 2021).

Productive partnerships will be essential to success. This includes new types of working arrangements and partnerships with and among private sector partners, as well as with stakeholders supporting wider digital transformation efforts outside the health sector. The World Bank has committed to support five pillars relating to digitalization and development (see Figure 13). The 10 recommendations of this report not only help support the World Bank's focus on digitalization and development in the health sector, but they also help prepare countries for the rapidly changing digital landscape and new technologies that may surpass what is already on offer.

Governments and stakeholders should prioritize, connect, and scale to move beyond the hype of digital technology to embedded solutions that improve health. The future of health care is here, and, collectively, one may move from the hype and hope of "wouldn't it be nice if" to proceeding wisely, in responsible ways, focusing on solving problems, integrating digital solutions into health systems, doing so in ways that narrow the digital divide. Given the preponderance of technology that is becoming available in high-, lower-middle-, and low-income countries, the potential benefits, and the limited fiscal space, every scarce dollar for health and for digital transformation in a country is also a partial dollar for the digital and data aspects of health systems improvement. As the financial sector's digitalization efforts have shown, this will take global solidarity, strong government leadership to coordinate and avoid waste, and a focus on the common good.

REFERENCES

AAPA (American Academy of Physician Associates). 2023. "U.S. Adults Spend Eight Hours Monthly Coordinating Healthcare, Find System 'Overwhelming.'" *News Central*, May 17, 2023. https://www.aapa.org/news-central/2023/05/u-s-adults-spend-eight-hours-monthly-coordinating-healthcare-find-system-overwhelming/.

Abernethy, Amy, Laura Adams, Meredith Barrett, Christine Bechtel, Patricia Brennan, Atul Butte, Judith Faulkner, et al. 2022. "The Promise of Digital Health: Then, Now, and the Future." NAM Perspectives Discussion Paper (June 27), National Academy of Medicine, Washington, DC. https://nam.edu/the-promise-of-digital-health-then-now-and-the-future/.

A4AI (Alliance for Affordable Internet). 2021. "Affordability Report 2021: A New Strategy For Universal Access." A4AI, Washington, DC. https://a4ai.org/research/affordability-report/affordability-report-2021/.

Agyepong, Irene, Neil Spicer, Gorik Ooms, Albrecht Jahn, Till Bärnighausen, Claudia Beiersmann, Hannah Brown Amoakoh, et al. 2023. "Lancet Commission on Synergies between Universal Health Coverage, Health Security, and Health Promotion." *Lancet Commissions* 401 (10392): 1964–2012. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(22)01930-4/fulltext.

Akram, Asif, Caitlin Augustin, and Jeanne Koepsell. 2022. "Digital Health 2.0: Getting Tools and Services to People Who Need Them Most." *Frontline Health Workers Coalition* (blog), June 16, 2022. https://www.frontlinehealthworkers.org/blog/digital-health-20-getting-tools-and-services-people-who-need-them-most.

Al-Adwan, Ahmad Samed, and Hilary Berger. 2015. "Exploring Physicians' Behavioural Intention toward the Adoption of Electronic Health Records: An Empirical Study from Jordan." *International Journal of Healthcare Technology and Management* 15 (2): 89–111. https://doi.org/10.1504/IJHTM.2015.074538.

Alami, Hassane, Marie-Pierre Gagnon, and Jean-Paul Fortin. 2017. "Digital Health and the Challenge of Health Systems Transformation." *mHealth* 3 (8): 31. https://pubmed.ncbi.nlm.nih.gov/28894741/.

Arora, Anmol, and Ananya Arora. 2022. "Generative Adversarial Networks and Synthetic Patient Data: Current Challenges and Future Perspectives." *Future Healthcare Journal* 9 (2): 190–93. https://doi.org/10.7861/fhj.2022-0013.

August, Ella, Lia Tadesse, Marie S. O'Neill, Joseph N. S. Eisenberg, Rex Wong, Joseph C. Kolars, and Abebe Bekele. 2022. "What Is Global Health Equity? A Proposed Definition." *Annals of Global Health* 88 (1): 50. doi: 10.5334/aogh.3754.

Bagnoli, Lilianna, Tanya Kapoor, and Sarah Mullane. 2022. "Opinion: Digital Health Solutions Need to Consider the Health Worker." *Global Views*, January 13, 2022. https://www.devex.com/news/sponsored/opinion-digital-health-solutions-need-to-consider-the-health-worker-102333.

Bally, Esmee L. S., Demi Cheng, Amy van Grieken, Mireia Ferri Sanz, Oscar Zanutto, Aine Carroll, Andrew Darley, Bob Roozenbeek, Diederik W. J. Dippel, and Hein Raat. 2023. "Patients' Perspectives Regarding Digital Health Technology to Support Self-Management and Improve Integrated Stroke Care: Qualitative Interview Study." *Journal of Medical Internet Research* 25 (April 4): e42556. https://www.jmir.org/2023/1/e42556.

Barony Sanchez, Romina Helena, Laurie-Ann Bergeron-Drolet, Maxime Sasseville, and Marie-Pierre Gagnon. 2022. "Engaging Patients and Citizens in Digital Health Technology Development through the Virtual Space." *Frontiers in Medical Technology* 4 (November 25): 958571. https://doi.org/10.3389/fmedt.2022.958571.

Bashir, Sajitha, Carl J. Dahlman, Naoto Kanehira, and Klaus Tilmes. 2021. *The Converging Technology Revolution and Human Capital: Potential and Implications for South Asia*. South Asia Development Forum Series. Washington, DC: World Bank. http://hdl.handle.net/10986/36156.

Baudier, Patricia, Galina Kondrateva, Chantal Ammi, Victor Chang, and Francesco Schiavone. 2023. "Digital Transformation of Healthcare during the COVID-19 Pandemic: Patients' Teleconsultation Acceptance and Trusting Beliefs." *Technovation* 120 (February): 102547. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9108035/.

Bilkey, Gemma A., Belinda L. Burns, Emily P. Coles, Trinity Mahede, Gareth Baynam, and Kristen J. Nowak. 2019. "Optimizing Precision Medicine for Public Health." *Frontiers in Public Health* 7 (March): 42. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6416195/.

Bosquet, Benoît. 2019. "Empowering Frontlines, Leveraging Technology: Basic Service Delivery in 21st Century Indonesia." *East Asia and Pacific on the Rise* (blog), October 23, 2019. https://blogs.worldbank.org/eastasiapacific/empowering-frontlines-leveraging-technology-basic-service-delivery-21st-century.

Boyland, Emma, David Thivel, Artur Mazur, Susanne Ring-Dimitriou, Marie-Laure Frelut, and Daniel Weghuber. 2020. "Digital Food Marketing to Young People: A Substantial Public Health Challenge." *Annals of Nutrition and Metabolism* 76 (1): 6–9. https://pubmed.ncbi.nlm.nih.gov/32101856/.

Bragg, Marie A., Margaret Eby, Josh Arshonsky, Alex Bragg, and Gbenga Ogedegbe. 2017. "Comparison of Online Marketing Techniques on Food and Beverage Companies' Websites in Six Countries." *Globalization and Health* 13 (1): 79. https://pubmed.ncbi.nlm.nih.gov/29073900/.

Braithwaite, Jeffrey. 2018. "Changing How We Think about Healthcare Improvement." *BMJ* 361 (May): k2014. https://www.bmj.com/content/361/bmj.k2014.

Braithwaite, Jeffrey, Russell Mannion, Yukihiro Matsuyama, Paul Shekelle, Stuart Whittaker, Samir Al-Adawi, Kristiana Ludlow, et al. 2017. "Accomplishing Reform: Successful Case Studies Drawn from the Health Systems of 60 Countries." *International Journal for Quality in Health Care* 29 (6): 880–86. https://doi.org/10.1093/intqhc/mzx122.

Brandeau, Margaret L., François Sainfort, and William P. Pierskalla. 2004. "Health Care Delivery: Current Problems and Future Challenges." *In Operations Research and Health Care: A Handbook of Methods and Applications*, edited by Margaret L. Brandeau, François Sainfort, and William P. Pierskalla, 1–14. International Series in Operations Research and Management Science 70. New York: Springer. doi: 10.1007/1-4020-8066-2_1.

Brownstein, John S., Benjamin Rader, Christina M. Astley, and Huaiyu Tian. 2023. "Advances in Artificial Intelligence for Infectious-Disease Surveillance." *New England Journal of Medicine* 388 (17): 1597–1607. https://www.nejm.org/doi/full/10.1056/NEJMra2119215.

Buckley, Ross P., Dirk A. Zetzsche, Douglas W. Arner, and Brian W. Tang. 2021. "Regulating Artificial Intelligence in Finance: Putting the Human in the Loop." *Sydney Law Review* 43 (1): 43–81. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3831758.

Budd, Jobie, Benjamin S. Miller, Erin M. Manning, Vasileios Lampos, Mengdie Zhuang, Michael Edelstein, Geraint Rees, et al. 2020. "Digital Technologies in the Public-Health Response to COVID-19." *Nature Medicine* 26 (8): 1183–92. https://doi.org/10.1038/s41591-020-1011-4.

Buis, Lorraine R., and Jina Huh-Yoo. 2020. "Common Shortcomings in Applying User-Centered Design for Digital Health." *IEEE Pervasive Computing* 19 (3): 45–49. https://ieeexplore.ieee.org/abstract/document/9153868.

Bunker, John P. 2001. "The Role of Medical Care in Contributing to Health Improvements within Societies." *International Journal of Epidemiology* 30 (6): 1260–63. https://doi.org/10.1093/ije/30.6.1260.

Carnicero, Javier, and Patricia Serra. 2020. "Governance for Digital Health: The Art of Health Systems Transformation." Inter-American Development Bank, Washington, DC. https://publications.iadb.org/en/governance-digital-health-art-health-systems-transformation.

CB Insights. 2022. *State of Digital Health 2021 Report*. January 20. New York: CB Insights. https://app.cbinsights.com/research/report/digital-health-trends-2021/.

CDC (Centers for Disease Control and Prevention). 2018. *Public Health Emergency Preparedness and Response Capabilities: National Standards for State, Local, Tribal, and Territorial Public Health*. Atlanta: CDC, US Department of Health and Human Services. https://www.cdc.gov/orr/readiness/00_docs/CDC_PreparednesResponseCapabilities_October2018_Final_508.pdf.

CDC (Centers for Disease Control and Prevention). 2023. "Artificial Intelligence and Machine Learning: Applying Advanced Tools for Public Health." Office of Public Health Data, Surveillance, and Technology, CDC, US Department of Health and Human Services, Atlanta. https://www.cdc.gov/surveillance/data-modernization/technologies/ai-ml.html.

Cheng, Qu, Philip A. Collender, Alexandra K. Heaney, Aidan McLoughlin, Yang Yang, Yuzi Zhang, Jennifer R. Head, et al. 2022. "Optimizing Laboratory-Based Surveillance Networks for Monitoring Multi-Genotype or Multi-Serotype Infections." *PLOS Computational Biology* 18 (9): e1010575. https://pubmed.ncbi.nlm.nih.gov/36166479/.

Chowdhury, Areeq, and Anna Pick. 2019. "Digital Health in LLMICs: Current and Future Technological Developments with the Potential to Improve Health Outcomes in Low- and Lower-Middle-Income Countries." P4P Background Paper 28 (September), Pathways for Prosperity Commission, Oxford, UK. https://pathwayscommission.bsg.ox.ac.uk/sites/default/files/2019-10/digital_health_in_llmics.pdf.

Colloud, Seya, Thomas Metcalfe, Scott Askin, Shibeshih Belachew, Johannes Ammann, Ernst Bos, Timothy Kilchenmann, et al. 2023. "Evolving Regulatory Perspectives on Digital Health Technologies for Medicinal Product Development." *NPJ Digital Medicine* 6 (1): 56. https://www.nature.com/articles/s41746-023-00790-2.

Connect Humanity. 2023. "State of Digital Inequity: Civil Society Perspectives on Barriers to Progress in Our Digitizing World, A Global Study." January 25, Connect Humanity, Palo Alto, CA. https://connecthumanity.fund/wp-content/uploads/2023/01/Connect-Humanity-Digital-Equity-01-24-23-FINAL2.pdf.

Cornet, Victor Philip, Tammy Toscos, Davide Bolchini, Romisa Rohani Ghahari, Ryan Ahmed, Carly Daley, Michael J. Mirro, and Richard J Holden. 2020. "Untold Stories in User-Centered Design of Mobile Health: Practical Challenges and Strategies Learned from the Design and Evaluation of an App for Older Adults with Heart Failure." *JMIR mHealth and uHealth* 8 (7): e17703. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7404009/.

Coughlin, Sheryl, David Roberts, Kenneth O'Neill, and Peter Brooks. 2018. "Looking to Tomorrow's Healthcare Today: A Participatory Health Perspective." *Internal Medicine Journal* 48 (1): 92–96. https://doi.org/10.1111/imj.13661.

Darrudi, Alireza, Mohammad Hossein Ketabchi Khoonsari, and Maryam Tajvar. 2022. "Challenges to Achieving Universal Health Coverage Throughout the World: A Systematic Review." *Journal of Preventive Medicine and Public Health* 55 (2): 125–33. https://doi.org/10.3961/jpmph.21.542.

Delaporte, Anne, and Kalvin Bahia. 2022. "The State of Mobile Internet Connectivity 2022." With contributions by Isabelle Carboni, Nadia Jeffrie, Claire Sibthorpe, and Melle Tiel Groenestege, GSMA Intelligence, GSM Association, London. https://www.gsma.com/r/somic/.

Dener, Cem, Joanna Alexandra Watkins, and William Leslie Dorotinsky. 2011. *Financial Management Information Systems: 25 Years of World Bank Experience on What Works and What Doesn't.* World Bank Study Series. Washington, DC: World Bank. https://doi.org/10.1596/978-0-8213-8750-4.

De Vito Dabbs, Annette, Brad A. Myers, Kenneth R. Mc Curry, Jacqueline Dunbar-Jacob, Robert P. Hawkins, Alex Begey, and Mary Amanda Dew. 2009. "User-Centered Design and Interactive Health Technologies for Patients." *Computers, Informatics, Nursing* 27 (3): 175–83. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2818536/.

Diamond, Megan B., Aparna Keshaviah, Ana I. Bento, Otakuye Conroy-Ben, Erin M. Driver, Katherine B. Ensor, Rolf U. Halden, et al. 2022. "Wastewater Surveillance of Pathogens Can Inform Public Health Responses." *Nature Medicine* 28 (October): 1992–95. https://www.nature.com/articles/s41591-022-01940-x.

Dobbie, Laurence J., Abd Tahrani, Uazman Alam, Jennifer James, John Wilding, and Daniel J. Cuthbertson. 2022. "Exercise in Obesity; The Role of Technology in Health Services: Can This Approach Work?" *Current Obesity Reports* 11 (3): 93–106. https://doi.org/10.1007/s13679-021-00461-x.

Doherty, Aoife, Audrey Wall, Nora Khaldi, and Martin Kussmann. 2021. "Artificial Intelligence in Functional Food Ingredient Discovery and Characterisation: A Focus on Bioactive Plant and Food Peptides." *Frontiers in Genetics* 12 (November): 768979. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8640466/.

Dohse, Heidi. 2021. "Patient Perspective: Wearable and Digital Health Tools to Support Managing Our Health during the COVID-19 Pandemic and Beyond." *Cardiovascular Digital Health Journal* 2 (1): 88–90. https://doi.org/10.1016/j.cvdhj.2020.12.002.

Domínguez-Rodríguez, Alejandro, and Anabel De La Rosa-Gómez. 2022. "A Perspective on How User-Centered Design Could Improve the Impact of Self-Applied Psychological Interventions in Low- or Middle-Income Countries in Latin America." *Frontiers in Digital Health* 4 (June): 866155. https://www.frontiersin.org/articles/10.3389/fdgth.2022.866155/full.

Dutta, Bireswar, and Hsin-Ginn Hwang. 2020. "The Adoption of Electronic Medical Record by Physicians: A PRISMA-Compliant Systematic Review." *Medicine* 99 (8): e19290. https://pubmed.ncbi.nlm.nih.gov/32080145/.

Elizarov, Ariel. 2023. "Medical Record Summarizer: LazarusAI." Loom, San Francisco. https://www.loom.com/share/4bcd5ca5ab6e45cd8fc122545f85e7e5.

Emara, Yasmine, Barbara Koroušić Seljak, Eileen R. Gibney, Gorjan Popovski, Igor Pravst, and Peter Fantke. 2022. "Workflow for Building Interoperable Food and Nutrition Security (FNS) Data Platforms." *Trends in Food Science and Technology* 123 (May): 310–21. https://www.sciencedirect.com/science/article/pii/S0924224422001133.

Eng, Thomas R. 2004. "Population Health Technologies: Emerging Innovations for the Health of the Public." *American Journal of Preventive Medicine* 26 (3): 237–42. https://doi.org/10.1016/j.amepre.2003.12.004.

EPIS (European Patient Innovation Summit). 2019. "Position Paper on Digital Health from a Patient Perspective." Document GLNS/NEUR/0036(1), May, Novartis, Basel, Switzerland. https://www.novartis.com/sites/novartis_com/files/epis-position-paper.pdf.

Eysenbach, Gunther. 2001. "What Is e-health?" *Journal of Medical Internet Research* 3 (2): e20. https://www.jmir.org/2001/2/PDF.

Ferraz Dos Santos, Laura, Rosália Figueiró Borges, and Denise Antunes de Azambuja. 2020. "Telehealth and Breastfeeding: An Integrative Review." Telemedicine Journal and e-Health 26 (7): 837–46. https://pubmed.ncbi.nlm.nih.gov/31633467/.

FIND. 2020. "Report Summary: Assessment of Diagnostic Gaps and Relevant Digital Health Solutions, Summary findings from Peru, India, Nigeria, and Uganda." FIND, Geneva. https://www.finddx.org/wp-content/uploads/2022/12/20201515_rep_assessment_dx_digital_health_FV_EN.pdf.

Fleming, Kenneth A., Susan Horton, Michael L. Wilson, Rifat Atun, Kristen DeStigter, John Flanigan, Shahin Sayed, et al. 2021. "The Lancet Commission on Diagnostics: Transforming Access to Diagnostics." *Lancet* 398 (10315): 1997–2050. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(21)00673-5/fulltext.

Floridi, Luciano. 2007. "A Look into the Future Impact of ICT on Our Lives." *Information Society* 23 (1): 59–64. https://doi.org/10.1080/01972240601059094.

Frank, Tine. 2017. "A Mobile Health Application to Manage Acute Malnutrition: Lessons from Developing and Piloting the App in Five Countries." Transform Nutrition Working Paper, March, World Vision and Save the Children, London. https://resourcecentre.savethechildren.net/pdf/tn_workingpaper1_mobileapp_online.pdf/.

Friel, Sharon, Jeff Collin, Mike Daube, Anneliese Depoux, Nicholas Freudenberg, Anna B. Gilmore, Paula Johns, et al. 2023. "Commercial Determinants of Health: Future Directions." *Lancet* 401 (10383): 1229–40. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(23)00011-9/fulltext.

Gentilini, Ugo, Mohamed Almenfi, Hrishikesh T. M. M. Iyengar, Yuko Okamura, John Austin Downes, Pamela Dale, Michael Weber, et al. 2022. S*ocial Protection and Jobs Responses to COVID-19: A Real-Time Review of Country Measures.* Living Paper Version 16 (February 2, 2022). Washington, DC: World Bank. http://hdl.handle.net/10986/37186.

Golinelli, Davide, Erik Boetto, Gherardo Carullo, Andrea Giovanni Nuzzolese, Maria Paola Landini, and Maria Pia Fantini. 2020. "Adoption of Digital Technologies in Health Care during the COVID-19 Pandemic: Systematic Review of Early Scientific Literature." *Journal of Medical Internet Research* 22 (11): e22280. https://www.jmir.org/2020/11/e22280.

Görgens, Marelize, Nejma Cheikh, Thomas David Wilkinson, Collins Owen Francisco Zamawe, Birte Snilstveit, Miriam Berretta, and Richard Appell. 2021. *Digital Health Interventions: An Evidence Gap Map Report.* Washington, DC: International Initiative for Impact Evaluation and World Bank.

Gupta, Ravi, Raghuram Iyengar, Meghana Sharma, Carolyn C. Cannuscio, Raina M. Merchant, David A. Asch, Nandita Mitra, and David Grande. 2023. "Consumer Views on Privacy Protections and Sharing of Personal Digital Health Information." *JAMA Network Open* 6 (3): e231305. https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2801917.

Győrffy, Zsuzsanna, Nóra Radó, and Bertalan Meskó. 2020. "Digitally Engaged Physicians about the Digital Health Transition." *PLOS ONE* 15 (9): e0238658. https://doi.org/10.1371/journal.pone.0238658.

Hashim, Ali, Khuram Farooq, and Moritz Piatti-Fünfkirchen. 2020. "Ensuring Better PFM Outcomes with FMIS investments: An Operational Guidance Note for FMIS Project Teams." Guidance Note: Governance Global Practice 6 (May), World Bank, Washington, DC. https://documents1.worldbank.org/curated/en/917121592283326885/pdf/Ensuring-Better-PFM-Outcomes-with-FMIS-Investments-An-Operational-Guidance-Note-for-FMIS-Project-Teams-Designing-and-Implementing-FMIS-Solutions.pdf.

HCWH (Health Care without Harm). 2007. *Green Guide for Health Care.* Version 2.2 (January). Washington, DC: HCWH. https://noharm-global.org/issues/global/green-guide-health-care.

Heinrichs, Helen, Florian Mueller, Lucia Rohfleisch, Volkmar Schulz, Steven R. Talbot, and Fabian Kiessling. 2022. "Digitalization Impacts the COVID-19 Pandemic and the Stringency of Government Measures." *Science Reports* 12 (1): 21628. https://www.nature.com/articles/s41598-022-24726-0.

