AHOP Policy Briefs - 2024

Health Data Digitalization in Africa

Unlocking the potential

Bataliack Serge
Ebongue Mbondji
Karamagi Humphrey
Leon Janauschek

African Health Observatory
PLATFORM ON HEALTH SYSTEMS AND POLICIES
World Health Organization
African Region

Health Data Digitalization in Africa

Unlocking the potential

Bataliack Serge
Ebongue Mbondji
Karamagi Humphrey
Leon Janauschek

African Health Observatory
PLATFORM ON HEALTH SYSTEMS AND POLICIES

World Health Organization
African Region

ISBN: 9789290314202

Suggested citation. Bataliack Serge, Ebongue Mbondji, Karamagi Humphrey, Leon Janauschek. Health data digitalization in Africa: unlocking the potential. Brazzaville: WHO Regional Office for Africa; 2024. Licence: CC BY-NC-SA 3.0 IGO.

Cataloguing-in-Publication (CIP) data. CIP data are available at http://apps.who.int/iris.

Sales, rights and licensing. To purchase WHO publications, see http://apps.who.int/bookorders. To submit requests for commercial use and queries on rights and licensing, see http://www.who.int/about/licensing.

Designed in Brazzaville, Republic of Congo

About AHOP

The African Health Observatory - Platform on Health Systems and Policies (AHOP) is a regional partnership that promotes evidence-informed policy-making. AHOP is hosted by the WHO Regional Office for Africa through the integrated African Health Observatory and is a network of centres of excellence from across the continent, leveraging existing national and regional collaborations. National Centres currently include the College of Health Sciences, Addis Ababa University, Ethiopia; KEMRI Wellcome Trust, Kenya; the Health Policy Research Group, University of Nigeria; the School of Public Health, University of Rwanda; and Institut Pasteur de Dakar, Senegal. AHOP draws on support from a technical consortium including the European Observatory on Health Systems and Policies (EURO-OBS), the London School of Economics and Political Science (LSE) and the Bill & Melinda Gates Foundation (BMGF). AHOP joins a cohort of regional health systems Observatories including the European Observatory and the Asia-Pacific Observatory (APO) who have shared their learning to inform the development of the AHOP approach.

About AHOP policy briefs

AHOP policy briefs are one of a suite of outputs produced by the platform. We aim to capture current concepts, experiences, and solutions that are of importance to health policymaking within the African region, often applying a comparative lens to learn from diverse approaches. We recognise that there are multiple approaches to writing policy briefs. Through consultation we have developed a distinct AHOP approach, with all our briefs following a common template. AHOP briefs bring together existing evidence and present it in an accessible format; use systematic methods transparently stated; and all undergo a formal and rigorous peer review process.

Acknowledgements

Series Editor: Leon Janauschek
Series Coordinator: Dorothy Chisare

Contributors: Special thanks go to Rokhaya Diop (Institut Pasteur de Dakar), Cheikh Loucoubar (Institut Pasteur de Dakar), Chinyere Mbachu (University of Nigeria), and Benjamin Tsofa (KEMRI Wellcome Trust) for their contributions to this policy brief.

Reviewers: The authors and editors are grateful to external reviewer Meredith Kimball (Exemplars in Global Health) for providing feedback and expertise on this brief. The brief was also reviewed internally by Lesong Conteh (LSE), Beth Kreling (LSE), Katie Shuford (LSE), Godwin Akpan (WHO), Wai Phyo (WHO), Michael Chaitkin (BMGF), and Nathan Shuftan (European Observatory) on behalf of the AHOP partners.

Production: Our thanks go to Ashleigh Slingsby for copyediting the brief, Alexia Honoré (LSE) for French copyedit support, and Cat Johnson (Manta Ray Media) for the design.

Cover photo credit: A health worker updates the file of a patient. WHO Malaria Vaccine Implementation Programme visit in Kenya. Fanjan Combrink, WHO, 2023.

Further information

Web: https://ahop.aho.afro.who.int
Email: WHO Team: afrgoahop@who.int; Technical Partners: ahop@lse.ac.uk
Twitter: @AHOPlatform

This programme is supported by the Bill & Melinda Gates Foundation.