Helleman, Jochem, Barbara Johnson, Cory Holdom, Esther Hobson, Deirdre Murray, Frederik J. Steyn, Shyuan T. Ngo, et al. 2022. "Patient Perspectives on Digital Healthcare Technology in Care and Clinical Trials for Motor Neuron Disease: An International Survey." *Journal of Neurology* 269 (11): 6003–13. https://pubmed.ncbi.nlm.nih.gov/35849154/.

Henning, Kelly J. 2004. "Overview of Syndromic Surveillance: What Is Syndromic Surveillance?" *Morbidity and Mortality Weekly Report* 53 (Supplement): 5–11, Centers for Disease Control and Prevention, Atlanta. https://www.cdc.gov/mmwr/preview/mmwrhtml/su5301a3.htm.

Hsiao, William, and Peter S. Heller. 2007. "What Should Macroeconomists Know about Health Care Policy?" IMF Working Paper WP/07/13, International Monetary Fund, Washington, DC. https://www.imf.org/external/pubs/ft/wp/2007/wp0713.pdf.

IEG (Independent Evaluation Group). 2021. *Mobilizing Technology for Development: An Assessment of World Bank Group Preparedness.* April 7. Washington, DC: World Bank.

Ireen, Santhia, Mohammad Jyoti Raihan, Nuzhat Choudhury, M. Munirul Islam, Md Iqbal Hossain, Ziaul Islam, S. M. Mustafizur Rahman, and Tahmeed Ahmed. 2018. "Challenges and Opportunities of Integration of Community Based Management of Acute Malnutrition into the Government Health System in Bangladesh: A Qualitative Study." *BMC Health Services Research* 18 (1): 256. https://pubmed.ncbi.nlm.nih.gov/29631574/.

Jayal, Gayatri. 2021. "How Chatbots Can Support the Right to Health." *dimagi* (blog), October 5, 2021. https://www.dimagi.com/blog/chatbots-support-the-right-to-health/.

Johnson, Rob, Anthony Watkinson, and Michael Mabe. 2018. *The STM Report: An Overview of Scientific and Scholarly Publishing 1968–2018*, 5th ed. The Hague, the Netherlands: International Association of Scientific, Technical, and Medical Publishers. https://www.stm-assoc.org/2018_10_04_STM_Report_2018.pdf.

Jousset, Océane, Marilyn Kimeu, Thomas Müller, Giovanni Sforza, Ying Sunny Sun, Ali Ustun, and Matt Wilson. 2023. "How Digital Tools Could Boost Efficiency in African Health Systems." *Healthcare: Our Insights* (blog), March 10, 2023. https://www.mckinsey.com/industries/healthcare/our-insights/how-digital-tools-could-boost-efficiency-in-african-health-systems#/.

Kaihlanen, Anu-Marja, Lotta Virtanen, Ulla Buchert, Nuriiar Safarov, Paula Valkonen, Laura Hietapakka, Iiris Hörhammer, Sari Kujala, Anne Kouvonen, and Tarja Heponiemi. 2022. "Towards Digital Health Equity: A Qualitative Study of the Challenges Experienced by Vulnerable Groups in Using Digital Health Services in the COVID-19 Era." *BMC Health Services Researc*h 22 (1): 188. https://pubmed.ncbi.nlm.nih.gov/35151302/.

Kaiser Permanente. 2022. "Accelerating Health Care's Digital Transformation." Press Release, January 17, 2022. https://about.kaiserpermanente.org/news/accelerating-health-cares-digital-transformation.

Kennedy, Shania. "Generative AI May Accelerate Drug Discovery for COVID Antivirals." *Precision Medicine News*, June 29, 2023. https://healthitanalytics.com/news/generative-ai-may-accelerate-drug-discovery-for-covid-antivirals.

Khoury, Muin J., and W. David Dotson. 2021. "Public Health Impact of Digital Health: Reinventing the Wheel." *Genomics and Precision Health* (blog), January 15, 2021. https://blogs.cdc.gov/genomics/2021/01/15/public-health-impact-2/.

Kickbusch, Ilona, Dario Piselli, Anurag Agrawal, Ran Balicer, Olivia Banner, Michael Adelhardt, Emanuele Capobianco, et al. 2021 "The *Lancet and Financial Times* Commission on Governing Health Futures 2030: Growing Up in a Digital World." *Lancet Commissions* 398 (10312): 1727–76. https://doi.org/10.1016/S0140-6736(21)01824-9.

Kimble, Chris. 2015. "Business Models for e-Health: Evidence from Ten Case Studies." *Global Business and Organizational Excellence* 34 (4): 18–30. https://onlinelibrary.wiley.com/doi/abs/10.1002/joe.21611.

Kokorelias, Kristina Marie, Michelle L. A. Nelson, Terence Tang, Carolyn Steele Gray, Moriah Ellen, Donna Plett, Carlotta Micaela Jarach, Jason Xin Nie, Kednapa Thavorn, and Hardeep Singh. 2022. "Inclusion of Older Adults in Digital Health Technologies to Support Hospital-to-Home Transitions: Secondary Analysis of a Rapid Review and Equity-Informed Recommendations." *JMIR Aging* 5 (2): e35925. https://aging.jmir.org/2022/2/e35925/.

Konduri, Niranjan, Francis Aboagye-Nyame, David Mabirizi, Kim Hoppenworth, Mohammad Golam Kibria, Seydou Doumbia, Lucilo Williams, and Greatjoy Mazibuko. 2018. "Digital Health Technologies to Support Access to Medicines and Pharmaceutical Services in the Achievement of Sustainable Development Goals." *Digital Health* 4 (January–December): 2055207618771407. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6016570/.

Kroll, Michele M. 2022. "Prolonged Social Isolation and Loneliness Are Equivalent to Smoking 15 Cigarettes a Day." *Health and Well-Being* (blog), May 2, 2022. https://extension.unh.edu/blog/2022/05/prolonged-social-isolation-loneliness-are-equivalent-smoking-15-cigarettes-day.

Kruk, Margaret E., Anna D. Gage, Catherine Arsenault, Keely Jordan, Hannah H. Leslie, Sanam Roder-DeWan, Olusoji Adeyi, et al. 2018. "High-Quality Health Systems in the Sustainable Development Goals Era: Time for a Revolution." *Lancet Global Health* 6 (11): e1196–e1252. https://www.thelancet.com/journals/langlo/article/PIIS2214-109X(18)30386-3/fulltext.

Kurowski, Christoph, David B. Evans, Martin Schmidt, Alexander Irwin, Ajay Tandon, Patrick Hoang-Vu Eozenou, and Iryna Postolovska. 2022. "Back to the Future? Amid Complex Crisis, Weak Spending Prospects Threaten Fragile Health Systems—Again." *Investing in Health* (blog), September 21, 2020. https://blogs.worldbank.org/health/back-future-amid-complex-crisis-weak-spending-prospects-threaten-fragile-health-systems.

Kurowski, Christoph, David B. Evans, Ajay Tandon, Patrick Hoang-Vu Eozenou, Martin Schmidt, Alec Irwin, Jewelwayne Salcedo Cain, Eko Setyo Pambudi, and Iryna Postolovska. 2021a. "From Double Shock to Double Recovery: Implications and Options for Health Financing in the Time of COVID-19." HNP Discussion Paper (March), Health, Nutrition, and Population Global Practice, World Bank, Washington, DC.

Kurowski, Christoph, David B. Evans, Ajay Tandon, Patrick Hoang-Vu Eozenou, Martin Schmidt, Alec Irwin, Jewelwayne Salcedo Cain, Eko Setyo Pambudi, and Iryna Postolovska. 2021b. "From Double Shock to Double Recovery: Implications and Options for Health Financing in the Time of COVID-19; Technical Update: Widening Rifts." HNP Discussion Paper (September), Health, Nutrition, and Population Global Practice, World Bank, Washington, DC.

Kurowski, Christoph, David B. Evans, Ajay Tandon, Patrick Hoang-Vu Eozenou, Martin Schmidt, Alec Irwin, Jewelwayne Salcedo Cain, Eko Setyo Pambudi, and Iryna Postolovska. 2022. "From Double Shock to Double Recovery: Implications and Options for Health Financing in the Time of COVID-19; Technical Update 2: Old Scars, New Wounds." HNP Discussion Paper (September), Health, Nutrition, and Population Global Practice, World Bank, Washington, DC. https://openknowledge.worldbank.org/server/api/core/bitstreams/76d5786b-9501-5235-922a-caa71f99f0fc/content.

Kurowski, Christoph, Anurag Kumar, Julio Mieses, Martin Schmidt, and Denise V. Silfverberg. 2023. "Health Financing in a Time of Global Shocks: Strong Advance, Early Retreat." HNP Discussion Paper (May), From Double Shock to Double Recovery Series, Health, Nutrition, and Population Global Practice, World Bank, Washington, DC.

Lång, Kristina, Viktoria Josefsson, Anna-Maria Larsson, Stefan Larsson, Charlotte Högberg, Hanna Sartor, Solveig Hofvind, Ingvar Andersson, and Aldana Rosso. 2023. "Artificial Intelligence-Supported Screen Reading versus Standard Double Reading in the Mammography Screening with Artificial Intelligence Trial (MASAI): A Clinical Safety Analysis of a Randomised, Controlled, Non-inferiority, Single-Blinded, Screening Accuracy Study." *Lancet Ocology* 24 (8): 936–44. https://www.thelancet.com/journals/lanonc/article/PIIS1470-2045(23)00298-X/fulltext.

Leckenby, Emily, Dalia Dawoud, Jacoline Bouvy, and Páll Jónsson. 2021. "The Sandbox Approach and Its Potential for Use in Health Technology Assessment: A Literature Review." *Applied Health Economics and Health Policy* 19 (6): 857–69. https://pubmed.ncbi.nlm.nih.gov/34254275/.

Ledel Solem, Ingrid Konstanse, Cecilie Varsi, Hilde Eide, Olöf Birna Kristjansdottir, Elin Børøsund, Karlein M. G. Schreurs, Lori B. Waxenberg, et al. 2020. "A User-Centered Approach to an Evidence-Based Electronic Health Pain Management Intervention for People with Chronic Pain: Design and Development of EPIO." *Journal of Medical Internet Research* 22 (1): e15889. https://www.jmir.org/2020/1/e15889/.

Lenz, Sarah. 2021. "'More Like a Support Tool': Ambivalences around Digital Health from Medical Developers' Perspective." *Big Data and Society* 8 (1): 1–13. https://doi.org/10.1177/2053951721996733.

Lupton, Deborah. 2021. "Young People's Use of Digital Health Technologies in the Global North: Narrative Review." *Journal of Medical Internet Research* 23 (1): e18286. https://www.jmir.org/2021/1/e18286/.

Lv, Hao, Lei Shi, Joshua William Berkenpas, Fu-Ying Dao, Hasan Zulfiqar, Hui Ding, Yang Zhang, Liming Yang, and Renzhi Cao. 2021. "Application of Artificial Intelligence and Machine Learning for COVID-19 Drug Discovery and Vaccine Design." *Briefings in Bioinformatics* 22 (6): bbab320. https://pubmed.ncbi.nlm.nih.gov/34410360/.

Mace, Ryan A., Meghan K. Mattos, and Ana-Maria Vranceanu. 2022. "Older Adults Can Use Technology: Why Healthcare Professionals Must Overcome Ageism in Digital Health." *Translational Behavioral Medicine* 12 (12): 1102–05. https://academic.oup.com/tbm/article-abstract/12/12/1102/6693996?redirectedFrom=fulltext.

Mamuye, Adane L., Tesfahun M. Yilma, Ahmad Abdulwahab, Sean Broomhead, Phumzule Zondo, Mercy Kyeng, Justin Maeda, Mohammed Abdulaziz, Tadesse Wuhib, and Binyam C. Tilahun. 2022. "Health Information Exchange Policy and Standards for Digital Health Systems in Africa: A Systematic Review." *PLOS Digital Health* 1 (10): e0000118. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9931258/.

Manteghinejad, Amirreza, and Shaghayegh Haghjooy Javanmard. 2021. "Challenges and Opportunities of Digital Health in a Post-COVID-19 World." *Journal of Research in Medical Sciences* 26 (1): 11. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8103966/.

Meara, John G., Andrew J. M. Leather, Lars Hagander, Blake C. Alkire, Nivaldo Alonso, Emmanuel A. Ameh, Stephen W. Bickler, et al. 2015. "Global Surgery 2030: Evidence and Solutions for Achieving Health, Welfare, and Economic Development." *Lancet Commissions* 386 (9993): 569–624. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(15)60160-X/fulltext.

Mercer, Caroline. 2019. "How Health Care Contributes to Climate Change." *CMAJ* 191 (14): E403–E404. https://doi.org/10.1503/cmaj.109-5722.

Meskó, Bertalan, Zsófia Drobni, Éva Bényei, Bence Gergely, and Zsuzsanna Győrffy. 2017. "Digital Health Is a Cultural Transformation of Traditional Healthcare." *mHealth* 3 (September 14): 38. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5682364/.

Mora, Camilo, Tristan McKenzie, Isabella M. Gaw, Jacqueline M. Dean, Hannah von Hammerstein, Tabatha A. Knudson, Renee O. Setter, et al. 2022. "Over Half of Known Human Pathogenic Diseases Can Be Aggravated by Climate Change." *Nature Climate Change* 12 (August): 869–75. https://doi.org/10.1038/s41558-022-01426-1.

Morris, Zoë Slote, Steven Wooding, and Jonathan Grant. 2011. "The Answer Is 17 Years, What Is the Question: Understanding Time Lags in Translational Research." *Journal of the Royal Society of Medicine* 104 (12): 510–20. https://doi.org/10.1258/jrsm.2011.110180.

Muinga, Naomi, Steve Magare, Jonathan Monda, Mike English, Hamish Fraser, John Powell, and Chris Paton. 2020. "Digital Health Systems in Kenyan Public Hospitals: A Mixed-Methods Survey." *BMC Medical Informatics and Decision Making* 20 (1): 2. https://bmcmedinformdecismak.biomedcentral.com/articles/10.1186/s12911-019-1005-7.

Nakrem, Sigrid, Marit Solbjør, Ida Nilstad Pettersen, and Hanne Hestvik Kleiven. 2018. "Care Relationships at Stake? Home Healthcare Professionals' Experiences with Digital Medicine Dispensers: A Qualitative Study." *BMC Health Services Research* 18 (1): 26. https://doi.org/10.1186/s12913-018-2835-1.

Natalucci, Valentina, Federica Marmondi, Michele Biraghi, and Matteo Bonato. 2023. "The Effectiveness of Wearable Devices in Non-Communicable Diseases to Manage Physical Activity and Nutrition: Where We Are?" *Nutrients* 15 (4): 913. https://pubmed.ncbi.nlm.nih.gov/36839271/.

NICE (National Institute for Health and Care Excellence, UK). 2023. "Evidence Standards Framework for Digital Health Technologies." NICE, Manchester, UK. https://www.nice.org.uk/corporate/ecd7/chapter/update-information.

Nolan, Richard L., and David C. Croson. 1995. *Creative Destruction: A Six-Stage Process for Transforming the Organization.* Spie Proceedings Series 2362. Boston: Harvard Business School Press. https://www.hbs.edu/faculty/Pages/item.aspx?num=243.

Obesity Evidence Hub. 2022. "Impact of Unhealthy Food Marketing on Children." Prevention: Marketing to Children, Obesity Evidence Hub, Victoria, Australia. https://www.obesityevidencehub.org.au/collections/prevention/the-impact-of-food-marketing-on-children.

Otto, Kate, Meera Shekar, Christopher H. Herbst, and Rianna Mohammed. 2015. "Information and Communication Technologies For Health Systems Strengthening: Opportunities, Criteria for Success, and Innovation for Africa and Beyond." HNP Discussion Paper, January, Health, Nutrition, and Population, Human Development Network, World Bank, Washington, DC. https://openknowledge.worldbank.org/server/api/core/bitstreams/74159b7e-b9ae-5b24-805b-a42b0c443ec7/content.

Pagliari, Claudia, David Sloan, Peter Gregor, Frank Sullivan, Don Detmer, James P. Kahan, Wija Oortwijn, and Steve MacGillivray. 2005. "What Is eHealth (4): A Scoping Exercise to Map the Field." *Journal of Medical Internet Research* 7 (1): e9. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1550637/.

PAHO (Pan American Health Organization) and ITU (International Telecommunication Union). 2023. "The Role of Digital Technologies in Aging and Health." International Telecommunication Union, Geneva; Pan American Health Organization, Washington, DC. https://www.paho.org/en/documents/role-digital-technologies-aging-and-health.

Paina, Ligia, and David H. Peters. 2012. "Understanding Pathways for Scaling Up Health Services through the Lens of Complex Adaptive Systems." *Health Policy and Planning* 27 (5): 365–73. https://doi.org/10.1093/heapol/czr054.

Painuly, Sakshi, Sachin Sharma, and Priya Matta. 2023. "Artificial Intelligence in e-Healthcare Supply Chain Management System: Challenges and Future Trends." In *2023 International Conference on Sustainable Computing and Data Communication Systems (ICSCDS)*, 569–74. New York: Institute of Electrical and Electronics Engineers. https://ieeexplore.ieee.org/document/10104746.

PATH. 2018. "Data Use Partnership, Building a Digital Health Investment Road Map in Tanzania: A Look Back at What Worked." PATH, Seattle. https://media.path.org/documents/PATH_DUP_RoadMapTanzania_ExecSummary_R2.pdf.

Patil, Sumeet R., Sneha Nimmagadda, Lakshmi Gopalakrishnan, Rasmi Avula, Sumati Bajaj, Nadia Diamond-Smith, Anshuman Paul, Lia Fernald, Purnima Menon, and Dilys Walker. 2022. "Can Digitally Enabling Community Health and Nutrition Workers Improve Services Delivery to Pregnant Women and Mothers of Infants? Quasi-Experimental Evidence from a National-Scale Nutrition Programme in India." *BMJ Global Health* 6 (Supplement 5): e007298. https://pubmed.ncbi.nlm.nih.gov/35835476/.

Paul, Debleena, Gaurav Sanap, Snehal Shenoy, Dnyaneshwar Kalyane, Kiran Kalia, and Rakesh K. Tekade. 2021. "Artificial Intelligence in Drug Discovery and Development." *Drug Discovery Today* 26 (1): 80–93. https://pubmed.ncbi.nlm.nih.gov/33099022/.

Perakslis, Eric, and Geoffrey S. Ginsburg. 2021. "Digital Health: The Need to Assess Benefits, Risks, and Value." *JAMA* 325 (2): 127–28. https://jamanetwork.com/journals/jama/article-abstract/2774657.

Philip, Keir E. J., Feifei Bu, Michael I. Polkey, Jamie Brown, Andrew Steptoe, Nicholas S. Hopkinson, and Daisy Fancourt. 2022. "Relationship of Smoking with Current and Future Social Isolation and Loneliness: 12-Year Follow-Up of Older Adults in England." *Lancet Regional Health: Europe* 14 (March): 100302. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8743222/.

PIB (Press Information Bureau, India). 2023. "Dr Mansukh Mandaviya Delivers Keynote Address on Digital transformation Challenges, Opportunities, and Success on the Concluding Day of the Global Conference on Digital Health." Press Release, March 21, 2023. https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1909067.

PLOS Medicine Editors, Annette Rid, Michael A. Johansson, Gabriel Leung, Hannah Valantine, Esteban G. Burchard, Sam S. Oh, and Cathy Zimmerman. 2016. "Towards Equity in Health: Researchers Take Stock." *PLOS Medicine* 13 (11): e1002186. https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1002186.

Poole, Emily, Carl Toohey, and Peter Harris. 2014. "Public Infrastructure: A Framework for Decision-Making." In *Financial Flows and Infrastructure Financing*, edited by Alexandra Heath and Matthew Read, 97–135. Sydney: Reserve Bank of Australia. https://www.rba.gov.au/publications/confs/2014/pdf/poole-toohey-harris.pdf.

Rajpurkar, Pranav, and Matthew P. Lungren. 2023. "The Current and Future State of AI Interpretation of Medical Images." *New England Journal of Medicine* 388 (21): 1981–90. https://www.nejm.org/doi/pdf/10.1056/NEJMra2301725.

Rasheed, Huma, Ludwig Höllein, and Ulrike Holzgrabe. 2018. "Future Information Technology Tools for Fighting Substandard and Falsified Medicines in Low- and Middle-Income Countries." *Frontiers in Pharmacology* 9 (August): 995. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6127459/.

RBCCM (Royal Bank of Canada Capital Markets). 2019. "Episode 1: The Healthcare Data Explosion." Royal Bank of Canada, Montreal. https://www.rbccm.com/en/gib/healthcare/episode/the_healthcare_data_explosion#content-panel.

RECAINSA (Red Centroamericana de Informática en Salud). 2023. "Global Digital Health Monitor Launch." *Agenda Digital, Agenda Global*, May 27, 2023. https://recainsa.org/global-digital-health-monitor-launch/.

Reinsel, David, John Gantz, and John Rydning. 2020. "Data Age 2025: The Digitization of the World from Edge to Core." IDC White Paper US44413318 (May), International Data Corporation, Framingham, MA. https://uploads-ssl.webflow.com/5ecd514b143c3cedeacb6071/5f57e24df0e2c0dd7cfb56d2_the-digitization-of-the-world.pdf.

Robertson, Christopher, Andrew Woods, Kelly Bergstrand, Jess Findley, Cayley Balser, and Marvin J. Slepian. 2023. "Diverse Patients' Attitudes towards Artificial Intelligence (AI) in Diagnosis." *PLOS Digital Health* 2 (5): e0000237. https://journals.plos.org/digitalhealth/article?id=10.1371/journal.pdig.0000237.

Rodriguez, Sarai. 2023. "Financial Incentives Drive Healthy Behavior Change in Online Grocery Retail." *Patient Care Access News*, March 14, 2023. https://patientengagementhit.com/news/financial-incentives-drive-healthy-behavior-change-in-online-grocery-retail.

Rudin, Robert S., Sofia Perez, Jorge A. Rodriguez, Jessica Sousa, Savanna Plombon, Adriana Arcia, Dinah Foer, David W. Bates, and Anuj K. Dalal. 2021. "User-Centered Design of a Scalable, Electronic Health Record-Integrated Remote Symptom Monitoring Intervention for Patients with Asthma and Providers in Primary Care." *Journal of the American Medical Informatics Association* 28 (11): 2433–44. https://academic.oup.com/jamia/article/28/11/2433/6354174.

Sahu, Kirti Sundar, Shannon E. Majowicz, Joel A. Dubin, and Plinio Pelegrini Morita. 2021. "NextGen Public Health Surveillance and the Internet of Things (IoT)." *Frontiers in Public Health* 9 (December): 756675. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8678116/.

Sau, Nasreen, Anju Jaggi, and Mindy Claire Cairns. 2019. "Clinicians' Views on the Uptake of Technology in Health Care." *International Journal of Therapy and Rehabilitation* 26 (6): 1759–79. https://www.magonlinelibrary.com/doi/abs/10.12968/ijtr.2019.26.6.11.

Scott, Richard E., and Maurice Mars. 2013. "Principles and Framework for eHealth Strategy Development." *Journal of Medical Internet Research* 15 (7): e155. https://www.jmir.org/2013/7/e155/.

Shekar, Meera, Jakub Kakietek, Julia Dayton Eberwein, and Dylan Walters. 2017. *An Investment Framework for Nutrition: Reaching the Global Targets for Stunting, Anemia, Breastfeeding, and Wasting.* Directions in Development: Human Development Series. Washington, DC: World Bank. https://www.worldbank.org/en/topic/nutrition/publication/an-investment-framework-for-nutrition-reaching-the-global-targets-for-stunting-anemia-breastfeeding-wasting.

Shin, Hyun Joo, Kyunghwa Han, Leeha Ryu, and Eun-Kyung Kim. 2023. "The Impact of Artificial Intelligence on the Reading Times of Radiologists for Chest Radiographs." *NPJ Digital Medicine* 6 (1): 82. https://www.nature.com/articles/s41746-023-00829-4#citeas.

Shortell, Stephen M. 2013. "Bridging the Divide between Health and Health Care." *JAMA* 309 (11): 1121–22. https://jamanetwork.com/journals/jama/article-abstract/1669826.

Shrank, William H., Teresa L. Rogstad, and Natasha Parekh. 2019. "Waste in the US Health Care System: Estimated Costs and Potential for Savings." *JAMA* 322 (15): 1501–09. https://jamanetwork.com/journals/jama/article-abstract/2752664.

Sines, Chad C., and Gerald R. Griffin. 2017. "Potential Effects of the Electronic Health Record on the Small Physician Practice: A Delphi Study." *Perspectives in Health Information Management* 14 (Spring): 1. https://pubmed.ncbi.nlm.nih.gov/28566989/.

Singhal, Shubham, Mathangi Radha, and Nithya Vinjamoori. 2022. "The Next Frontier of Care Delivery in Healthcare." *Our Insights*, March 24, 2022. https://www.mckinsey.com/industries/healthcare/our-insights/the-next-frontier-of-care-delivery-in-healthcare.

Snowdon, Anne. 2020. "HIMSS Defines Digital Health for the Global Healthcare Industry." *Digital Health*, March 2, 2020. https://www.himss.org/news/himss-defines-digital-health-global-healthcare-industry.

Subandoro, Ali Winoto, Kyoko Okamura, Michelle Mehta, Huihui Wang, Naina Ahluwalia, Elyssa Finkel, Andrea L. S. Bulungu, Girmaye Dinsa, Latifat Okara, and Shelby Wilson. 2022. *Positioning Nutrition within Universal Health Coverage: Optimizing Health Financing Levers.* HNP Discussion Paper, January. Washington, DC: Health, Nutrition, and Population Global Practice, World Bank. https://openknowledge.worldbank.org/entities/publication/bb02c78e-2f41-5151-812d-385701bc0344.

SUN (Scaling Up Nutrition). 2022. "Digital Solutions for Health and Nutrition: Burkina Faso." Case Studies on Examples of Best Practice, SUN, Geneva. https://scalingupnutrition.org/sites/default/files/2022-09/TASC_Case%20Study_%20Digital%20Solutions%20Burkina%20Faso_English.pdf.

Tangcharoensathien, Viroj, Orana Chandrasiri, Watinee Kunpeuk, Kamolphat Markchang, and Nattanicha Pangkariya. 2019. "Addressing NCDs: Challenges from Industry Market Promotion and Interferences." *International Journal of Health Policy and Management* 8 (5): 256–60. https://doi.org/10.15171/ijhpm.2019.02.

Tariq, Amina, Shanchita R. Khan, and Amna Basharat. 2020. "Internet Use, eHealth Literacy, and Dietary Supplement Use among Young Adults in Pakistan: Cross-Sectional Study." *Journal of Medical Internet Research* 22 (6): e17014. https://www.jmir.org/2020/6/e17014/.

Tomasella, Flavio, and Heather May Morgan. 2021. "'Sometimes I Don't Have a Pulse . . . and I'm Still Alive!' Interviews with Healthcare Professionals to Explore Their Experiences of and Views on Population-Based Digital Health Technologies." *Digital Health* 7 (January–December): :20552076211018366. https://doi.org/10.1177/20552076211018366.

Torgan, Carol E. 2009. "The mHealth Summit: Local and Global Converge." *Kinetics* (blog), November 6, 2009. https://caroltorgan.com/mhealth-summit/.

Transform Health. 2022. *Closing the Digital Divide: More and Better Funding for the Digital Transformation of Health.* Geneva: Transform Health. https://transformhealthcoalition.org/wp-content/uploads/2022/10/Closing-the-digital-divide-mainReport.pdf.

Tufford, Adèle R., Philip C. Calder, Pieter Van't Veer, Edith F. Feskens, Theo Ockhuizen, Aletta D. Kraneveld, Jan Sikkema, and Jan de Vries. 2020. "Is Nutrition Science Ready for the Twenty-First Century? Moving towards Transdisciplinary Impacts in a Changing World." *European Journal of Nutrition* 59 (Supplement 1): 1–10. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7220883/.

UNICEF (United Nations Children's Fund). 2019. "Health System Strengthening: Transforming the Health Information System in Bangladesh through the Implementation of DHIS2; Case Study Bangladesh." July, Regional Office for South Asia, UNICEF, Kathmandu, Nepal. https://www.unicef.org/rosa/reports/health-system-strengthening-transforming-health-information-system-bangladesh.

UNICEF (United Nations Children's Fund) and WHO (World Health Organization). 2021. "National Nutrition Information System: The Fundamentals Series, Modules 1–5." UNICEF and WHO, New York. https://apps.who.int/iris/handle/10665/359737.

United Nations. 2019. "The Age of Digital Interdependence: Report of the UN Secretary-General's High-level Panel on Digital Cooperation." United Nations, New York. https://www.un.org/en/pdfs/DigitalCooperation-report-for%20web.pdf.

UNSCN (United Nations Standing Committee on Nutrition). 2020. "Nutrition in a Digital World." *Nutrition* 45 (July), UNSCN, Rome. https://www.unscn.org/uploads/web/news/UNSCN-Nutrition-45-WEB.pdf.

USAID (United States Agency for International Development). 2020. "Using Digital Tools to Strengthen Nutrition Service Delivery: An Overview." USAID Advancing Nutrition, Arlington, VA. https://www.advancingnutrition.org/sites/default/files/2021-10/using_digital_tools_strengthen_nutrition_service_delivery_overview.pdf.

Uscher-Pines, Lori, Rebecca Lawrence, and Molly Waymouth. 2023. "Telehealth for Breastfeeding Support and Lessons for Digital Equity." *JAMA Health Forum* 4 (3): e225464. https://pubmed.ncbi.nlm.nih.gov/36867418/.

van Stam, Gertjan. 2022. "Conceptualization and Practices in Digital Health: Voices from Africa." *African Health Sciences* 22 (1): 664–72. https://www.ajol.info/index.php/ahs/article/view/224696.

Walcott, David, and Sofiat Akinola. 2021. "Shift to Digital during the Pandemic Could Enable Universal Health Coverage." *WHO South-East Asia Journal of Public Health* 10 (Supplement 1): S91–S92. DOI: 10.4103/2224-3151.309883.

Wang, Changwon, Chungkeun Lee, and Hangsik Shin. 2023. "Digital Therapeutics from Bench to Bedside." *NPJ Digital Medicine* 6 (1): 38. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10006069/.

Webb, Marnie. 2023. "We Must Take Up the Banner of Affordable, Equitable Access to the Internet." *Medium: TechSoup Global Network* (blog), January 25, 2023. https://techsoup.medium.com/we-must-take-up-the-banner-of-affordable-equitable-access-to-the-internet-a4e48afb664d.

Wernhart, Anna, Susanne Gahbauer, and Daniela Haluza. 2019. "eHealth and Telemedicine: Practices and Beliefs among Healthcare Professionals and Medical Students at a Medical University." *PLOS One* 14 (2): e0213067. https://pubmed.ncbi.nlm.nih.gov/30818348/.

WHO (World Health Organization). 2016a. *Global Diffusion of eHealth: Making Universal Health Coverage Achievable.* Report of the Third Global Survey on eHealth. Geneva: Global Observatory for eHealth, WHO. https://www.who.int/publications/i/item/9789241511780.

WHO (World Health Organization). 2016b. *Monitoring and Evaluating Digital Health Interventions: A Practical Guide to Conducting Research and Assessment.* Geneva: WHO. https://apps.who.int/iris/bitstream/handle/10665/252183/9789241511766-eng.pdf?sequence=1&isAllowed=y.

WHO (World Health Organization). 2018. "Classification of Digital Health Interventions v1.0." Document WHO/RHR/18.06, WHO, Geneva. https://apps.who.int/iris/bitstream/handle/10665/260480/WHO-RHR-18.06-eng.pdf.

WHO (World Health Organization). 2020a. "Implementing Telemedicine Services during COVID-19: Guiding Principles and Considerations for a Stepwise Approach." Document WPR/DSE/2020/032, Regional Office for the Western Pacific, WHO, Manila. https://apps.who.int/iris/handle/10665/336862.

WHO (World Health Organization). 2020b. "Urgent Health Challenges for the Next Decade." P*hoto Story: Detail,* January 13, 2020. https://www.who.int/news-room/photo-story/photo-story-detail/urgent-health-challenges-for-the-next-decade.

WHO (World Health Organization). 2021a. "Digital Technologies for Health Financing: What Are the Benefits and Risks for UHC? Some Initial Reflections." Health Financing Working Paper 19, WHO, Geneva. https://www.who.int/publications/i/item/9789240031005.

WHO (World Health Organization). 2021b. "Fast Facts on Climate Change and Health." Climate Fast Facts Series, September 8, WHO, Geneva. https://www.who.int/publications/m/item/fast-facts-on-climate-change-and-health.

WHO (World Health Organization). 2021c. "Global Strategy on Digital Health 2020–2025." WHO, Geneva. https://www.who.int/docs/default-source/documents/gs4dhdaa2a9f352b0445bafbc79ca799dce4d.pdf.

WHO (World Health Organization). 2022a. "Global Genomic Surveillance Strategy for Pathogens with Pandemic and Epidemic Potential 2022–2032." WHO, Geneva. https://www.who.int/initiatives/genomic-surveillance-strategy.

WHO (World Health Organization). 2022b. "Monitoring the Implementation of Digital Health: An Overview of Selected National and International Methodologies." Document WHO/EURO:2022-5985-45750-65816, WHO Regional Office for Europe, Copenhagen. https://www.who.int/europe/publications/i/item/WHO-EURO-2022-5985-45750-65816.

WHO (World Health Organization). 2022c. "Using Digital Technologies in Food Fortification for Improved Nutrition Outcomes." *Events Detail*, September 19, 2022. https://www.who.int/news-room/events/detail/2022/09/19/default-calendar/using-digital-technologies-in-food-fortification-for-improved-nutrition-outcomes.

WHO (World Health Organization) and ITU (International Telecommunication Union). 2012. *National eHealth Strategy Toolkit.* Geneva: ITU and WHO.

Wiggers, Peter, Henk Kok, and Maritha de Boer-de Wit. 2004. *IT Performance Management.* Computer Weekly Professional Series. Oxford, UK: Elsevier Butterworth-Heinemann.

Wilkinson, Thomas David, Mengxiao Wang, Jed Friedman, and Marelize Görgens. 2023. "A Framework for the Economic Evaluation of Digital Health Interventions." Policy Research Working Paper 10407, World Bank, Washington, DC. http://hdl.handle.net/10986/39713.

Wilson, David, Aziz Sheikh, Marelize Görgens, and Katherine Ward. 2021. "Technology and Universal Health Coverage: Examining the Role of Digital Health." *Journal of Global Health* 11 (November 20): 16006. doi: 10.7189/jogh.11.16006.

Wilson, Kate, Brian Latko, Cheryl Cashin, Alice Garabrant, Cees Hesp, Paul Stepney, Herman Bennema, et al. 2013. "Provider Payment Reform and Information Technology Systems: A Chicken and Egg Question for National Health Coverage Programs." September, Joint Learning Network for Universal Health Coverage, Arlington, VA. https://www.jointlearningnetwork.org/wp-content/uploads/2019/11/provider-payment-reform-it-systems.pdf.

Wong, Chi Heem, Kien Wei Siah, and Andrew W. Lo. 2019. "Estimation of Clinical Trial Success Rates and Related Parameters." *Biostatistics* 20 (2): 273–86. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6409418/.

World Bank. 2013. *Improving Nutrition through Multisectoral Approaches.* Report. Washington, DC: World Bank. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/625661468329649726/la-cuantificaci-243-n-de-los-efectos-de-los-proyectos-mexico.

World Bank. 2016a. "SABER: Education Management Information Systems." Education Global Practice: Systems Approach for Better Education Results, World Bank, Washington, DC. https://documents1.worldbank.org/curated/en/645041496302045154/pdf/Systems-Approach-for-Better-Education-Results-SABER-education-management-information-systems.pdf.

World Bank. 2016b. *World Development Report 2016: Digital Dividends.* Washington, DC: World Bank. https://www.worldbank.org/en/publication/wdr2016.

World Bank. 2018. "Disruptive Technologies and the World Bank Group: Creating Opportunities, Mitigating Risks." Document DC2018-0010, September 18, World Bank, Washington, DC. https://www.devcommittee.org/content/dam/sites/devcommittee/doc/documents/mgr/DC2018-0010%20Disruptive%20Technologies.pdf.

World Bank. 2019. "Mainstreaming the Approach to Disruptive and Transformative Technologies at the World Bank Group." Document DC2019-0002, March 20, World Bank, Washington, DC. https://www.devcommittee.org/sites/dc/files/download/Documents/2019-04/DC2019-0002-Mainstreaming%20disruptive%20%204-13.pdf.

World Bank. 2020. "Global Experiences from Regulatory Sandboxes." Fintech Note 8, Finance, Competitiveness, and Innovation Global Practice, World Bank, Washington, DC. http://hdl.handle.net/10986/34789.

World Bank. 2021. *World Development Report 2021: Data for Better Lives.* Washington, DC: World Bank. https://www.worldbank.org/en/publication/wdr2021.

World Bank. 2022a. "Digitalization and Development." Development Committee Ministerial Plenary Paper, Spring Meetings, April 2022, World Bank, Washington, DC. https://www.devcommittee.org/content/dam/sites/devcommittee/doc/documents/mgr/Final%20on%20Digitalization_DC2022-0002.pdf.

World Bank. 2022b. "National Digital Identity and Government Data Sharing in Singapore: A Case Study of Singpass and APEX." World Bank, Washington, DC. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099300010212228518/p171592179b3e5df14cae14ed71a1631d5663205bf94.

World Bank. 2022c. "The Role of Digital in the COVID-19 Social Assistance Response." G2Px Initiative, World Bank, Washington, DC. https://documents1.worldbank.org/curated/en/099830009302217091/pdf/P1731660f8c52f062092ac00d53c648bac7.pdf.

World Bank. 2023. "Accelerating the Uptake of Digital Innovations in Health Care in the European Union." World Bank, Washington, DC.

Wu, Ya-Huei, Manon Lewis, and Anne-Sophie Rigaud. 2019. "Cognitive Function and Digital Device Use in Older Adults Attending a Memory Clinic." *Gerontology and Geriatric Medicine* 5 (January–December): 2333721419844886. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6498770/.

Xiong, Shangzhi, Hongsheng Lu, Nicholas Peoples, Ege K. Duman, Alberto Najarro, Zhao Ni, Enying Gong, et al. 2023. "Digital Health Interventions for Non-communicable Disease Management in Primary Health Care in Low- and Middle-Income Countries." *npj Digital Medicin*e 6 (February): 12. https://doi.org/10.1038/s41746-023-00764-4.

Yi, Myongho. 2018. "Major Issues in Adoption of Electronic Health Records." J*ournal of Digital Information Management* 16 (4): 180–91. https://www.dline.info/fpaper/jdim/v16i4/jdimv16i4_3.pdf.

Zaresani, Arezou, and Anthony Scott. 2020. "Does Digital Health Technology Improve Physicians' Job Satisfaction and Work–Life Balance? A Cross-Sectional National Survey and Regression Analysis Using an Instrumental Variable." *BMJ Open* 10 (12): e041690. https://bmjopen.bmj.com/content/bmjopen/10/12/e041690.full.pdf.

ANNEX A

WAYS IN WHICH DIGITAL ADDS VALUE TO HEALTH SYSTEMS

Clinical and administrative processes

- Improved quality, efficiency, and streamlining in patient care: HISs and digital health records can streamline data management, reduce administrative burdens, and facilitate better communication among health care providers. Having instant and constant access to data on a patient's health can make it much easier for medical professionals to diagnose, monitor and adjust treatments for maximum effectiveness. Shin et al. (2023) show, for example, that artificial intelligence (AI) embedded in radiology could save 33 percent of radiologists' time without decreasing the accuracy of their diagnoses.

- Decision support tools for front-line health staff. These technologies equip health care professionals with insights and suggestions that enhance diagnostic accuracy, thereby improving health results. Additionally, these resources can incorporate preventive care reminders and warnings about potential high-risk conditions. In low resource settings, clinical decision support tools could provide health care workers with access to higher level expertise that would not otherwise have been available.

Access, communication, and integration

Enhanced accessibility: Digital health solutions can bridge geographical and financial barriers, providing health care services to rural or remote areas, and underserved populations through telemedicine, mobile health applications, and remote monitoring. It can also positively impact productivity of the existing health workforce and empower them to deliver more health care.

- *Address health inequities:* According to the World Economic Forum (2021), digital technology can help to address inequity in health care by decreasing inequities in (a) access to specialized medical care, (b) access to trusted and reliable health information, (c) access to medical commodities and other interventions, (d) representation in public health systems and services, and (e) support for catastrophic medical expenses by helping to identify, in times of crises, vulnerable populations that might be missed.

- *Preventive care and early intervention:* Wearable devices, mobile health apps, and remote monitoring can help track patients' vital signs and behaviors, allowing for early detection of potential health issues and timely interventions, reducing the need for hospitalizations, and lowering health care costs.
- *Personalized health care and precision medicine:* Digital health technologies, such as genomics, AI, and machine learning, can help in the development of targeted therapies and precision medicine, tailoring treatments to individual patients' specific needs and genetic profiles.
- *Empowered patients:* Digital health tools can educate and engage patients, fostering self-care, self-management, and adherence to treatment plans, ultimately leading to better health outcomes.

Data, reporting, and analytics

- *Better disease prevention and improved public health:* Big data analytics and AI can help identify trends, track disease outbreaks, and inform public health policies, enabling more effective and targeted interventions at the population level.
- *Cost-effectiveness:* Digital health technologies can reduce health care costs by streamlining processes, facilitating preventive care, and enabling remote consultations, thereby decreasing the need for in-person visits and expensive hospital stays. Inversely, they can also increase costs and this dimension needs to be carefully explored.
- *Removing fragmentation of service delivery.* Currently many countries have their data in multiple siloed structures that do not or struggle to exchange information with each other. If planned correctly by aligning with a standard objective of closer integration, digital health can be effectively used to improve the level of coordination required.

ANNEX B

STEPS INVOLVED IN CONDUCTING THE WORLD BANK DIGITAL HEALTH PORTFOLIO REVIEW

Overview of steps

Step 1. Develop a taxonomy with which to classify types of digital health–related investments.

Step 2. From the World Bank database of projects (investments), extract active and closed projects in 2012–22), managed by (a) HNP GP, (b) DD GP, and (c) GOV GP and that had digital health–related investments.

Step 3. Selection of most relevant projects (managed by HNP GP, DD GP, GOV GP, and SPJ GP) using relevance scores from a classification algorithm to find projects with most terms from the key word search list, and cross verified with project lists from similar projects that identified digital projects.

Step 4. Manual review of information in Project Appraisal Documents (PADs) to estimate the share of total funding per project that is dedicated to specific digital health–related activities.