Contents

Abbreviations

AFP	acute flaccid paralysis
Africa CDC	Africa Centres for Disease Control and Prevention
AHI	African Health Initiative
AI	artificial intelligence
AU	African Union
AVADAR	auto-visual AFP detection and reporting
C2P	Coach2PEV
DHI	digital health intervention
DHIS2	District Health Information Software 2
DHP	Digital Health Platform
DIAL	Digital Impact Alliance
EHR	electronic health record
ePOCT	electronic Point-of-Care Tool
ERPX3	Enterprise Resource Planning X3
FMoH	Federal Ministry of Health (Nigeria)
GDHM	Global Digital Health Monitor
GIS	geographic information systems
HDC	Health Data Collaborative
HDD	health data digitalization
HIE	Health Information Exchange
HIS	health information system
ICT	information and communications technology
ICATT	IMCI Computerized Adaptation and Training Tool
IDSR	integrated disease surveillance and response
IeDA	Integrated electronic diagnosis approach
iHRIS	integrated Human Resources Information System
IoT	Internet of things
IRIS	Institutional Repository for Information Sharing
ITU	International Telecommunication Union
mHealth	mobile health
ML	machine learning
MoH	ministry of health
MoHSA	Ministry of Health and Social Action (Senegal)
MOTECH	Mobile technology for community health
NHIS	national health information system
PHC	primary health care
PPP	public-private partnership
RC	WHO Regional Committee for Africa
SDGs	Sustainable Development Goals
SMART	standards-based, machine-readable, Adaptive, requirements-based and testable guidelines
UN	United Nations
WHO	World Health Organization

Glossary

Data digitization

The process of converting analogue information or data into digital format. This involves using digital technologies to capture, store, process and transmit data, enabling more efficient management, analysis, and utilization of information.

Digital health

"The field of knowledge and practice associated with the development and use of digital technologies to improve health" (WHO, 2021b). Digital health expands the concept of eHealth to include digital consumers with a wide range of smart and connected devices. It also encompasses use of other digital technologies for health, such as the Internet of things (IoT), advanced computing, big data analytics, artificial intelligence (AI) – including machine learning (ML) – and robotics (WHO, 2017).

Health data

The systematic application of information and communication technologies, computer science, and data to support informed decision-making by individuals, the health workforce, and health systems to strengthen resilience to disease and improve health and wellness. They include all data on the health status of a data subject that reveal information relating to the data subject's past, current or future physical or mental health status. This includes information about a person collected in the course of the registration for or provision of health care services to that person. It can be represented by a number, symbol or particular sign assigned to a person for their unique identification for health purposes (WHO, 2021b).

Health data digitalization (HDD)

Transforming business processes by leveraging digital technologies for acquiring, formatting, encrypting and storing health data harmoniously, offering the potential to improve efficiency, accessibility, and accuracy of health care delivery, strategies, plans, and research. In other words, HDD transforms traditional, paper-based health records and processes into electronic formats.

Health digitalization (also known as digital health or eHealth)

Using digital technologies to improve the delivery and management of health services. This transformative process encompasses various aspects of health and the leveraging of information and communication technologies to enhance the efficiency, accessibility, and quality of health care.

Health information system (HIS)

A system that integrates data collection, processing, and reporting and use of the information necessary for improving health service effectiveness and efficiency through better management at all levels of health services (WHO, 2021b).

Information and communications technologies (ICT)

Technologies used in manipulating and communicating information especially in modern telecommunication systems. Those systems have evolved to intensive use of computing technology coupled with the enormous increase in communications between computers relying on the telecommunications infrastructure to do so (ITU, n.d.).

Internet of things (IoT)

A system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction (WHO, 2021b).

Interoperability

The ability of different applications to access, exchange, integrate and cooperatively use data coordinated through shared application interfaces and standards within and across organizational, regional and national boundaries to provide timely and seamless information portability and optimize health outcomes (WHO, 2021b).

Key messages

The state of health data digitalization (HDD) in Africa is varied: Well-established electronic health record (EHR) systems in the Region typically concentrate on particular diseases such as malaria, tuberculosis or HIV/AIDS. Most countries are in the early stages of developing national digital health data systems.