Step 1: Creation of a taxonomy of digital health–related investments

In 2021, the World Bank's Human Capital Project released a policy brief on disruptive and transformative technology for integrated human service delivery: Arresting Human Capital Losses due to COVID-19: Reimagining Service Delivery in a Digital Age. This policy brief suggested that to be successful in embedding disruptive and transformative technology into human development service delivery, three kinds of investments are needed: Foundational, Functional and Frontier investments:

- Foundational: technology infrastructure, civil registration and patient unique ID system, data governance, and training in digital literacy.
- Functional: HISs, health service delivery redesign for digitalization, client facing digital health information applications, provider facing digital health information applications, linking health care providers and clients through innovative virtual service delivery, health care provider training in the use of app-, AI-, and machine learning–based applications for health service delivery, applications for improved

health system management, Apps for improved health service delivery, digitalized and improved efficiency of health care management.

- Frontier: any of the investments in functional can also be frontier investments, if they are being piloted, as opposed to scaled. Also, proofs of concept that have potential to scale, anything in functional that is being implemented as pilot is counted as frontier including AI- and machine learning–based applications for health service delivery, and emerging technologies such as virtual reality training and distributed ledger/blockchain-based insurance and claims schemes.

The purpose of creating the taxonomy was to create a bridge language between health professionals and technology professionals, and to articulate the functionalities of digital health implementation. The purpose was also to capture the different ways in which digital and mobile technologies are being used to support health system needs at the policy and programmatic levels as well as new emerging technologies and innovations.

The taxonomy was developed using these three types of investment as the main taxonomy categories, and subcategories were then developed using the WHO Classification of Digital Health Interventions as a basis (WHO 2018). Because this WHO classification focuses on digital health interventions and the World Bank's investments are wider than individual digital health interventions, the taxonomy was expanded beyond the WHO classification to focus on types of investments and not types of services that digital health interventions provide. The taxonomy is detailed in Annex Table B.1.

Annex Table B.1 Taxonomy Used to Map Digital Health Projects, by Type (Foundational, Functional and Frontier)

Foundational investments: Investments to create a data and digital ecosystem for health service delivery and management
Technology infrastructure - hardware and connectivity
Enterprise architecture
Identification and registries
Governance of digital health solutions and health data
Capacity in the design, management and use of digital health solutions in the health system

Table continued...

Annex Table B.1 Taxonomy Used to Map Digital Health Projects, by Type (Foundational, Functional and Frontier) (continued)

Functional Investments: Scale up and maintenance of information systems, digital technologies and applications through which to deliver and manage health services
Digitally enabled health service delivery redesign
Health information systems (logistics/supply chain)
Health information systems (financing)
Health information systems (surveillance and disease monitoring)
Health information systems (laboratory management system)
Client-facing digital health information applications
Health information systems (provider or patient-centric)
Linking health care providers and clients through virtual service delivery
Human resources for health (digital focus, digital skills)
Frontier investments: Test new technologies within a framework of evidence as part of a system-wide revolution (transformation). Any of the investments in functional can also be frontier investments, if they are being piloted or implemented in a proof of concept way, as opposed to scaled
Artificial intelligence– and machine learning–based applications for health service delivery
Emerging technologies

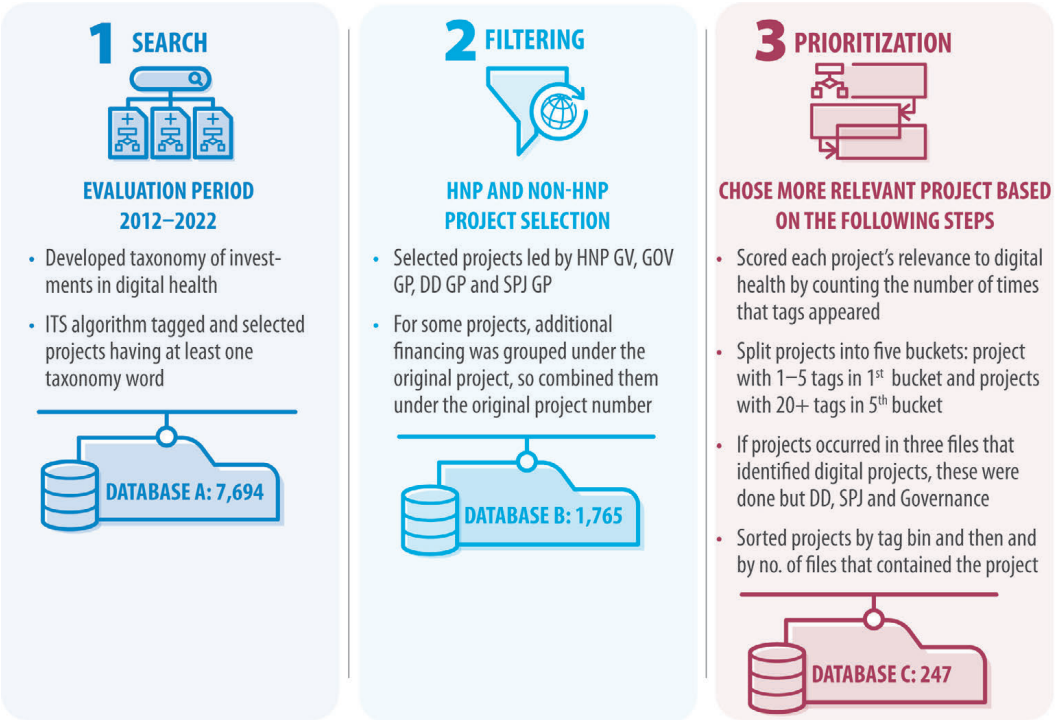
Step 2: Identify the subset of World Bank projects with digital health components managed by the four global practices (HNP GP, DD GP, GOV GP, and SPJ GP)

First, create a database of HNP GP-managed projects. At the time that the review was conducted, the World Bank's operational coding of projects did not include the option to tag digital health investments in health sector projects, and, so, such tags could not be used to extract these data from all HNP-managed investments, a subset of investments with digital health components. In a further complication, PADs also do not follow a format that makes for easy identification of digital health components in projects. Therefore, the team had to implement several substeps, 2.1 to 2.4, detailed in Figure B.1, to create a database of digital health projects managed by HNP GP.

A text analysis algorithm was used by the World Bank's Information Technology Solutions team to identify digital health projects by searching for projects with one or more keywords in the PAD of the project (the set of key words was created for a similar assessment at the human development level). The list of key words (tags) in the taxonomy were developed by the human development team and sent to the team to run the algorithm against all human development projects.

The team ran the code against all approved projects (both active and closed) from 2012 through February 2022. PADs that had a match with at least one of the tags in any part of the text were pulled into a set of digital health projects. In total, 826 projects were identified. Of these 826 projects, projects mapped to HNP GP were retrieved, which narrowed down the list to 323 projects. Lastly, projects with additional financing were grouped as one, resulting in 224 unique projects for analysis.[1]

Figure 41 Digital Health Portfolio Identification Process



As part of quality assurance, the list of HNP projects were cross verified to check if they appeared in the technology portfolio assessments conducted by other GOV GPs, DD GPs,

[1] Of 224 projects, only 193 had a digital health component and had been tagged for female education, family spacing, food supplements, and activity cost.

or the South Asia regional human development team. As a second step, a similar tagging exercise was carried out on the projects of DD GP, GOV GP, and SPJ GP, and 120 projects were selected for the assessment process.

After the HNP GP–managed projects were selected, other projects managed by DD GP, SPJ GP, and GOV GP with digital health–related investments were also selected using a similar methodology.

Step 3: Selection of the most relevant projects for the assessment process

To determine the relative relevance to digital health, a prioritization approach was used:

- Count the number of tags for each project.
- Sort the projects by total number of tags. Based on the total number of tags, the projects were split into five categories. For example, projects with 1–5 tags were placed in the first category, and projects with 20+ tags were put in the fifth category.
- To identify projects with greater relevance to digital health, the list of projects was finally sorted by both their tag bin, followed by the maximum number of matches with the 3 other assessment files.

Step 4: Valuing investments financed through Bank-supported operations.

All the identified PADs (including additional financing) were manually reviewed. While reviewing each PAD, analysts recorded the following details:

- Whether or not the project is digital health related.
- Map the different digital health interventions within each project and to ensure that these were categorized as per the new taxonomy.
- The estimated cost of each activity/intervention. In cases where the cost for each activity was provided, that amount was used. However, in majority of the projects, the cost was estimated by dividing the entire project cost evenly across the number of activities in the project.
- This information was recorded into an Excel file and further consolidated into a separate database which forms the basis of our analysis

Analysis limitations

- Manual **reviews were a time intensive process:** Manual reviews of projects were a time-consuming process.
- Lack of **detailed digital health investment disbursements required a simplified cost estimation methodology:** Only a few projects provided a breakdown of the reported digital health activity(ies). Primarily, reviewers divided costs of components or subcomponents among all activities within that component or subcomponent to deduce digital health activity costs. Although this process was standardized, the use of estimates in allocating costs to each project was simplified to arrive at a standard methodology (due to time constraints). Thus, the final project cost estimates are broad estimations; accordingly, the reported total dollar amount of digital health investments can either be an overestimate or underestimate (especially if the count of the number of activities is under or over counted).
- **Difficulty in understanding the scale of operations and digital maturity of countries made cost estimations difficult:** From the PAD, it was difficult to discern the digital maturity of the countries to gauge the amount of funds allocated for each activity. Even in instances where the digital health interventions were clearly listed, the scale of operations was not explicitly mentioned, that is, whether the digital health intervention was being piloted or implementation was planned at scale. This made it even more difficult for the team to estimate the activity costs for each of the projects.
- **Lack of consistent vocabulary on digital health in project PADs.** The digital health activities described in the PAD did not follow a prescribed taxonomy (because none existed). The World Bank system for assigning sector and thematic codes did not include digital health or subcategories. (As of July 2023, the World Bank coding of operations will include digital health and disruptive technology.) This incomplete information or lack of clarity on digital health activities and costs in some projects posed additional challenges related to taxonomy mapping both by subtopic and by investment type (that is, foundational, functional, and frontier) and cost estimates.

ANNEX C

ROLE AND PERSPECTIVES OF THE PRIVATE SECTOR IN DIGITAL HEALTH

Charles Dalton and Monique Mrazek, IFC

1. Summary: Opportunities and challenges

The private sector is an innovator, developer, and user of digital health solutions. The market opportunity for growth in the application of digital health in transforming health care is considerable. For emerging markets, digital health innovation when implemented effectively has the potential to leapfrog traditional care delivery models that are constrained by infrastructure and human resource gaps and can also expand access to reach a broader array of population groups.

Digital health solutions when planned and implemented well can benefit public or private health service provision. However, the take-up of digital health solutions in the public sector often lags behind the private sector for many reasons. It is important to unlock the collaboration, innovation flow and take-up of digital health solutions to benefit all.

Innovations developed by the private sector do not occur only in the form of digital connectivity and telehealth. The innovations already deployed in some emerging and developed markets are expansive and include, for example, data analytics, AI applications, digitally connected devices, remote patient monitoring, genomics, and other deep technological innovations. It is not all positive. There are instances of expectations not being met, often because market understanding is limited and cutting and pasting from one country to another do not necessarily work. Furthermore, the expected data analytical benefits do not materialize because of the existence of data silos and privacy-sharing rules.

Engaging with the private sector can certainly bring a benefit to the public sector when considering digital health. A key question for decision-makers: how to maximize the benefits of digital innovations to strengthen the entire health care system and advance toward UHC?

There is a growing perception in many markets that governments are not doing enough to facilitate better planning and implementation of digital health solutions.

To maximize benefit, increased focus is required relating to conducive regulation, national digital health strategies, new contracting models and data access and management rules. While there is considerable potential for enhanced public and private collaboration, governments require considerable support to unlock the true benefit of digital health.

2. The private sector as producers of digital health solutions (insights into the extent and breadth, plus geographical reference, for example, emerging and developing markets are also developing digital health interventions)

Globally, the private sector is a core driver of innovation and development in digital health. The market size of this innovation is considerable. According to CB Insights, in 2021 alone there were more than US$57.2 billion in investments in digital health, a 79% increase over the year previous. Although the bulk of the volume of investments is going to developed markets such as North America and Europe, there has been an increasing amount of investment in emerging markets particularly in Asia and Latin America.

IFC, through its Disruptive Technologies and Funds Department, has direct or indirect investment exposure to health technology and digital health innovators operating across emerging markets. The investments cover a wide array of services that are especially interesting for growth in the sector over the next few years, including data analytics and AI, virtual care and services, femtech, genomic and point-of-care, and innovative health service delivery models (Box C1). The expectation is that these model types will be expanded as technology advances and will benefit all health service touch points, from the tertiary to community levels.

TechEmerge

Box C.1 IFC Investment in Early-Stage Health Technology and Digital Health Innovators

Artificial Intelligence: Proximie allows multiple people in remote locations to virtually interact in a way that mimics what they would experience if they were collaborating in the same operating room. It means they can physically show each

Box continued...

Box C.1 IFC Investment in Early-Stage Health Technology and Digital Health Innovators (continued)

other where to make an incision, in real time, or use physical gestures to illustrate a technique. Using AI, machine learning and augmented reality, clinicians can remotely interact in a live procedure or assessment from start to finish, in a visual and intuitive way. Proximie is light, easily deployed in low bandwidth settings, and is as usable in low resource environments as it is in high-end hospitals. This is particularly useful in resource constrained environments where knowledge and specialist expertise might be limited.

Virtual Care and Service: TATA 1mg (formerly 1mg) is a leading digital consumer health care platform in India. The company operates four verticals: (i) e-pharmacy where patients in cities across India can order medicines and health products online and get it delivered at home from licensed pharmacies; (ii) teleconsultations where patients from anywhere in India can consult qualified and registered doctors by chat for free; (iii) lab testing where tests can be booked online, samples collected at home and results viewed online; and (iv) authentic health and medicine content written by qualified health professionals. TATA 1mg is an example of where appropriately developed supply chains can overcome past market inefficiencies ensuring quality and more affordable medicines are delivered.

Femtech: Niramai has developed a novel software-based medical device to detect breast cancer at a much earlier stage than traditional methods or self-examination. The device has been cleared by the US Food and Drug Administration. The device is a low-cost, automated, portable cancer screening tool that can be operated in any clinic. Niramai's imaging method is radiation free, non-touch, not painful, and works among women at any age. The core technology has been developed using patented machine learning algorithms for the detection of breast cancer. Early-stage breast screening in many emerging markets lags developed markets. In the former, self-examination or physical examination by a health professional is the primary screening option. More accessible and reliable technologies are required to address diagnostic needs.

Innovative Care Model: Clinicas del Azucar is the largest diabetes and hypertension care platform in Mexico. The company operates clinics across Mexico. The model aims to provide all the care a diabetic or hypertensive patient needs under one roof through medical consultations, diagnostic tests, nutritional and phycological support, medicines, and other specialized retail products. Clinicas del Azucar has also started offering this comprehensive model virtually or as a hybrid. The company uses its data to improve patient outcomes and optimize its operations.

Because new health technologies are disrupting all aspects of the global economy, there are several hurdles beyond financing. Awareness and business expertise are often barriers to entry as great as upfront financing. IFC is well positioned to connect these emerging technologies with clients in emerging markets. The TechEmerge program was developed by IFC to accelerate the adoption of technology where it is needed most through regimented and structured processes. This process starts with a needs assessment and then moves to global sourcing, a competitive selection process, a curated matching program, small scale, partially grant-funded, local pilots, and then finally adoption post-pilot. The TechEmerge Program was piloted in India in 2016 with 20 pilots across 70 clinical sites in seven regions. From there the program was validated by replicating the process in Brazil in 2019 and expanded to Sub-Saharan Africa beginning in East Africa in 2020.

Key highlights

The program:

- Helps young innovative technology companies (Innovators) accelerate deployment of their technologies in emerging markets by harnessing the global reach of IFC and its partners.
- Supports larger clients/corporates and other institutions in emerging markets (tech users) in increasing their productivity and competitiveness by adopting cutting-edge technologies, and ultimately,
- Facilitates and supports technologies to provide better services and enable economic growth.

The benefits to health systems that participate in the TechEmerge Program are as follows:

- Access to a vetted global network of health technology innovators.
- Access to funding to support a pilot project of new technology in their health system.
- Guidance from the TechEmerge team to source high performing startups and reduce the risk of technology adoption.

The benefits to innovators are as follows:

- Access to robust network of health systems (potential users/buyers of new tech solutions) in the region of focus.

- Access to funding to support pilot project of new technology in the region of focus.
- Guidance from the TechEmerge team to develop pilot implementation and market entry strategies.

To date the program has been orientated toward the private sector but could with appropriate structuring be used with the public sector.

3. The private sector as a user of digital health

While the private sector in multiple markets is now rapidly adopting digital health solutions (for example, Abdali Hospital in Jordan and Kaiser Permanente in the United States) there is also now significant interest and early adoption in many emerging markets.[2] Globally, initial change has taken place with new players now in the market, and who were more agile and nimble to be able to adopt digital health and deliver care though innovative business models (for example, Pingan Good Doctor in China and One Medical in the United States). However, increasingly, traditional bricks-and-mortar health care providers are also leveraging digital health to deliver care in diverse ways, often closer to the patient.

Overall and interestingly during the COVID-19 pandemic there was increased digital health acceptance, especially telemedicine, from both patients and health professionals. There has been an increased realization that digital health requires enhanced integration into the system given patient needs for service access. This has been further accelerated during COVID-19 since patients were not able to come in-person to receive care due to infection risk, followed by the subsequent relaxing of regulatory requirements in many countries globally. It has also highlighted how regulation for the longer-term needs to align to the possibilities of emerging technology solutions being offered and the required system changes.

Private providers

Many traditional bricks and mortar service providers are now looking at ways to innovate beyond their historical delivery models. Importantly, there is a growing realization that to maximize the benefit of digital health there is a requirement to embed it into the system rather than it sitting outside in a silo.

Careful planning is required, and many providers recognize that the full benefits of digital health lie in implementation from a people, process and technology

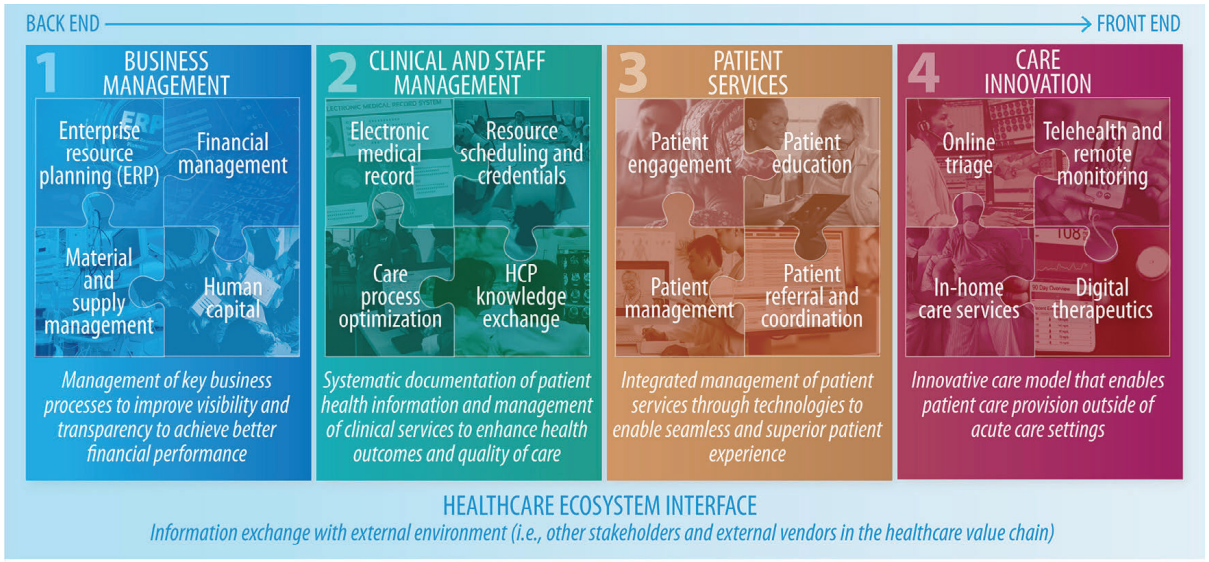
[2] See Kaiser Permanente (2022); Offering Optimal Patient Care through the Latest Integrated Hospital Information System (web page), Abdali Hospital, Amman, Jordan, https://www.abdalihospital.com/offering-optimal-patient-care-through-latest-integrated-hospital-information-system.

perspective underpinned by strong change management. Importantly, investment is also required in the supporting backbone, such as ICT hardware and software architecture, connectivity, and data storage.

Broadly, the private sector is looking at digital health as depicted below and as equally relevant for public sector service providers (Figure 42).

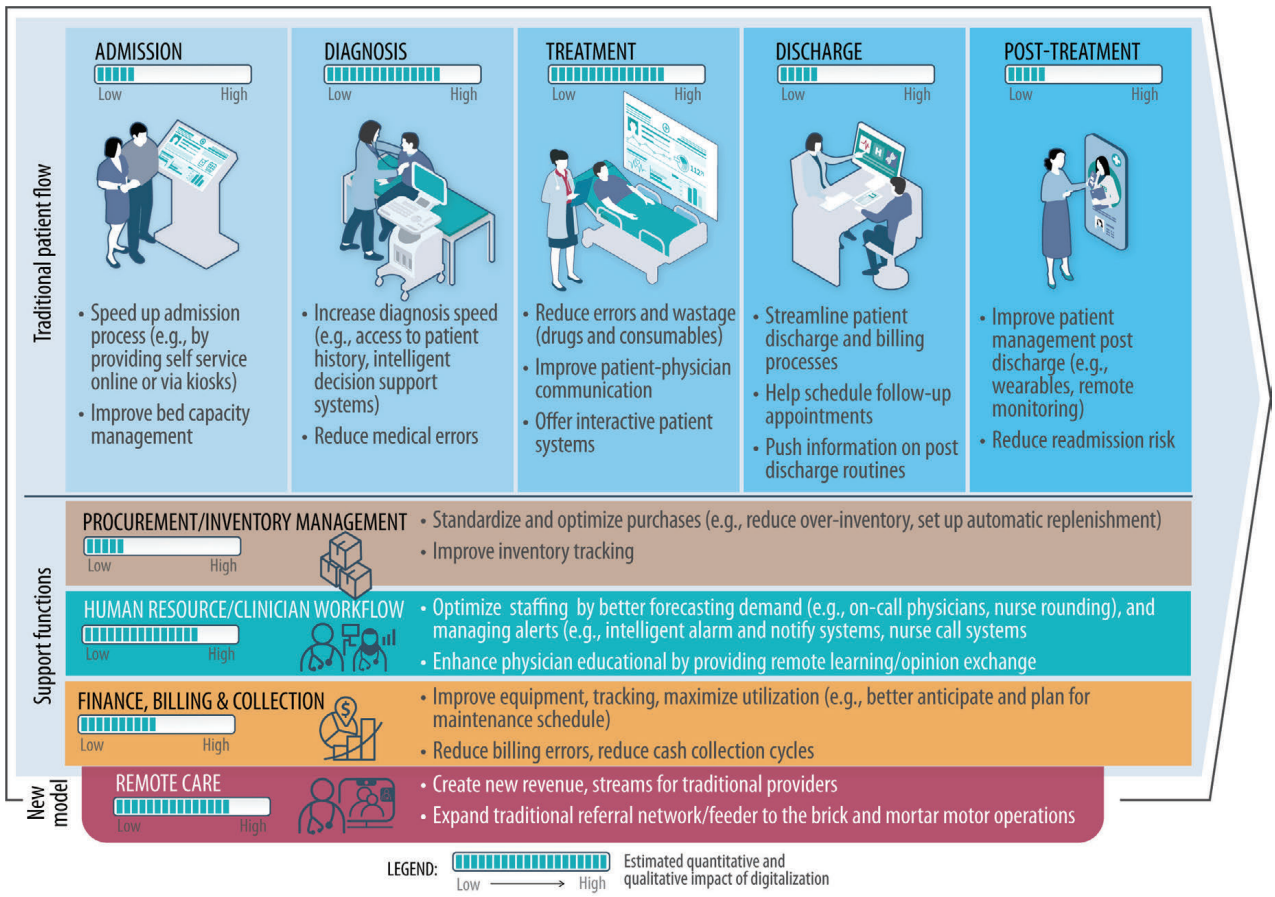
Figure 42 How Digital Health Supports Health Systems

Figure 43 Areas in which Digital Health Adds Value in Health Care



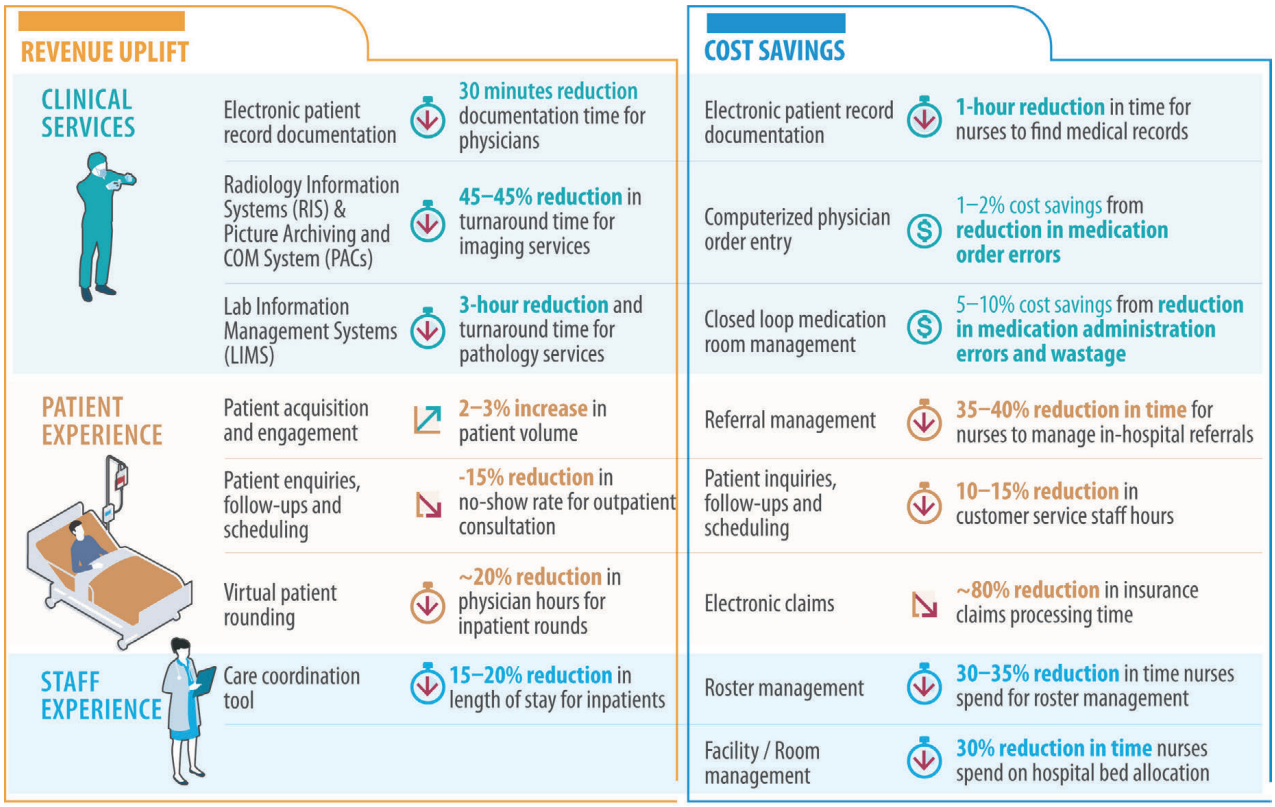
A general learning point from the private sector and equally applicable to the public sector, is the financial and efficiency benefits that can be realized from coordinated digital health implementation (Figure 44).

Figure 44 How Digital Health Reduces Fragmentation in Health Care Delivery



Expected financial benefits will of course vary but below are generic examples that financially benefit the business but can also positively contribute to patient experience (Figure 45).

Figure 45 Digital Health Adds Value by Driving Financial Savings or New Streams of Revenue



In 2021, IFC launched a new upstream initiative to support traditional health providers to digitalize called the Global Digital Health Platform (DigiHealth), now branded D4Health. The initiative was first piloted in Sri Lanka with Hemas Holdings Ltd. Through the platform, IFC partners with health care organizations to develop, implement and finance their digital transformation strategies and the means for health care providers to transform their processes through automation, digitalization and advanced analytics. The platform is in the process of being expanded to private health service providers around the globe.

Private payers and administrators

Service delivery providers are not the only stakeholders who invest in or partner with digital health entities. There is continued take-up due to insurance entities embracing digital health. There are lessons to be shared and opportunities to work with social health insurance programs. The insurance utilization of digital

health varies per market context and maturity. More sophisticated payers have also evaluated how to process claims and pay for digital health orientated services.

The following are examples of where digital health is now being actively used by payers.

Data analytics. Good data analytics forms the basis of modern insurance entities. It enables payers to understand population risk, disease profiles and demand patterns which in turn helps them to design benefits structures and tariffs. There is growing focus on how payers and providers can jointly use data to plan both care and service interventions including risk sharing models that move away from traditional fee for service.

Disease management. Payers having analyzed the at-risk population are increasingly using digital health interventions to manage patients with chronic conditions such as diabetes, hypertension, and cardiovascular disease. Insurers are now using personalized technology (for example, symptom checkers) to track key indicators to better manage and coordinate care and to prevent unnecessary hospitalization. Overall, patient life expectancy and recovery when appropriate is better. With data in hand, payers are also able to work with providers to plan packages of care and proactively coordinate interventions.

Claims assessment. Payers are increasing the use of digital tools to process claims. An imperative is that claims use a standardized coding system (for example, International Classification of Diseases 11). AI tools can accurately assess claims. Not only against benefits available, but also to test those services provided align with expected best practice clinical protocols (for example, dental claims).

Payment. Modern insurers utilize digital solutions for all payment interaction. Digital technology can be used to manage claims, benefit evaluation and coding alignment to support payment efficiency.

Entity examples applying some or all of the above in emerging markets include Discovery Health (South Africa), MiCare (Asia), and Pingan Health (China).

Other sectors related to health (Life Science and Medical Equipment sectors)

Looking beyond the health services and the payer sector there is also continued digital innovation within the Life Science and Medical Equipment sectors. Both have embraced digital processes and solutions that leverage digital solutions. On the

MedTech side, many medical devices are now digitally enabled in some way. Take the stethoscope which has now been digitalized to produce clearer audio including from noise-canceling features and are increasingly integrating AI to accelerate time to diagnosis. Patient monitoring solutions are transforming both the bedside, as well as the home care setting with devices that monitor patients vitals and other indicators on a regular or even real-time basis. Labs are being transformed with digital microscopes, digital pathology and connecting every instrument to the cloud. AI is playing an increasing role in medical imaging from supporting the radiologist in triaging the images to helping to optimize work flows.

On the pharmaceutical side, digitization is also transforming this sector. In drug discovery and drug development, AI is increasingly playing a role in helping identify new drugs and vaccines as was the case in the development of the COVID-19 vaccine (Lv et al. 2021). Digital therapeutics are an emerging area where a software program is clinically proven to deliver a therapeutic intervention to a patient by treating a broad range of conditions. Other areas include applications in precision medicine, manufacturing, and e-pharmacy. IFC recently launched D4Pharma, a sister program to D4Health, but focusing on digitization strategies for pharmaceutical companies. Looking forward, the private sector continues to expand its use of digital solutions when appropriate. There is increasing realization that some solutions may be more hype and the reality of operationalizing some of these solutions needs to be managed. There are many examples of health tech companies that started off by offering only services virtually and soon added an offline component reflecting the reality that some services in health care can only be in-person.

4. Investor perspectives: What inhibits investment and growth of digital health solutions?

For digital health to grow sustainably and quickly it must be backed by investors and seen as an industry sector where growth and development is occurring. Investors will be looking for not only basic growth indicators of the market such as total addressable market and company performance including some demonstration of ability to scale, but also at the regulatory environment that ensures a predictable ability to operate and a level playing field[3]. From an individual business perspective, investors often aim to see a company that has a demonstrated commercial model

[3] Uncertain regulatory environments have often been a point of concern for many investors. A prime example is the uncertainty about telehealth regulation in Brazil.

that is showing at least some initial traction as measured not only by sales but also by market fit as demonstrated by usage or stickiness. This is important to get some comfort in an earlier stage company that there is market fit and that the business model is replicable and scalable. Most business models can be categorized as business to consumer, business to business, or business to business to consumer.

Government as a customer or business to government is also a legitimate path, however, investors may shy away from companies that generate most of their revenues from government particularly if these are based in less stable markets. There are several challenges in working with government from the contracting process including the time of that process and transparency, to the reliability of the contract with the government, as well as the timeliness of payment from the government. Unfortunately, there are many examples of lengthy contracting cycles with governments, unexpected contract breakage on the part of governments and lengthy delays in payment adding significant receivables days to the balance sheets of the private company. The impact of these challenges in working with governments is amplified for an earlier stage company who may still not be profitable and may not have access to adequate working capital financing.

To increase this payable resiliency, industry leaders in the investment community such as IFC can and should encourage new methods of contracting to help embed these providers into the fabric of public provisioning. To solve this contracting problem on the public side there must be more detailed needs assessments and understanding of the digital health landscape by governments. These governments will need help to identify their needs and will often turn to private sector and thought leaders such as IFC for advisory support.

5. The public sector working with the private sector for digital health orientated services

The private sector as a producer and user of solutions does offer the public sector many solutions to support the strengthening of systems and services. Given the demand to supply gaps facing many health systems and with intent to realize UHC ambitions there is a realistic requirement for the public and private sectors to work more closely together.

As with the private sector, the choice of digital solutions in the public sector requires careful selection, planning, and implementation. Automatic reaction or following

the hype can be costly with minimal benefit realization. There has been some notable investment failures for example, the US$12 billion UK National Program for IT of the National Health Service was halted in 2012 because of nondelivery and, at least partly, poor planning and oversight.

In many markets, the private and public sectors for digital health may need to find new ways of collaboration and adoption of innovative of partnership and contracting.

The opportunities for partnership are far ranging but require careful evaluation. The public sector has the option to contract directly for a specific suite or individual digital solution but could also utilize existing private service providers that already have digital solutions available in their service offering (for example, diabetes management). The structure and oversight of the health system by government will vary by country and it is important for the private sector to understand that one size might not fit all. Innovative thinking is required from both perspectives.

Contracting methods may vary. Examples include the following:

- Traditional PPP: Provision of a service or technology for a given longer period using innovative financing.
- Traditional procurement: A standard tender option for the direct procurement of a solutions or services.
- Innovative contracting: Contracting for a defined period for the provision of a specific solution, services, or both. Ideally for the private sector the minimum contracting period should be 5 years. It is often not financially/commercially viable for the private sector to undertake year-long contracts given the period required for return on investment. A one-year contracts can be much longer for governments given that the private sector could understandably factor the risk of contract length into their pricing and plus, the public sector does not benefit from true collaboration.
- Contacting via social health insurance: Social health insurance pays for select solutions and or services from the private sector utilizing agreed upon tariff solutions.

In addition to contracting considerations there are other constraints to consider achieving the full benefit of public private collaboration in the digital health sector. It requires innovative approaches from both a public and private perspective.

- Supporting innovation. It is probable that many governments are not aware of the digital solutions / services available to them including many homegrown. Some countries of health systems have supported pilot schemes to test and validate digital solutions. Others may work with development partners to develop or test solutions. A risk for the private sector is post pilot. Will the government have sustainable funding to support continued or expanded rollout? Are there options for working with banks and funding entities to support projects further?

Establishing the appropriate procurement channels and methods for private companies to enter the public sector is difficult. Some countries have experimented with ways to get around red tape and open a front door between the technology company and the system. For example, learning from past mistakes, the National Health Service in the United Kingdom has been seeking to accelerate the innovation and adoption of appropriate digital health solutions (Digital health and care - GOV.UK (www.gov.uk)) through a variety of pilot schemes. Public sector regulators must be able to work arm-in-arm with the private sector to ensure that regulations protect citizens, but do not overly hamper or constrain the private sector.

Coordinating expectation. It is critical that as the digital health space continues to mature it is done with the public and private sectors hand in hand. They must be in lockstep with each other because if not parallel care delivery will occur wasting resources and reducing efficiency of the system overall. The public sector could benefit from embracing digital health innovations created by private companies and integrate them into the broader care ecosystem.

Building sustainable solutions. For these adopted solutions to be sustainable long term they must well thought-out. Governments need to decide what digital health services will replace and how they will provide those services. Once that is decided they need to understand how these private sector providers will cooperate and integrate within the private health care system. This is most important from a data sharing and security standpoint; how will private and public providers share digital health records as completely as possible while still respecting the privacy and rights of each individual patient.

Contracting. An essential requirement if considering PPPs for digital health is to understand and clarify the different PPP modalities identified above that can work for digital health. Traditional PPPs and private finance initiative type models lend themselves more to capital expenditure–intensive projects, while digital health does not. Currently, there are few examples of pure digital health PPP initiatives. Indeed,

in the past, the rapid pace of digital health and the technology underpinning it has made medium- and long-term PPPs difficult to structure, and the value for money is difficult to demonstrate.

Some PPPs may include digital components, such as building the hospital and providing the equipment, including the hospital information system. At a minimum, any future PPP project should consist of feasibility and assessment of digital requirements, including the IT infrastructure required. Digital health may lend itself to services, but not capital expenditure–oriented PPPs. Furthermore, digital health may not necessarily suit PPP structures and could be orientated toward more traditional procurement if country-specific policy allows. Even then, enhancements to conventional procurement/ contracting models may be required; for example, one-year contracts do not align with a digital health solution rollout. Below are examples of digital health projects in which the public sector has utilized the private sector, but not through nontraditional PPP means. Instead, the examples demonstrate traditional procurement, pilot projects, and service contracting through social health insurance or standard government service contracting.

- Contracting for mobile consultations
- Teleconsultation for primary care
- Hospital information system or enterprise resource program
- Development and deployment of digital health apps
- Provision of benefit/claims management and managed care systems for social health insurance programs
- Community-based ICT solutions for maternal health care
- Improving HIV treatment with National ID numbers
- Mobile training and support of community workers
- Doctor booking, prescription coordination, and management of an electronic health record
- Digital health platform for the coverage of essential health services
- Medical imaging telemedicine
- Digital record archiving

Regulation alignment. As the public sector beings to regulate the digital health space it must be cautious. Frameworks that are developed must allow the private sector to participate in the development of the digital health space. This is a prime example of good intentions when developing a regulatory framework without considering the implications on the ground from the guidelines. Other common regulatory issues that will require attention include: teleconsultation; e-prescriptions; AI diagnostics. In addition, there is a need to consider the roles to be played by health professionals. For example, in some countries policy limits nurses and what they can do but with digital health they can undertake broader roles.

IFC is in the process of developing a tool to help better understand regulatory limitations. The overall objective is to create a regulatory assessment tool that will review the overall digital health relevant regulations and analyze implications for private investment. The goal of the tool will be to provide IFC investment teams with an upfront analysis of the digital health readiness of the country as it relates to digital health regulations. The results from country assessments could be used to help dialogue with government.

6. Checklist: Issues for considerations in World Bank projects.

A nonexhaustive checklist has been developed to support decision-making with reference to digital health projects and engagement with the private sector.

Ideally, many governments still require an upfront assessment resulting in a digital health feasibility that adequately informs strategic direction, implementation planning and private sector engagement. The World Bank digital landscape maturity tool now in development will be beneficial to support such initiatives and highlight both public and private perspectives.

Lessons learned from the private sector clearly demonstrate that systematic planning is highly beneficial for digital health and, when implemented correctly, can result in longer-term benefits relative to knee-jerk and often expensive short-term initiatives.

The checklist can be used for whole-system or specific solutions.

Annex Table C.1 Checklist: Issues for Consideration in World Bank Projects

Needs assessment, feasibility	☐ Has a study been completed to understand the need, benefits and implementation requirements? ☐ Has a landscaping assessment been completed to determine need vs. available solutions? ☐ Ideally, a digital health solution identification should align with health system strengthening and digital health strategies.
Risk assessment	☐ Has the feasibility assessment considered implementation risk? For example, does the country have the right networking, IT architecture and staff resources to implement then manage? ☐ Can the solution operate within current regulatory parameters, or will policy change be required? ☐ Can the solution where required dovetail and talk to other solutions?
Financing	☐ Has a business case and long-term budget been identified for the solution/ service? ☐ Is there benefit to consider an initial pilot phase to confirm the expected benefit? ☐ Will the solution be part donor funded and will there be budget available post donor support?
Procurement and contracting	☐ Have different procurement models been evaluated? ☐ Does the requirement lend itself to a PPP? ☐ Can it be contracted via standard (or updated) procurement and contracting arrangements? ☐ Could or should the solution be acquired directly, or can it be acquired via a private sector service provide that has it embedded in a service offering?
Management and monitoring	☐ Does the government have the required structures and resources to measure and evaluate performance?

ANNEX D

INDICATORS THAT CONSTITUTE THE GLOBAL DIGITAL HEALTH MONITOR

Indicator 1: Digital health prioritized at the national level through dedicated bodies / mechanisms for governance: Does the country (or state/union territory) have a separate department/agency /state/union territory/ national working group for digital health?

Indicator 2: Digital health prioritized at the national (or union territory level) level through planning: Is digital health included and budgeted for in national health or relevant national strategies or plan(s)? The focus of this indicator is on the inclusion of digital health or e-health in the national health strategy.

Indicator 2a: Health is prioritized in national digital transformation and data governance policies: Do national digital transformation and data governance policies and approaches consider and address potential benefits and risks for public health and individual health?

Indicator 3: National e-health or digital health strategy or framework: Does the country (or union territory) have an e-health or digital health strategy or framework and a costed digital health plan?

Indicator 3a: National digital strategy alignment with UHC Core Components: Is the national digital health strategy of a country (union or territory) aligned with UHC or UHC core components?

Indicator 4: Public funding for digital health: Is public funding (including loans) for digital health sufficient for the digital health strategies, priorities (needs), or costed-plan of the country (union territory)?

Indicator 4a: Private sector participation and investments in digital health: Given the enabling environment, does the private sector participate and invest in digital health activities?

Indicator 5: Legal Framework for Data Protection (Security/ Cybersecurity): Is there a law on data security (across the full data life cycle, such as collection, processing, storage, transmission, use and destruction) that is relevant to digital health?

Indicator 6: Laws or Regulations for privacy, consent, confidentiality, and access to health information (Privacy): Is there a law to protect individual privacy, governing ownership, consent, access and sharing of individually identifiable digital health data?

Indicator 7: Protocol for regulating or certifying devices or health services, including provisions for AI and algorithms (at higher stages of maturity): Are there protocols, policies, frameworks or accepted processes governing the clinical and patient care use of connected medical devices and health services (such as telemedicine, applications), particularly in relation to safety, data integrity and quality of care, including provisions for AI and algorithms (at higher stages of maturity)?

Indicator 7a: Protocol for regulating and certifying AI within health services: Are there protocols, policies, frameworks or accepted processes governing the use of AI within health systems, services and applications, particularly in relation to ethics, equity, safety, data integrity and quality of care?