Digital health interventions (DHIs) in Africa lack scale and sustainability: Extreme fragmentation of DHIs hinders the development of holistic systems. Investments have been made in pilot projects that are rarely scaled up. A clear methodological approach with an inclusive vision, policy, and strategy is required.

Key enabling factors for HDD exist: These include the implementation of DHI and Health Information Exchange (HIE) regulations, the demographic potential of a large, young population that uses smartphones, the presence of an active digital economy, and access to funding opportunities.

Additional efforts are needed to support HDD: For example, promoting a digital culture in the health sector, fostering digital skill and career development for health care professionals, further developing the ICT infrastructure and Internet penetration, and implementing standardized project management approaches when setting up digital health data systems.

Intersectoral collaboration is essential: Governments, international organizations, health care providers, and technology partners need to address HDD challenges relating to data security, privacy, access equity and ownership; system interoperability; digital skills development; and resource mobilization.

HDD regulatory frameworks are required to harness the potential of the technology: Artificial intelligence (AI) and machine learning (ML) offer enormous possibilities for the use of health data. To ensure their safe and ethical application it is imperative to establish a solid national and regional regulatory framework.

Opportunities exist to support the expansion of HDD in Africa: The African Digital Health Platform (DHP) and the global Health Data Collaborative (HDC) support the fostering of a digital landscape. Countries can also explore leveraging HDD technologies that emerged out of the COVID-19 pandemic.

Re-engineering health systems with expanded HDD could improve the efficiency of health care service delivery: By increasing the adoption of DHIs, African health systems could achieve up to 15% in efficiency gains by 2030 and use these savings to enhance access to health care.

Executive summary

Opportunities

Health data digitalization (HDD) has been promoted in Africa to improve the quality of health services and enhance the decision-making process within the health system and beyond. It allows efficient and timely entry and storage of relevant health data to ensure that their real-time monitoring and analysis are used to make evidence-based decisions. HDD can give health professionals and administrators easier access to historical and current patient data and enable them to analyse such data to make more informed decisions. This data-driven approach helps health professionals choose appropriate treatments and supports policy-makers in designing impactful health policies.

Challenges

Fragmentation of the health system, in general, and of the health information system (HIS), in particular, has been one of the major problems in improving health services in Africa. This is compounded by a lack of data standards, persistent infrastructure challenges, and gaps in data literacy and digital skills of the health workforce. While HDD tends to appear as a viable solution, many uncertainties persist regarding its implementation, mainly linked to the slow progress of African countries in building an enabling environment for a fully digitalized health data system.

Impact

The impact of HDD on the health system is profound and multifaceted. It improves the quality, efficiency, and accessibility of health care services, supports data-driven decision-making, and empowers patients to take an active role in their health. However, weak or incomplete digitalized systems bring challenges related to data security and privacy and the need for workforce training and infrastructure development. Effective policies and governance are crucial in harnessing the full potential of digital health to strengthen the health systems' pillars.

The Region's level of HDD differs greatly. The well-established electronic health record (EHR) systems in Africa frequently concentrate on treating specific illnesses like HIV/AIDS, tuberculosis or malaria. The majority of countries are still developing their national health information systems (NHISs). Overall, Africa's HDD is poorly institutionalized and not sustainable enough to be supported by inclusive policies, strategies, or a defined scientific approach. One of the challenges in establishing holistic systems is the extreme fragmentation of interventions, with investments made primarily in pilot initiatives that are rarely scaled up.

Response

Efforts are being made to address the challenges associated with HDD to facilitate better management of health threats in Africa. These efforts include the introduction of capacity-building programmes, infrastructure development initiatives, policy and regulatory reforms, and public-private partnerships (PPPs). Much remains to be done at all levels. With countries at different stages of development, targeted strategies must be implemented and prioritized to deal with the different challenges.

Conclusion

While the challenges are significant, HDD in Africa continues to grow as the Region recognizes the potential benefits of improved health data management, accessibility, and use. When fully optimized and functional, integrated digital solutions provide opportunities to impact the Sustainable Development Goals (SDGs) positively. The growth of ICTs in Africa, the Internet's regional penetration, and the ongoing development of regional frameworks for HDD highlight the potential for the successful implementation of HDD in Africa. However, this requires fostering a digital culture among public health specialists, creating technology frameworks, and implementing standardized project management approaches when establishing digital health data systems. Furthermore, overcoming the challenges to HDD will require a coordinated effort involving governments, health care organizations, international partners and the private sector.