Indicator 8: Crossborder data security and sharing: Are there protocols, policies, frameworks or accepted processes in place to support secure crossborder data exchange and storage in support of public health goals while protecting individual privacy? Note: This includes health-related data that are coming into a country, going out of a country, or being used in a country and that are related to an individual from another country.

Indicator 9: Digital health integrated in health and related professional preservice training (prior to deployment): Is digital health part of curriculum for health and health-related support professionals in training, in general?

Indicator 10: Digital health integrated in health and related professional in-service training (after to deployment): Specifically, is digital health part of curriculum for health and health-related support professionals in the workforce in general? [Defined as community health workers, nurses, doctors, allied health, health managers/administrators, and technologists]

Indicator 11: Training of digital health work force: In general, is training in digital health / health informatics / health information systems / biomedical informatics degree programs (in either public or private institutions) producing trained digital health workers?

Indicator 12: Maturity of public sector digital health professional careers: Are there public sector professional titles and career paths in digital health?

Indicator 13: National digital health architecture or health information exchange: Is there a national digital health (e-health) architectural framework and health information exchange established?

Indicator 14: Health information standards: Are there digital health / health information standards for data exchange, transmission, messaging, security, privacy, and hardware?

Indicator 15: Network readiness

Indicator 16: Planning and support for ongoing digital health infrastructure maintenance: Is there an articulated plan for supporting the expansion of digital health infrastructure (including equipment- computers/ tablets/ phones, supplies, software, devices) provision and maintenance to all public health care facilities?

Indicator 17: Nationally scaled digital health systems: Public sector priorities are supported by nationally scaled digital health systems

Indicator 18: Digital identity management of service providers, administrators, and facilities for digital health, including location data for geographic information system mapping: Are health system registries of uniquely identifiable providers, administrators, and public facilities (and private if applicable) available, accessible, and current? Is the data geotagged to enable geographic information system mapping with protocols to protect sensitive data?

Indicator 19: Digital identity management of individuals for health: Are secure registries or a master patient index of uniquely identifiable individuals available, fully representative of the population, accessible and current for use for health-related purposes?

Indicator 19a: Digital identity management of individuals for health: Specifically, is there a secure master patient index of uniquely identifiable individuals available, accessible, and current for use for health-related purposes?

Indicator 19b: Digital identity management of individuals for health: Specifically, is there a secure birth registry of uniquely identifiable

individuals available, accessible, and current for use for health-related purposes?

Indicator 19c: Digital identity management of individuals for health: Specifically, is there a secure death registry of uniquely identifiable individuals available, accessible, and current for use for health-related purposes?

Indicator 20: Proposed new indicator related to patient feedback systems: Specifically, is there a secure patient feedback system, available, accessible?

Indicator 21: Population health management contribution of digital health: Are current country digital health initiatives contributing to public health reporting and decision-making?

Indicator 22: Readiness for emerging technologies adoption and governance: Specifically, is there a national plan specific to emerging technologies (such as AI, wearables, blockchain, the internet of things) to support public health goals?

Indicator 23: Diversity, Equity, and human rights analysis, planning and monitoring included in national digital health strategies and plans: Has the country assessed/adapted national digital health strategies from an equity and human rights perspective?

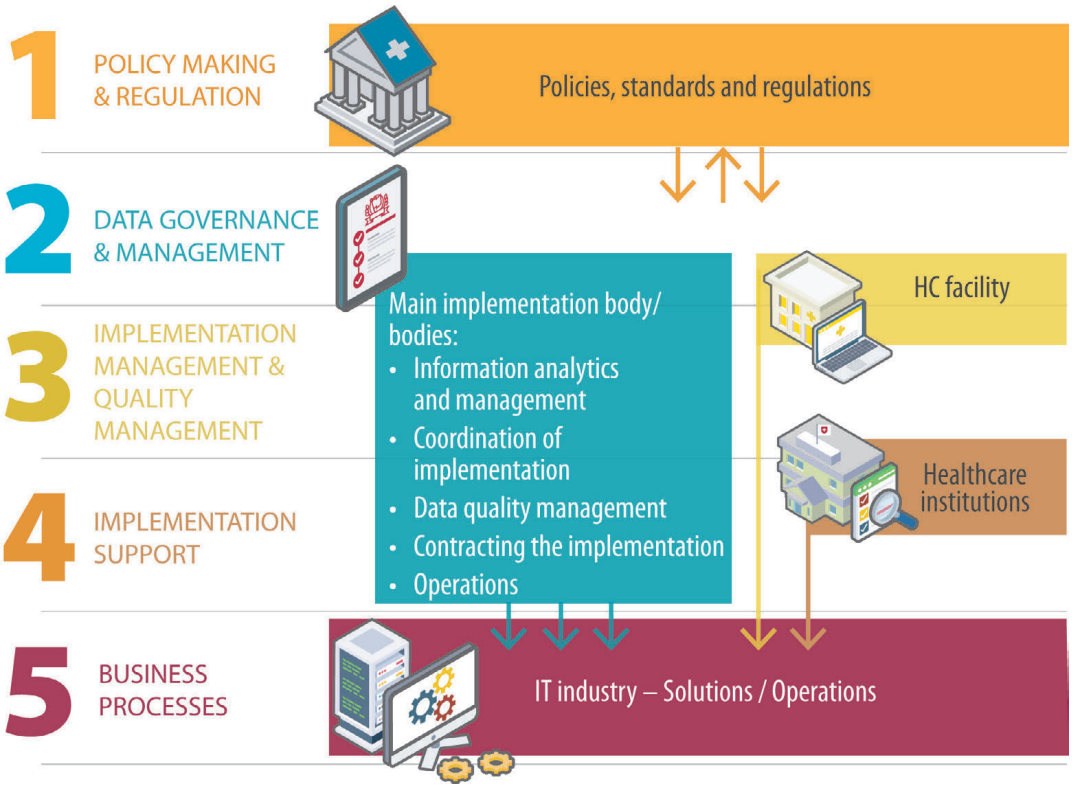
Indicator 23a: Gender considerations accounted for in digital health strategies and digital health governance: In other words, does the country include gender considerations in the national digital health strategy or its digital health governance?

ANNEX E

FIVE LAYERS OF DIGITAL HEALTH LEADERSHIP AND MANAGEMENT

In principle, there are five layers of digital health leadership to consider (Figure 46). These layers need to be institutionally distinct from each other to ensure separation of responsibilities, technical excellence, and accountability.

Figure 46 Digital-in-Health Governance Implementation and Management: Five Layers



Business processes: The management of daily operations of clinical and basic administrative systems that **support business processes** is done by health care facilities or local communities. It is typically contracted to the ICT industry. Software solution providers help users to use systems properly, provide training and helpdesks, and fix potential system malfunctions.

Implementation support: The government or health care facilities can systematically provide **implementation support.** For example, government can provide and maintain general infrastructure and shared services for software providers. Facilities can have their own teams for direct users support and basic maintenance of systems and infrastructure. Different arrangements are possible and agreements about who does what are usually contracted for each specific software solution; sometimes each facility can have different arrangements.

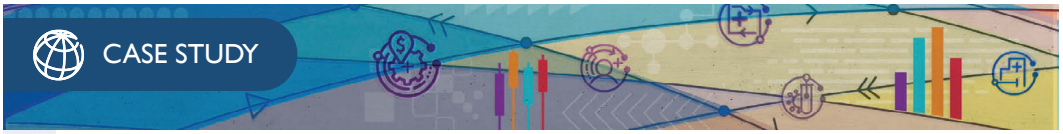
Implementation Management and Quality Management: To ensure better coordination and quality of solutions, the government needs to manage the overall process of implementing software solutions. It needs to provide guidance and technical support to help facilities to steer clear of process mistakes and contracting low quality solutions. That layer, the **implementation and quality management**, is usually delegated to a dedicated main digital health implementation body. Depending on the implementation strategy, that body can provide support through overall coordination, through implementation of quality assurance mechanisms (such as the software certification process mentioned earlier), but also through specific and practical technical work on managing central registries and databases, implementing central services, such as e-prescription and e-referrals, assuring data quality, and even directly supporting operations by maintaining common infrastructure. It can cooperate with facilities and even contract some solutions for them. For example, in a relatively small country, one implementation strategy can be that hospitals directly contract their own software solutions, while a central digital health implementation body contracts one solution to be used by all primary health care facilities.

Data governance and management: It is advisable to treat **data governance and management** separately from the use of operational systems because health data should be treated as a strategic national resource. One of the objectives of this layer is to change the focus from simply gathering data to data use, reuse, and repurposing (World Bank 2021). Inconsistent data management practices can lead to siloed data systems where value of data remains unrealized. Data governance can facilitate consistent data management decisions at every stage of a data life cycle. This enables fit-for-purpose flows of different data types across all stakeholders to realize value from data use. This layer of governance also takes care of health data analytics framework that includes health statistics and other forms of health data use for policy- and decision-making. These frameworks have the potential to create innovations in repurposing and combining diverse data sources (public intent and private intent data) that open doors to development impacts previously unimaginable.

Policy making and regulation: Finally, to stay coordinated and deliver value through synergy, all of these layers should use consistent **policies and a common regulatory and standardization framework.** The government, typically the MoH, or even other ministries (for instance, digital development) should provide the overall vision, strategic plans, standards, and basic regulations to facilitate more efficient and effective implementation on other layers. Institutional and organizational separation of these levels is critical. Countries that have followed similar national multi-stakeholder, and governance-focused approaches often support a national coordinating body, such as a technical working group or a steering committee, led by the ministries of health or public health delivery agencies, with the necessary representation and authority to perform the desired functions. The functions may include the adoption of standards, compliance, the definition of requirements, certification, and testing

ANNEX F

INDIA'S VISION FOR DIGITAL HEALTH: A CASE STUDY ON THE FUTURE OF DIGITAL TECHNOLOGY AND DATA EMBEDDED IN HEALTHCARE IN INDIA



DIGITAL-IN-HEALTH FLAGSHIP PROGRAM

Ayushman Bharat Digital Mission's **Integrated Digital Health Ecosystem** is the Foundation of **Universal Citizen-centered Health Care** in India

KEY

HEALTH SYSTEM CHALLENGE	Fragmented health and data systems occur at multiple levels, and a lack of access to timely information results in reduced quality of medical care.
SOLUTION	Use of standards based, flexible applications, software solutions, and technologies that work synergistically within the digital ecosystem. These technologies are a combination of interoperable open-source and proprietary applications that enable access to data and information in a timely manner to meet the unique needs of users.
TOOL	An integrated enterprise architecture through a unified digital health interface enables health information exchange across multiple digital health interventions.
TIMELINE	2018 till date.
RESOURCES USED	Implementation cost is approximately $4.5 million over 3 years.

Introduction

The COVID-19 pandemic ushered in the need for accelerated digitization of health care across the globe. The Government of India amply demonstrated their digital prowess in their response to the pandemic by building Digital Public Goods (DPGs) that leverage several standalone initiatives to develop an integrated national digital health ecosystem. The aim of this ecosystem is to support Universal Health Coverage through the provision of real-time data, information and infrastructure using open-source, interoperable, standards-based digital systems.

In the last decade, digital public infrastructure within India has expanded exponentially. Several initiatives like the digital identity system known as Aadhaar (for unique identification), and the Unified Payments Interface have become central to India's public service delivery architecture. The Unified Payments Interface has transformed heterogeneous payment modalities by aggregating them under one easy to use, highly secure mobile-based system for money transfer. Mobile and internet connections have expanded at a fast pace and penetrated ever deeper into rural areas. Currently over 572,000 villages out of 597,000 have mobile or network connectivity.

There are nearly 1.2 billion mobile subscribers, 800 million internet users, and 510 million smartphone users. This expansion can be attributed to the cost of mobile and internet connections dropping substantially, allowing for increased digital access across the country. Within the public digital infrastructure, there are 1.24 billion unique Aadhar digital IDs in place, and it is estimated that nearly 10 billion+ eKYC (Know Your Client) transactions and 2.64 billion Unified Payments Interface transactions take place monthly. This infrastructure forms the basis of the **Ayushman Bharat Digital Mission (ABDM)**.

During the pandemic, India leveraged various digital health interventions to provide contactless health care. Some examples of the Digital Public Goods developed during the pandemic include the COVID Vaccine Intelligence Network (CoWIN) application, which provided individuals with vaccine certificates, and the Aarogya Setu application. Aarogya Setu was originally a contact tracing app that provided real-time data on active cases, containment zones and helped more than 175 million citizens assess risk in their areas. It also facilitated the booking of COVID-19 vaccinations. It has now been transformed into a national health application that allows individuals to register for a Digital Health ID, telehealth consultations, as well as functioning as an Electronic Medical Record so that individuals can access digital lab reports, prescriptions, and diagnosis.

The high volume of over 350 million CoWIN registrations prompted India to adopt a completely digital approach to its vaccination strategy. Telehealth platforms like eSanjeevini also saw a steep increase in users during the pandemic, as 85 percent of physicians adopted telehealth platforms. Use of telehealth was only at 18 percent prior to COVID-19. This emphasized the need to better incorporate cutting-edge digital technologies into health care services to support this increased demand and to improve program coverage and enhance quality of care.

The impact of the pandemic put a spotlight on the benefits of digital innovation, technology-enabled solutions and served to accelerate their use.

The CoWIN platform allowed individuals to register on an online portal, schedule vaccinations at government hospitals, receive digital vaccination certificates and facilitated access to vaccinations at private sector hospitals. The platform was viewed positively by those individuals using it. It gave the government access to valuable COVID-19 data.

Within this short period of implementation, it became clear that a comprehensive digital health care ecosystem was necessary to bring together existing siloed efforts, and to proactively move towards a more holistic and citizen-centric system. The government responded by creating shared Digital Public Goods for health care and developed a framework for a nationwide digital health. This initiative was a turning point for health care in India. The Prime Minister launched the ABDM on September 27, 2021, under the aegis of the National Health Authority. Within a year of its launch, the ABDM had established a robust framework to provide accessible, affordable, and equitable digital health care. With India taking on the G20 presidency in 2023, the Global Initiative on Digital Health advocates for a connected and integrated health ecosystem to bring together global efforts on digital health. It also calls for the best use of technologies for improving health outcomes and scaling-up of these technologies as Global Digital Public Goods to accelerate Universal Health Coverage. Within

Digital highways harness data, technology, and connectivity to improve the way the digital architecture is designed, built, operated, and used. This will enable high performing, and faster delivery, and an enhanced customer experience for all.

this broad perspective, the ABDM aims to support the creation of an integrated digital health infrastructure by developing a digital backbone. The government will bridge gaps by building digital highways with the aim of improving the efficiency, effectiveness, and transparency of health service delivery in India for the myriad of different private and public stakeholders, that also encompasses alternative medicine, making it a diverse and complex ecosystem to be integrated.

Human Development Service Delivery Problem Improvement opportunities

India's vision to digitize healthcare started with the launch of the National Health policy in 2017, followed by the NITI Aayog's National Health Stack in 2018 which formed the basis for the National Digital Health Blueprint (NDHB) launched in 2019, culminating in the launch of the Ayushman Bharat Digital mission in 2021 (Sharma, R. S et al., 2023). The vision supported by previous investments in foundational technologies provided the groundwork for creating an integrated digital health ecosystem, the aim of which is to provide quality healthcare using accessible and affordable digital technology.

As detailed in the policy documents, some of the envisioned digital health interventions for addressing health service delivery reforms include:

- **Infrastructure:** Strengthening healthcare infrastructure and helping to reach the underserved particularly in rural areas.
- **Access to Care:** Reducing disparities that exist in access to healthcare between urban and rural areas
- **Workforce:** Building a network of trained healthcare professionals across the country, but especially in rural areas. Creating a workforce with a focus on distribution, skill mix, and performance
- **Affordability:** Improving the quality of public healthcare service delivery to all populations and the capacity to meet the demand
- **Quality of Care:** Improving overall quality and differences in health care by improving adherence to treatment guidelines, regulating prescription of medication, and appropriate use of high-end diagnostics and procedures.

Despite the burgeoning innovations, digitalization of health care in India is challenging. There are over 5 million health care professionals, and 1.2 million health care facilities serving a population of nearly 1.4 billion people. Bringing such a large number of stakeholders onto a single digital health system managed by the government in a single step was not viable, due to both the sheer volume, and the extremely varied needs. Although there has been rapid digitization in other sectors, such as finance and banking, travel and tourism, and the hospitality sectors, it must be acknowledged that digitizing health data is more nuanced and requires a more granular and involved approach. Health care data is more complex as it consists of numerous different types of files, requires stringent data protection and security regulations, and includes an infinite number of medical terminologies and definitions which are not universally understood. These include radiological images, lab reports, prescriptions, and outpatient and in-patient records. In addition, all of these

are written using different standards and formats. More importantly, health care data is highly sensitive and personal in nature and poses greater risk. Therefore, the digitization of health care is more complex and challenging when compared to other sectors.

Technology Principles

The ABDM is a platform based an open *Application Programming Interface (API)*, meaning it is flexible and allows both open-source and proprietary technologies to plug in. It is an ecosystem where all the *building blocks* and components of the ABDM are designed to be interoperable to facilitate the exchange of data. The platform makes use of open standards and data exchange protocols to ensure that different systems can communicate with each other effectively. They work together seamlessly, regardless of the application or technology provider used.

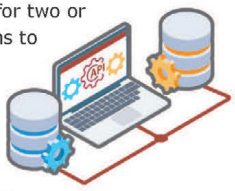
Security and privacy are recognized as top priorities underpinning the design and development of the APIs, and all systems need to comply with relevant data protection and security regulations[1]. It was imperative that robust measures are put in place before deployment to protect data from unauthorized access and theft.

The systems are designed based on user-centered design principles and consider the needs and preferences of health care providers, patients, and other stakeholders. The platform utilizes evidence-based approaches to inform its design and implementation.

Finally, the program uses an evidence-based approach to inform its design and implementation to ensure that the technology is effective, efficient, and cost effective. Together all these building blocks can be scaled as well as sustained to meet the growing needs of the program as it expands and evolves over time.

A *federated architecture* has been adopted using six core building blocks that have been developed using a minimalistic approach and are maintained centrally at the national level (Figure 1). All the other building blocks are designed to be operated in a federated model that allows regional, state-level and institution-level platforms and systems to function independently, but in an interoperable fashion.

An **API** provides a way for two or more computer programs to communicate with each other. It is a software interface, offering a service to other pieces of software. It enables multiple software components to "talk to each other" using a set of definitions and protocols, such as a data dictionary. APIs are an accessible way to extract and share data within and across organizations.



Building blocks refers to software code, platforms, and applications, that are interoperable, provide basic digital service at scale and can be reused for multiple use cases and contexts. It serves as a component of a larger system or stack, and can be used to facilitate the delivery of digital public services via functions for e.g., registration, scheduling, ID authentication, messaging, etc. The building blocks can be combined and adapted to be included as a part of a stack of technologies to form a Digital Public Infrastructure. https://digitalpublicgoods.net/DPI-DPG-BB-Definitions.pdf

1 At the time of writing, India's new Digital Data Protection Bill 2023 (https://www.meity.gov.in/writereaddata/files/The%20Digital%20Personal%20Data%20Potection%20Bill%2C%202022_0.pdf) had not been promulgated. Adjustments to the system described in this case study may need to be made depending on the Bill's final form, as adopted as law.

OPEN-SOURCE APPLICATIONS are built on publicly available source codes that can be accessed, modified, and distributed by anyone, are free to use, encourage collaboration, and contribute to innovations by allowing developers to contribute to the code base. They can be used by developers to build new solutions that leverage the health stack (initiative by government of India to improve digital health infrastructure) or other open-source tools, and they can be customized to meet the needs of different health care providers and patients.

PROPRIETARY APPLICATIONS: Proprietary applications, on the other hand, are built on a code that is owned and controlled by a particular company or organization. They are typically sold as commercial products, and users may be required to pay licensing fees or subscription costs to access them. In the context of ABDM, proprietary applications may be used by health care providers or insurers to manage patient data, billing information, or other aspects of their operations. While proprietary applications may not be as open or customizable as open-source solutions, they can still play an important role in the digital ecosystem by providing specialized features or services that are not available elsewhere.

While open-source applications may encourage collaboration and innovation, proprietary applications may provide specialized services or features that are not available in open-source alternatives.

Main components of the digital health ecosystem enabled by ABDM:

- **Hospital Management Information System (HMIS):** A comprehensive information system that collects, stores, and analyzes data related to health service delivery and utilization
- **Health Insurance:** Ayushman Bharat provides health insurance coverage to eligible households in India through the Pradhan Mantri Jan Arogya Yojana (PM-JAY) scheme (a public health insurance scheme)
- **e-Governance:** Digital platforms are used to manage various aspects of the health care delivery system, such as enrolling beneficiaries, managing claims, and monitoring program performance
- **Telehealth:** The program includes the provision of telehealth services to rural and remote areas, allowing patients to access medical consultations and advice from specialists
- Use of both **Open Source and Proprietary Software** and technological applications
- **Health Information Exchange**: A platform that enables the exchange of health information between health care providers and stakeholders, such as patients, insurance companies, and public health agencies.
- **Electronic Health (EHRs):** EHRs are maintained for each beneficiary enrolled under PM-JAY, and they contain a complete record of all medical treatments received by the patient
- **Health Analytics:** The data collected through HMIS and EHRs is analyzed to identify patterns, trends, and opportunities for improvement in the health care delivery system

These building blocks work together to create a comprehensive digital health ecosystem, aimed at improving access to quality health care for all Indians, particularly the most vulnerable and marginalized communities.

As defined by ABDM, the data is federated and stored close to the point of generation. All the registries and other master databases of ABDM are built as a *"single source of truth"* on different aspects and are backed by strong data governance principles which includes clear ownership, roles and responsibilities and dedicated data governance structures established at both the central and state levels.