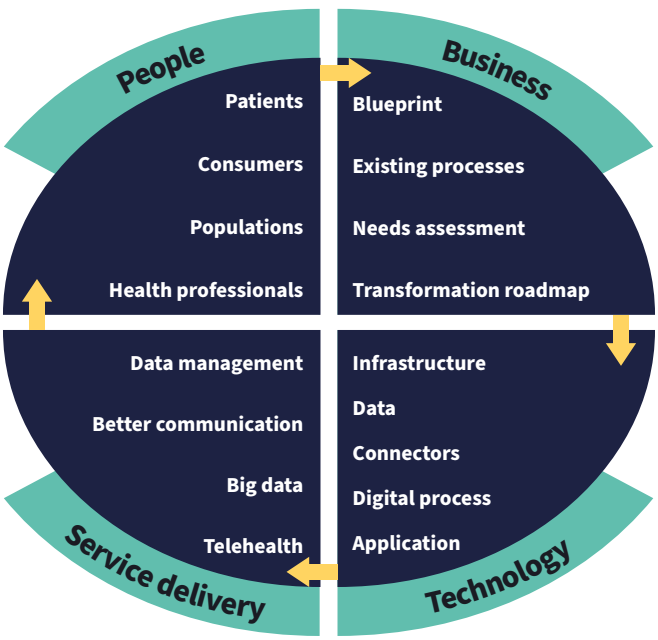
Introduction

The health information system (HIS) is a fundamental component of national health systems, as it provides essential information to guide health care-related decisions, health policy and decision-making processes to improve population health. While effective health systems are necessary to advance universal health coverage and achieve the health-related SDGs, verticalization and fragmentation of HISs pose challenges for African health systems (Ibeneme, et al., 2022).

Digital health has been introduced as "… the field of knowledge and practice associated with the development and use of digital technologies to improve health" (WHO, 2021b), expanding the concept of eHealth to include digital consumers and newer applications of digital technologies for health such as the Internet of things (IoT), advanced computing, big data analytics, AI – including ML – and robotics (Karamagi et al., 2022). Recent publications show that digital technologies are well positioned to accelerate the improvement of health systems in Africa by helping overcome the limitations in health practices and services and enhancing their coverage and quality. While digital health is still in its early stages in most African countries, improvements in smartphone connectivity; data management policies focusing on interoperability, privacy, and security; and data infrastructure are beginning to transform the functioning of health systems across Africa (Jousset, et al., 2023).

Digital health adoption is increasingly becoming critical to make data and information more accessible and to translate them into knowledge to inform policies for better decision-making. Indeed, digital technologies play a crucial role in generating, processing, accessing, analysing, and utilizing health data. Health data digitalization (HDD) thus refers primarily to leveraging digital technologies into business processes for acquiring, formatting, encrypting, and storing health data harmoniously. It thereby offers the potential to improve health care efficiency, accessibility, accuracy, strategies and plans, and research (see Figure 1). HDD is, therefore, an essential step towards strengthening HISs.

Figure 1: Health Data digitalization key blocks



Source: Authors

Using data to its full potential in the health system may yield insightful findings that serve as the cornerstone of data-driven policy-making, which will improve public health. This includes assisting in the prevention of diseases, offering more precise diagnoses, forecasting epidemics and outbreaks, and monitoring policies and services. Several initiatives have been undertaken in the

Region to move the HDD agenda forward, expanding technological solutions for health data management and use. However, beyond the progress made by some of these initiatives, there is a need for an evidence-based review of the current state of HDD in Africa, including identifying and understanding emerging issues and challenges and key areas of focus related to HDD across the pillars of the health system.

Key questions

This policy brief draws on lessons from the experiences, challenges, and perspectives related to HDD to inform the development and implementation of evidence-based policies to enhance the HDD landscape in Africa. We have also highlighted examples from African Health Observatory Platform on Health Systems and Policies (AHOP) National Centre countries in some sections, that is Ethiopia, Kenya, Nigeria, Rwanda, and Senegal. The policy implications offer avenues for improving health care delivery and policy-making by maximizing HDD to address the identified challenges and enhance possibilities for better overall health outcomes.