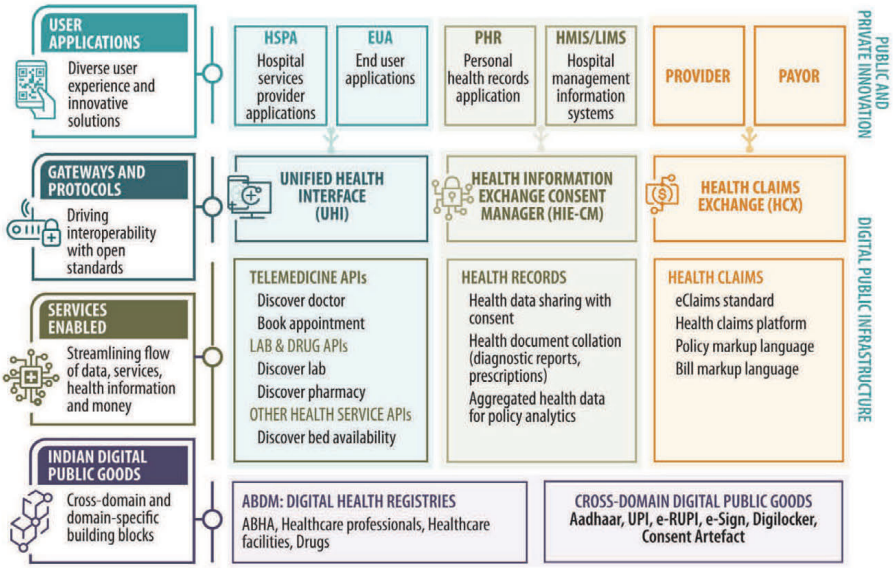
Figure 1 is a representation of the architecture of the Ayushman Bharat Digital Mission formerly known as the National Digital Health Mission.

The key objectives of these overarching technology principles are to ensure that:

- **Patients** can securely store and access their medical records, such as prescriptions, diagnostic reports, and discharge summaries, and share them with health care providers for assured and appropriate treatment and follow-up. In addition, patients can access accurate information on both private and public health facilities, and service providers can access health services remotely through tele-consultation and e-pharmacy
- **Health care professionals** have full access to a patient's medical history, after obtaining informed consent, to ensure they can prescribe the right interventions. This integrated ecosystem facilitates an improved continuum of care, digitizes insurance claims that can be processed for faster reimbursement, and overall enhances service provision
- **Policy makers and program managers** have access to better quality macro and micro-level data, advanced analytics, and usage of health biomarkers in diagnosis, which enables geographic and demography-based program monitoring and the use of preventive health care. This facilitates informed decision making to improve policy design, strengthen program implementation, and increase the accountability of health care providers
- **Researchers** can use aggregated data to study and evaluate the effectiveness of various programs and interventions, and this facilitates a comprehensive feedback loop between researchers, policymakers, and providers.

Federated Architecture is a pattern in enterprise architecture which allows interoperability and information sharing between semi-autonomous decentralized organized lines of business (LOBs), information technology systems and applications that share a common vision. It works well in heterogeneous environments where a central one-fits-all approach cannot be applied; and provides high flexibility and agility to the various autonomous (and interlinked) components within the system for coordinated sharing and exchange of information. There is no centralized repository of health care records either in one place or in one system; and can be stored in multiple places as per the choice of hospitals, doctors, and patients. This is known as a federated architecture in IT or digital system. Only the data collected through registries such as Health ID registry, Health care Professional Registry and Health care Facility Registry is stored centrally because these datasets are essential in providing interoperability, trust, identification, and single source of truth across different digital health systems.

Figure 1 Technology Architecture of the Ayushman Digital Health mission



Source: NHA Annual Report 2021–2022_d4f624f7b5.pdf, page 86.

Major implementation milestones

The ABDM was launched in 2020 to accelerate the digitalization of health care across India by building digital highways to promote connectivity between disparate existing digital health systems, developed prior to COVID-19, and integrate existing digital health solutions to support the creation of interoperable platforms, bringing them all together under one comprehensive and holistic ecosystem. The key milestones that led to the launch of the ABDM are illustrated in Figure 2.

Since its launch, the foundations for a robust public digital health infrastructure are being laid through core registry building blocks or modules of:

- Individuals/citizens/patients (ABHA ID registry)
- Health care professionals (Health care Professionals Registry)
- Health care facilities, including but not limited to hospitals, laboratories, and pharmacies (Health Facility Registry)

In these registries, each individual entity is assigned a Unique Identifier (UID), which is used across the entire ecosystem. This helps to establish linkages through APIs and enhances accessibility of information. The aim is to digitally empower individuals, patients, doctors, and health facilities to streamline the delivery of health care services and related information. Some of the key implementation milestones since the ABDM's inception in 2018 include:

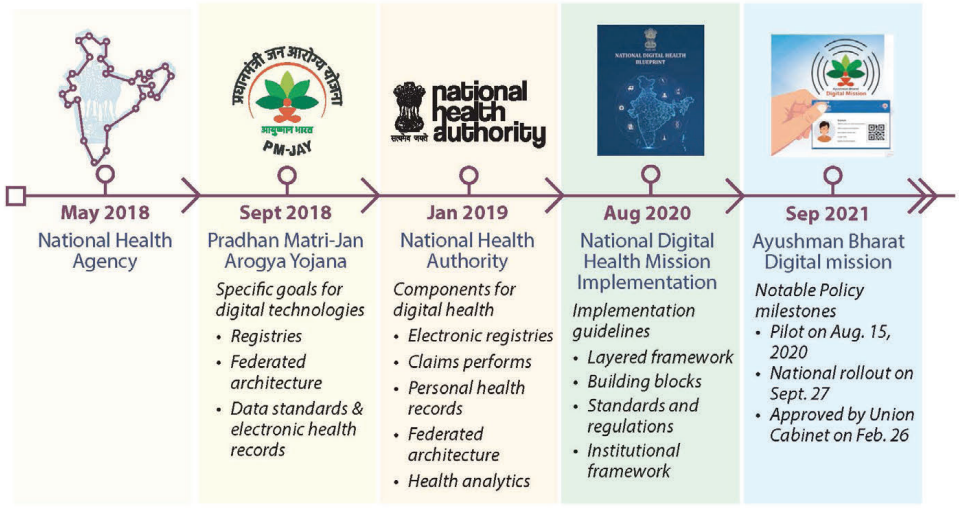
1. **Launch of a real-time HMIS through an online portal.** The HMIS is a digital initiative under the Ministry of

Health, and Family Welfare (MOHFW), which collects, stores, and analyzes health service delivery and utilization data. The HMIS portal uses all applicable government standards, such as standardized facility UIDs, entity names, geographic boundaries (up to the level of villages), population data and other relevant information, including Geographic Information System (GIS) based layers that are used in the Integrated Health Information Platform. APIs link it to other programs

2. **Creation of individual ABHA Numbers and health accounts as a basis for a seamless online platform.** ABHA numbers are comprised of a randomly generated 14-digit identification number are created either using the individual's/patient's mobile number or Aadhar number. This enables each person to get a unique health account, an Ayushman Bharat Health Account (ABHA) linked to their ID. After obtaining the patients consent, a digital version of the health record is uploaded to the ABHA account to create a seamless online platform that allows users, insurance companies and hospitals across the country to access and share EMRs through the web application. The ABHA also enables citizens to compile a comprehensive medical history across various health care providers, thereby improving clinical decision-making. As of August 2023, nearly 442 million ABHA numbers, were generated, and 293 million patient health records were linked to the individuals' ABHA accounts (ABDM Dashboard, 2023)

3. **Creation of UIDs for service providers.** Using a similar approach to the UIDs for individuals, 14-digit UIDs are generated for both the Health Facility Registry and the Health Professional Registries. The Health Facility Registry is "a single centralized repository of all the health facilities in the country" to

Figure 2 Key milestones leading to the launch of the Ayushman Bharat Digital Mission



Source: Adapted from NHA_Annual_Report_2021_2022_d4f624f7b5.pdf page 82.

facilitate storage and exchange of standardized data from both the public and private health facilities in the nation. Health facilities would have provision of electronic processing of documents for various purposes like for empanelment, claims processing, e-signature etc. The Health Professional Registry is also commonly known as the Digi Doctor Platform or Doctors Directory. Digi Doctor Platform is "A single, updated repository of all doctors enrolled in nation with all the relevant details of doctors such as name, qualifications, name of the institutions, qualifications, specializations, registration number with State medical councils, years of experience, etc. Doctor's Directory is one of the essential building blocks of the national e-health architecture

These provide verified digital identities to large and small public and private health facilities and professionals. This serves as a single source of truth for verified health care provider related information and connects them to the central digital ecosystem. The Health Facility Registry and Health Provider Registry help improve the identification/ discovery of health care facilities and allow health professionals to build an online presence and offer their services more effectively. In addition, a Drug Registry is also being designed to create a single, up-to-date, centralized repository of all approved drugs across all systems of medicine

4. **Integration of EHRs for Pradhan Mantri Jan Arogya Yojana (PM-JAY).** As of August 2023, a total of 110 digital health services/applications have been integrated with ABDM. (National Health Authority and ABDM, 2023). The EHR forms an important part of the PM-JAY which is a flagship health insurance scheme, launched in September 2018 to provide health insurance coverage to eligible households. To ensure timely insurance payments, EHRs are maintained for each beneficiary enrolled under PM-JAY. A dashboard has been created that has both aggregated and a drill-down view of various datasets, and it provides real time reports of transactions and analyzes utilization trends. The PM-JAY also has in place hospital registration, beneficiary identification, and transaction management system(s)

5. **Expansion and integration of Telehealth Services "eSanjeevani" with ABDM.** The program has telehealth services available, allowing patients in rural and remote areas to access digital medical consultations to solicit advice from specialists.

List of Digital services provided include:

(A) Citizen/Patient Services: (i) Single, Secure Health Id to all citizens, (ii) Personal Health Record, (iii) Single (National) Health Portal, (iv) App Store, (v) Specialized Services for Remote Areas/ Disadvantaged Groups, (vi) NDHM Call Centre, (vii) Digital Referrals & Consultations, (viii) Online Appointments, (ix) e-Prescription Service, (x) Digital Child Health, (xi) National "Opt-out" (for privacy);

(B) Services by/for Health care Providers/ Professionals: (xii) Summary Care Record, (xiii) Open Platform to access Emergency Services, (xiv) Technology for Practitioner (GP) Transformation, (xv) Digital Referrals, Case Transfers (xvi) Clinical Decision Support, (xvii) Digital Pharmacy & pharmacy Supply Chain, (xviii) Hospital Digitization, (ix) Digital Diagnostics;

(C) Technical Digital Services: (xx) Architecture & Interoperability, (xxi) Health Information Exchange, (xxii) Standards, (xxiii) Health Network, (xxiv) Data & Cyber Security, (xxv) Information Governance.

The integration allows existing users of eSanjeevani to create an ABHA account, manage their existing health records, such as prescriptions and lab reports, and to share these with the doctors on eSanjeevani for better clinical decision-making and to support the continuum of care. As of August 2023, eSanjeevani services have reached over 145 million Indians (eSanjeevani website, 2023)

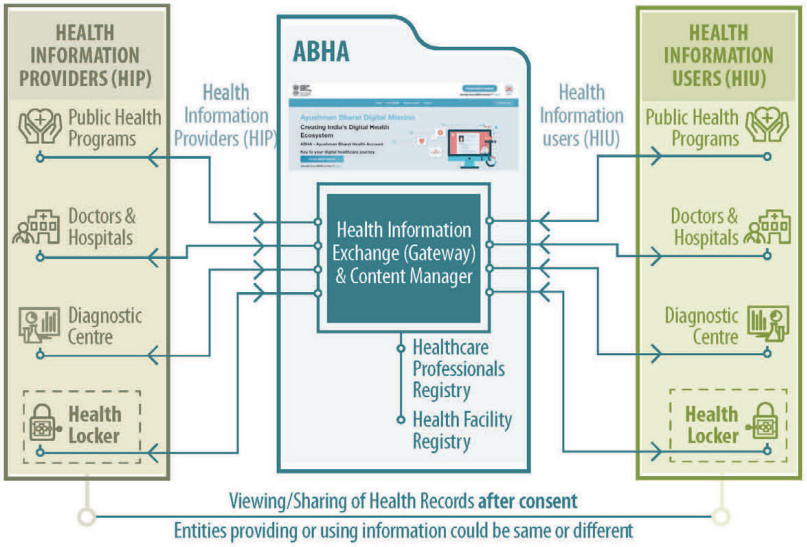
6. **Launch of Health Information Exchange and Consent Manager (HIE-CM):** The HIE-CM platform was launched to facilitate the exchange of health information between health care providers and other stakeholders, such as patients, insurance companies and public health agencies. This system ensures that the identity of persons intending to share information is first verified, consent of the person/patient is taken and logged, and only after that are the health records shared
7. **Implementation of health analytics.** The data collected through both the HMIS and EHRs is being analyzed to identify patterns, trends, and opportunities for improvement in the health care delivery system

Figure 3 highlights the different components of the ABDM and how these are linked in terms of their functionality and use.

Institutional and strategic alignment to implement change

Under a partnership between the Ministry of Health and Family Welfare and the Ministry of Electronics and Information Technology, the National Health Authority has been identified as the lead

Figure 3 Overview of the functioning of ABDM



Source: ABDM Handbook (2022).

implementing agency. The National Health Authority has been entrusted with:

- Administrative and technical leadership
- Building the technological infrastructure
- Creating a national digital health ecosystem
- Developing models for self-financing within the ABDM

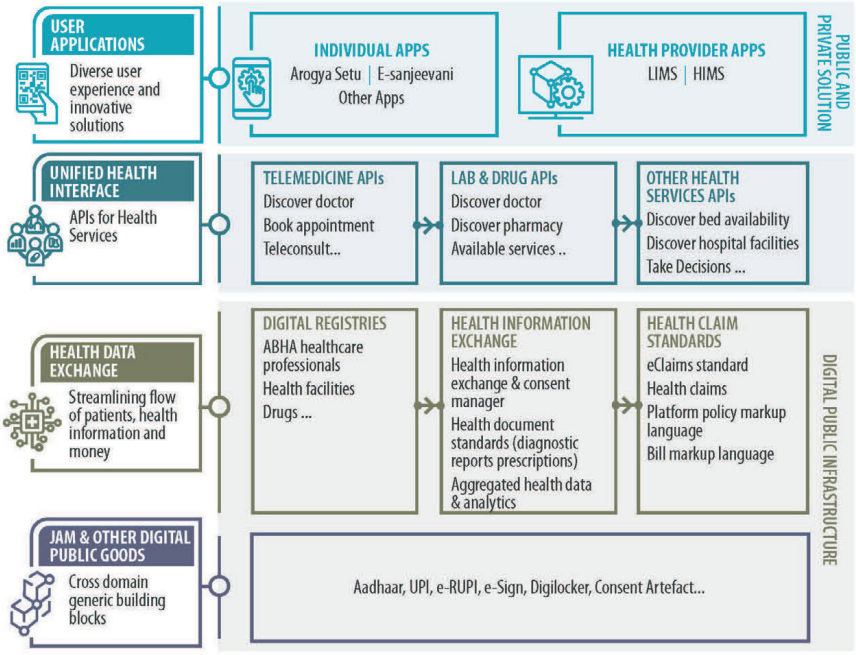
The National Health Authority is also tasked with:

- Implementing policies and decisions approved by the Mission Steering Group and Empowered Committee
- Developing strategic partnerships with private sector and civil society bodies
- Coordinating with the Ministry of Health and Family Welfare and States/Union Territories to resolve technical and operational issues and capacity building

The National Health Authority works in close coordination with other ministries and government departments, the private sector and civil society organizations. The multi-stakeholder mechanism through which the program operates includes the following:

1. **The National Health Authority** is the implementing agency for PM-JAY and is responsible for the overall management and program performance. It provides technical support to the States/Union Territories on program implementation

Figure 4 ABDM Stack–Modular and Interoperable



Source: ABDM Handbook (2022).

2. **State Health Agencies** have been set up by each state and have full operational autonomy and responsibility to ensure that the program is effectively implemented

3. **Insurance companies** are responsible for providing health insurance coverage to beneficiaries, managing claims and reimbursement process(es). They are selected through bidding and are paid a premium by the government for providing insurance coverage.

4. **Health care providers:** Private and public health care providers, such as hospitals and clinics, are eligible to participate in the program and provide health care services to beneficiaries. They are required to follow the standard treatment protocols and the quality standards set by the National Health Authority

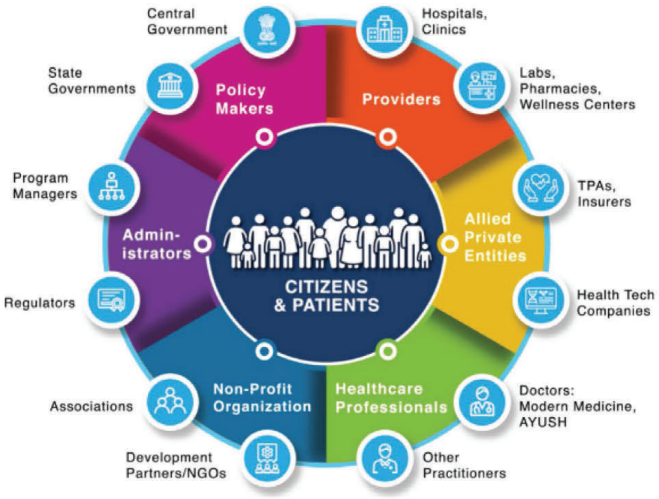
5. **Technology providers** are responsible for developing and implementing the platform being used for the program, such as mobile apps and web portals, which serve to ensure seamless implementation and reduce the chances of fraud and abuse. These partners are mainly from the private sector and are recruited at competitive market rates

Figure 5 highlights the range of stakeholders present within the ABDM network, their roles in supporting patients and citizens to get comprehensive health care.

Scaling considerations and sustainability

The ABDM was launched as a pilot on 15th August 2020 in six Union Territories of India, namely Andaman & Nicobar, Chandigarh, Dadra & Nagar Haveli, and Daman & Diu, Ladakh, Lakshadweep and Puducherry, with the aim of

Figure 5 Stakeholders in the ABDM Network



Source: ABDM, 2023.

Strategic alignments as a part of service delivery reform and to implement change:

- **Distributed:** Health care delivered not only in fixed facilities, but also in workplaces, communities, and people's homes by a wider cadre of health workers, including patients themselves and their caregivers
- **Connected:** Share data with each other and systems outside of health care and be available to health workers and patients on mobile devices
- **Continuous:** Health care to serve people during the 5,000 waking hours of the year, not only the 15 minutes they spend in a fixed facility
- **Human centered:** Health care to put the patient and their caregivers at the center and empower health workers
- **Decentralized:** Decision-making to be less concentrated and put more into the hands of local leaders, health workers, and ultimately patients
- **Collaborative:** Health care to seamlessly combine the insights of non-experts, experts, and non-human agents
- **Responsive:** A system that automatically adapt itself to new data and new diseases

Digitalization is a key ingredient of this transition within the health system to ensure better service delivery and to strengthen core public health functions

establishing a national digital health ecosystem by creating an online platform, enabling interoperability of health data within the health ecosystem to create longitudinal electronic health records of citizens and facilitate delivery of health services through this digital health ecosystem. To date, three key registries namely the Health UID, Health Professional Registry, Health Facility Registry, and digital infrastructure for data exchange have been developed and implemented in these Union Territories with an estimated budget of $6.4 million.

To enhance program coverage, the 2023 budget allocation to NHA has been increased by 70 percent, and each State Digital Health Mission has been tasked with implementing ABDM within their respective territories. The State level scale-up plans were/ are in the process of being developed and they include the development and/or updating of state specific technology and infrastructure that builds on central principles of ABDM, national policies, regulations, and standards. The state is responsible for the capacity building of health care professionals to enable them to be able to lead and implement, as well as conducting the overall monitoring and evaluation of the program in their respective states. A total of 31 states are making steady progress towards building a comprehensive digital health ecosystem. As of August 2023, about 293 million digital health records have been linked to the ABHA accounts of individuals and 442 million citizens have generated their unique ABHA allowing them to access and manage their digital health records anytime, anywhere. They can also access paper-less digital health services under ABDM. The digital linking of individual's health records with ABHA is being carried out extensively across different health facilities of the country with the support of State Governments.

To ensure greater uptake and sustainability, the government intends to conduct public awareness campaigns to encourage individuals to enroll in the program. These will target those living in rural and remote areas, and the economically weaker percentiles. To ensure those who are unconnected, marginalized, remote, tribal, and digitally illiterate are reached by ABDM, specialized systems and offline modules are planned. The network of Panchayati Raj (local government) institutions with support from the frontline health workers, Accredited Social Health Activists and Anganwadi workers will facilitate this last mile outreach. In addition to the necessary infrastructure, the program will require an increase in the number of digitally trained health care providers and insurance companies to provide quality care to the increased number of individuals. Improved partnerships with private health care providers are planned to reduce the financial burden on the government and to improve the quality of care provided under the program.

Enablers and Challenges

Enablers contributing to the success of the ABDM include:

1. **Creation of innovative technologies and leveraging these to enhance quality of care and health service delivery.** The ABDM's digital ecosystem includes a set of digital tools, systems, and platforms that are used to implement and manage the health program. These tools include a variety of: (i) Mobile Applications used for beneficiary identification, eligibility verification, and for accessing health services; (ii) Web Portals: used by health care providers, insurance companies, and government agencies to manage the program, including enrollment of beneficiaries, reimbursement of claims, and monitoring of program's performance; (iii) EHRs used by health care providers to store and manage the health information of beneficiaries, including their medical history, treatments received, and test results; (iv) information systems like 'e-Hospital', which is a cloud-based Hospital Management Information System to connect patients, hospitals and doctors on a single digital platform; and 'e-Shushrut', incorporates an integrated computerized clinical information system for improved hospital administration and patient health care. It also provides an accurate electronically stored medical record of the patient; (v) telehealth and remote consultation services which includes video and tele-consultations and e-Sanjeevani (a web-based comprehensive telehealth solution that facilitates doctor to doctor, and patient to doctor teleconsultations); (vi) Payment systems used to manage the payments to insurance companies, health care providers, and technology providers, for example Paytm and Unified Payment Interface (vii) 'Scan and share' uses a QR code-based token system to manage queues at hospital counters and streamline the outpatient registration process in large hospitals.

In addition, there are several other user friendly and clinical decision support systems that are under development and have the potential to overhaul the health care sector of India. Some of these include the Internet of Medical Things to digitize and connect all critical care units of a hospital such as the ICUs, operating rooms, ventilators, navigation systems and artificial intelligence with

advanced diagnostic capabilities and remote diagnosis, 3D printing technology, robot assisted diagnosis and treatment of diseases, including minimally invasive surgeries, wearable health care devices, etc. is planned. The ABDM leverages these emerging technologies by using Block Chain technology and tracks their development and updates via the Innovation Wing in the National Health Authority.

2. **Establishment of a standardized digital health care ecosystem that supports stakeholders to connect in a trusted environment.** The digital ecosystem under the ADBM provides a conducive and interoperable platform for all the above-mentioned applications to work together seamlessly via different digital pathways through the Unified Health Interface. The Unified Health Interface enables all health care service providers and end-user applications to interact with each other on its network and provides a seamless experience for service discovery, appointment booking, teleconsultations, ambulance access, and more. The Unified Health Interface is based on open network protocols and can address the current challenge of different digital solutions being unable to communicate with each other. Moreover, it gives the stakeholders a trusted environment, promotes innovations to enhance quality of care in an efficient, transparent manner. The Government of India has also routinely allotted a sizable budget for technological advancement and digitization in the health care sector. Digitization of health care records is key for making the benefits of the new technology more scalable, and the Union Budget has made provisions for a planned rollout of the digital registries, ABHA numbers, consent framework, and others that aid in universal access to health facilities.

3. **Development of succinct policies, strategy, regulations, and standards for a unified digital health ecosystem**. A series of policies, guidelines, regulations and standards across all levels and core components of the ABDM have been developed and operationalized/deployed and are regularly updated with a view to strengthening the digital health care infrastructure. Some of these include:

   - **ABDM Strategy Overview and Action Plan:** presents the broad context, scope, rationale, key constructs or building blocks, implementation strategy, outcomes, and institutional structure for developing a digital ecosystem for health care services in the country
   - **National Digital Health Blueprint** lays out the framework of key building blocks essential for the evolution of the National Digital Health Ecosystem. It recommends a Federated architecture, Universal Health ID, Electronic Health records, Metadata and data standards, Health informatics standards, Registries for Non-Communicable Diseases (NCDs), Directories of Providers, professionals and paramedical(s), Legislation and Regulations on Data Management, with focus on privacy and security, and data analytics
   - **Guidelines and strategies related to the digital infrastructure** across the different levels of health care. These guidelines ensure that

the requisite digital infrastructure is in place, is regularly maintained and upgraded. There are policies related to the availability of technology and the connectivity of health care providers, for example

- **Development of technical standards and regulations** to ensure that the technology and different applications used meets the required standards for security, reliability, and privacy
- **Hardware guidelines** for states and health care institutions
- **Interoperability guidelines** to ensure that digital tools used under the program can communicate and exchange data with other digital health systems used for e.g., EHR etc. This helps to promote innovations, contribute to quality of care, and long-term program sustainability
- **Data protection and privacy policies** and strategy outlines the minimum standards for data privacy protection to be followed by all participants/stakeholders of ABDM. There are a set of robust laws to protect digital data for e.g., Health Data Management Policy. These laws help to promote and implement e-health standards, protect patient privacy and security, and regulate the storage and sharing of EMRs
- **Data Management policies and regulations** ensure that data generated is stored, used, shared, and managed securely and efficiently, and it is used to improve the quality of care provided in line with the privacy and security data standards

Apart from developing policies specifically for the digital health architecture, additional guidelines and regulations are developed by the health sector to ensure that quality of care meets the PM-JAY standards. Some of this includes standards for health care providers, insurance companies, technology providers, and for the quality of care provided to beneficiaries. There are also policies related to the financial sustainability of the program, effective and efficient use of resources, prevention of fraud and abuse, monitoring the performance of health care providers, insurance companies, technology providers, and program evaluation. Together these policies and regulations help to ensure the transparency, accountability, and efficiency of program. These are continuously reviewed and updated to ensure that they are aligned with the ever-evolving needs of the beneficiaries and the program.

4. **Public-private partnership is the nucleus of the ABDM and has played a pivotal role in its evolvement.** The private sector plays a pivotal role in the establishment of the ABDM's comprehensive and interoperable digital architecture. The private sector has joined hands with the National Health Authority and is involved in the following ways:
   - **Technology providers:** The private sector through "small start-ups" and "developers" is

involved in the development and implementation of the technology platform, and other innovative applications like the mobile apps, and web portals to ensure seamless implementation and reduce the chances of fraud and abuse

- **Health care providers:** Private health care providers, such as hospitals and clinics, are eligible to participate in the program and provide health care services to beneficiaries. They are required to follow the standard treatment protocols and the quality standards set by the National Health Authority. The private sector also plays a role in building the capacity of health care providers and improving the quality of care. This process is currently a bit slow with only 5 percent of private sector hospitals participating. Data security concerns relating to the use of sensitive and confidential data from HIV, AIDS, and TB patients, for example, there is a reluctance to participate in ABDM

- **Private insurance companies:** provide health insurance coverage, manage claims and the reimbursement process. They are selected through a bidding process and are paid a premium by the government for providing insurance coverage

Through a stakeholder engagement plan, the ABDM informs, communicates and problem solves with the private sector in an efficient and consultative manner.

Some of the key challenges faced under the ABDM include:

- **Uncertainty related to private sector engagement:** ABDM has provided guidelines for public-private partnerships. In this short implementation period, though the private sector and insurance companies have worked well within the ABDM network, there are some concerns on the inclusion of private sector beyond the technology related companies and startups. Clarity is needed on how to increase the engagement of private sector hospitals, and integration of small clinics and independent doctors into the ABDM ecosystem. While there are many advantages to the partnerships with technology companies and start-ups, there have been several implementation and technical challenges encountered. Some of these issues include data security, data privacy, and challenges integrating ABDM with private sector hospital software persists, incentives for the private sector to merge with the ABDM and the need for a legislative framework to ensure their cooperation in a national mission are required

- **Need to strengthen data privacy and cybersecurity across the ecosystem:** It is widely acknowledged that the program has strong multiple gateways to ensure data privacy and cybersecurity. At the entry point, the 14-digit UID format is the same for individuals, service providers and health

facilities. This format makes it difficult for hackers to penetrate; and even when a theft is successful it would be difficult to gauge the type of data. Additional steps that have been put in place include strong data privacy and cybersecurity laws and regulations that specify that health data should not be stored in a government owned cloud or server. The data stays at its original source and can be retrieved as and when needed, but only after obtaining the patient's consent. Despite all these robust data privacy and cybersecurity safeguards, there is concern among private sector service providers that the health insurance companies can still access patient information simply by virtue of being in the ecosystem, analyze disease trends, and then use this information to increase insurance premiums. To ensure additional safety, there is also a need to encrypt stored data, distribute this data across various independent servers to prevent the original sensitive data from being recovered by hackers and tag the encrypted data to ensure proper authentication and consent from the concerned authorities. Though the consent of an individual is being taken to access and store data it must be made mandatory, and additional consent needs to be taken to anonymize personal information so that it can be included in public datasets. The consent for sharing anonymized data needs to be taken at grassroots levels, such as at the health care facility, and service provider levels. These anonymized indices can then be made public to help detect patterns, trends and used for other statistical analysis

- **Need for incentives to enhance compliance:** According to a recent report titled 'Leapfrogging to a Digital Healthcare System (FICCI, 2020)', it is estimated that there are over 500 software providers who provide HMIS software to hospitals and the adoption of EHR in India is less than 10 percent and is characterized by fragmentation and low digital penetration. Adopting ABDM requires doctors to write prescriptions on their laptops/ computers/tablets, which is a huge behavioral change. Given the workload on them, incentivizing them to use computers and laptops is a big challenge that needs to be addressed through awareness campaigns. The same is true for other healthcare professionals like nurses, pharmacy etc. In such campaigns, efforts are being made to show the doctors and healthcare staff the advantages of ABDM: time saved due to prefilled prescriptions, ability to quickly look at records chronologically rather than *searching paper records*. To address this issue a Digital Health Incentive scheme has been developed to provide financial incentives to health facilities, diagnostic laboratories, and Digital Solution companies to enhance adoption of the ABDM

- **Need to address inequities:** In many hospitals, particularly small hospitals, there is lack of investment in computer hardware and digital storage space in health facilities, which are prerequisites for ABDM.

At some remote places, internet connectivity issues also exist

- **Financial sustainability:** There is a perception that the ABDM is expensive, and it is not clear if the government can bear the cost of the entire program rollout, hence the financial sustainability of the program remains an area of concern

In short, additional work is needed to secure public trust for more citizens to continue to enroll into the program allowing it to reach critical mass and offer better value for money.

Advice for others

ABDM is an ambitious program that has the potential to revolutionize health care access in India. During its short implementation period, the mission has brought to focus several efficiency related concerns to the fore that create challenges the health system and were exacerbated by the pandemic. The program has been able to bring about large-service delivery reform and has overhauled the country's health care data systems. Some of the key lessons learned from ABDM's short implementation period include:

1. It is a voluntary scheme and relies on the trust and consent of its citizens. The mission is built on principles of fundamental rights and other legislation such as the IT Act 2008, and the Aadhar Act. The Digital Personal Data Protection Bill 2023, under discussion in the Parliament, will provide safeguards for personal data protection and processing. It is also informed by core democratic principles of cooperative federalism and is presided over by Supreme Court judgements
2. India has adopted an incremental and a phased approach to implement ABDM. This approach allows for feedback loops and lessons learned from each phase, are utilized, monitoring results and experiences of the early adopters for further improvements
3. Instead of one standardized, centralized system, a multi-stakeholder approach has been adopted and the national e-health system is flexible to adapt to the needs of the various stakeholders at all levels yet weaving them together under one common platform
4. A national strategy exists that guides the adoption and implementation of the Mission. This strategy is tailor-made for each region and considers their strengths, weaknesses and adapts well to areas which are remote and/or have poor digital connectivity. Furthermore, the strategy recognizes that digitization process will take many years and has scope to incorporate new advances in technology
5. The government has invested in establishing the required digital ecosystem, such as information system architecture, clinical coding and standards, process harmonization and information governance as a core foundation before moving on to the implementation of the technology
6. Instead of focusing on the development of an IT system, the digital health program is linked to the Primary Health Care system and focuses on the end goal of delivering quality health services for all. Changes are made to clinical protocols, institutional culture, and administrative workflows with digitalization

7. A network of stakeholders across all the core components were engaged in the design and implementation of the ABDM using a public-private partnership model. Under this model, the roles and responsibilities of each stakeholder in the whole ecosystem are clear and well defined. Stakeholders include the government themselves, policymakers, private health providers, allied private entities like health technology companies, doctors, NGOs, and various administrators like program managers and regulators. This arrangement addresses some of the earlier challenges that the government had with the private sector regarding payments. The government, through the involvement of multiple stakeholders and the private sector, has now established effective payment mechanisms across the ABDM platform to reconcile bills and pay health care providers

8. Public-private partnerships with technology companies, startups and private hospitals are an integral piece of the ABDM's strategy to streamline health care processes. Technology companies play a pivotal role in innovation and the creation of new digital health solutions. The ABDM keeps the platform up to date which means it complements the private sector technology that plugs in to it. This technology is regularly updated and upgraded, but issues of data privacy and cybersecurity still need to be addressed from time to time. Newer technologies like Artificial Intelligence, the Internet of Things, Block Chain (Blockchain Technology can guarantee that the data that is created is encrypted and cannot be altered), and Cloud Computing are also being explored to make the ABDM more efficient and effective. Unlike the partnerships with technology companies that are more well established, partnerships with private sector hospitals are still in their nascent stages and will continue to evolve with time.

9. The UIDs for individuals, service providers and health facilities are the key to interoperability across the entire digital health ecosystem. It also serves as the first step in ensuring data privacy. To further enhance security, the government has developed data management and sharing standards which are governed by a robust legal system

10. Under the ABDM, all digital services are available in various regional languages and have been designed in ways to make them accessible and user friendly

11. The government is currently working on a mass awareness raising campaign to promote the use of ABDM and generate demand

12. The expansion in health insurance coverage to reach over 500 million people makes PM-JAY one of the largest health insurance programs in the world. It is critical to providing financial protection for the economically weaker sections of the society in case of medical emergencies. It alleviates poverty stemming from high out of pocket health expenses. The scale of the program is extremely impressive and other countries have much to learn from this huge mobilization effort.

References

ABDM. (2023). Retrieved from https://abdm.gov.in/abdm.

ABDM Dashboard. (2023). Retrieved from https://dashboard.abdm.gov.in/abdm/.

Bajpai, N., Wadhwa, M. (2020). CSD Working Paper Series – India's National Digital Health Mission. In. Towards a New Indian Model of Information and Communications Technology-Led Growth and Development. Retrieved from https://csd.columbia.edu/sites/default/files/content/docs/ICT%20India/Papers/ICT_India_Working_Paper_36.pdf.

Bajpai, N., Wadhwa, M. (2020). India's National Digital Health Mission. ICT India Working Paper # 36. CSD Working Paper Series: Towards a New Indian Model of Information and Communications Technology-Led Growth and Development. Retrieved from https://csd.columbia.edu/sites/default/files/content/docs/ICT%20India/Papers/ICT_India_Working_Paper_36.pdf.

Bargnagarwala, T. (2022). How India is creating digital health accounts of its citizens without their knowledge. Retrieved from https://scroll.in/article/1031157/how-india-is-creating-digital-health-accounts-of-its-citizens-without-their-knowledge.

eSanjeevani website. (2023). Retrieved from https://esanjeevani.mohfw.gov.in/#/.

National Digital Health Mission. (2020). Strategy Overview Making India a Digital Health Nation Enabling Digital Health care for all. Ministry of Health and Family Welfare (MOHFW), Ministry of Electronics and information technology and national health authority. Retrieved from https://abdm.gov.in:8081/uploads/ndhm_strategy_overview_1aebd4820e.pdf.

National Health Authority. (2022). A brief guide on Ayushman Bharat Digital Mission and its various building blocks. Retrieved from https://abdm.gov.in:8081/uploads/ABDM_Handbook_19_10_2022_24c5078481.pdf.

National Health Authority. (2022). Draft Revised Health Data Management Policy. Retrieved from https://abdm.gov.in/publications.

PIB Delhi. (2022). Press Information Bureau (PIB), MOHFW. Government of India accessed on 20th Feb 2023. Retrieved from https://www.pib.gov.in/PressReleasePage.aspx?PRID=1884387.

Saha, P. (2020). India's National Digital Health Mission: A New Model to Enhance Health Outcomes. The Open Group. Retrieved from https://blog.opengroup.org/2020/08/19/indias-national-digital-health-mission-a-new-model-to-enhance-health-outcomes/.

Sharma, A. (2022). India's progress in digital health care ecosystem: Evolution of Policy regulations and future. Business World India. Retrieved from https://www.businessworld.in/article/India-s-Progress-In-Digital-Healthcare-Ecosystem-Evolution-Of-Policy-Regulations-And-Future/24-06-2022-433956/.

Sharma, R. S., Aishwarya Rohatgi, Sandeep Jain, and Dilip Singh. 2023. "The Ayushman Bharat Digital Mission (ABDM): Making of India's Digital Health Story." CSI Transactions on ICT, March. https://doi.org/10.1007/s40012-023-00375-0.

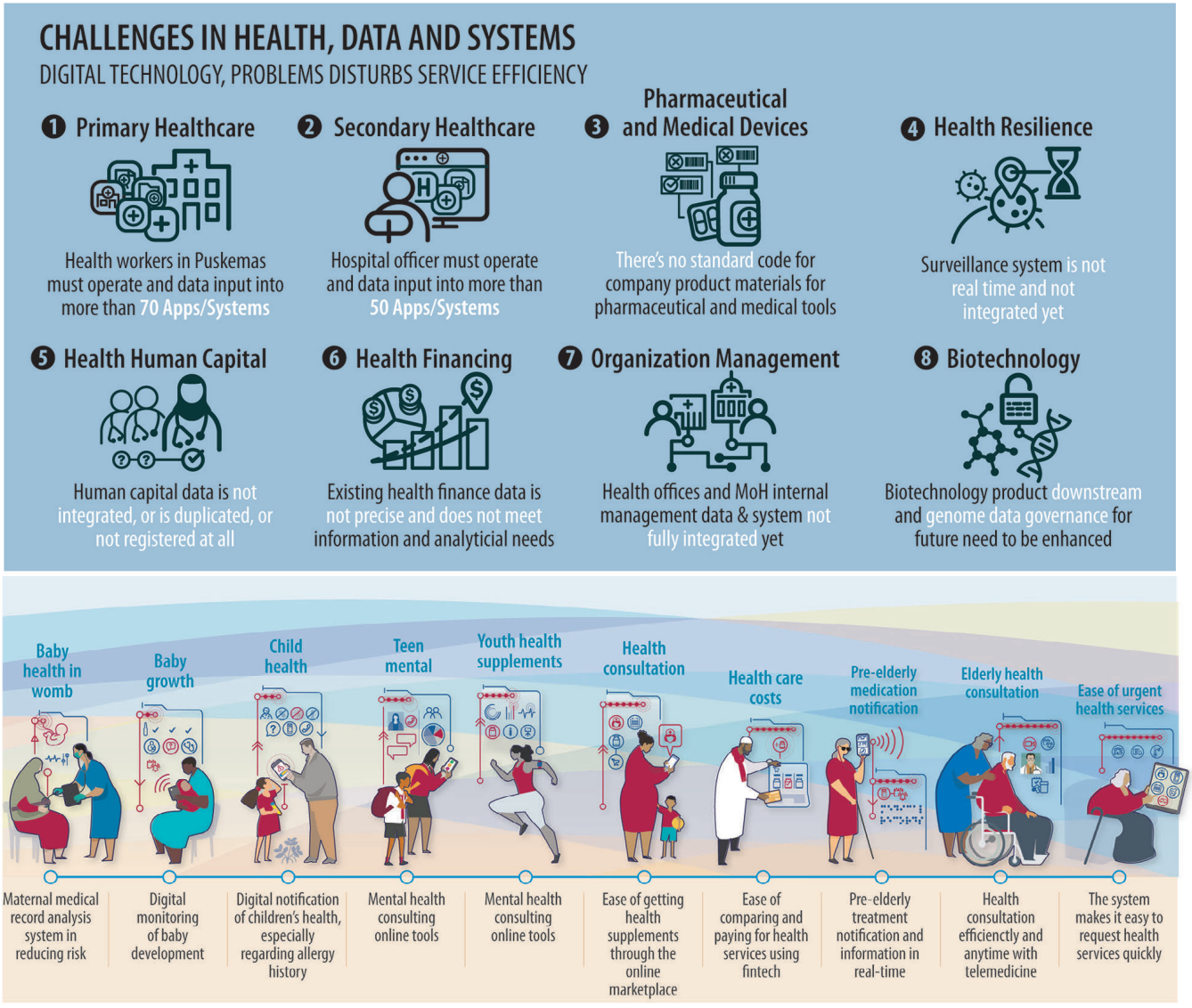
Singh, A. (2022). Strengthening Ayushman Bharat Mission through AI adoption. Centre for Strategic and International studies. Retrieved from https://www.csis.org/blogs/new-perspectives-asia/strengthening-ayushman-bharat-through-ai-adoption.

Sudan, P. (2022). A digital health revolution to empower citizens. The Tribune. Retrieved from https://www.tribuneindia.com/news/comment/a-digital-health-revolution-to-empower-citizens-373953.

ANNEX G

INDONESIA'S VISION FOR DIGITAL HEALTH

Figure 47 Indonesia's Challenges and Vision for Growing Its Digital-in-Health Vision



Source: Presentation of Pak Setaiji Setaiji 2023.

Technology and data are integral to global daily life, including in the health sector. As health systems face increasing demands to deliver new, more, better, and seamless services affordable to all people, data and technology are essential. Digital technology can strengthen health systems, improve health financing and public health, and increase reach for underserved populations. With the potential and perils of innovations like artificial intelligence, the future of health and health care is expected to be technology-embedded and data-linked.

The "Digital-in-Health: Unlocking the Value for Everyone" report presents a new way of thinking about digital health investments expanding the focus from digitization of health data to integrating digital and health as one: Digital-in-health. The report proposes ten recommendations across three priority areas for governments to invest in: prioritize, connect and scale.

Together with the report the Implementation Know-How Briefs that can be downloaded here, are practical guides for countries to implement the ten recommendations. Every Implementation Know-How Brief provides a general orientation with key terminologies and a practical guide on how to start planning and implementing the ten recommendations:

Digital health assessments

Telemedicine and virtual health care

Private sector involvement in digital health

Interoperability in health sector

Workflow mapping for digital technology (re)design in health systems

Data governance for health data

Cybersecurity for health sector

Digital health records

Determining value of digital technology in health

Certification and regulatory sandboxes for digital technologies in health

#InvestInHealth
Follow us at @WBG_Health

THE WORLD BANK