This policy brief aims to answer the following questions:

- What is the current state of HDD in Africa?
- What are the challenges in HDD in Africa?
- What are the enablers of HDD in Africa?
- What can be done to optimize HDD and improve regional health outcomes?

Methodology

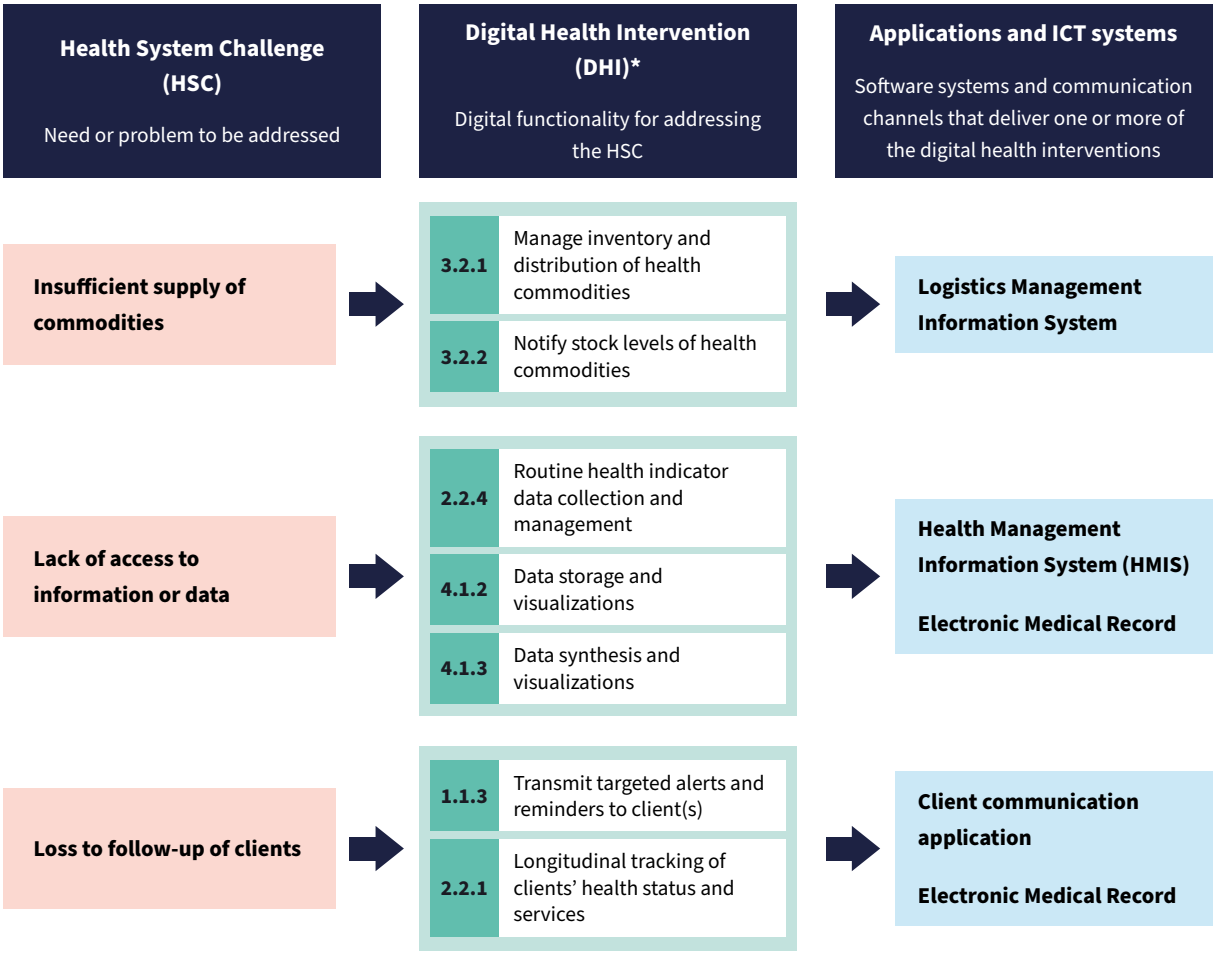
This brief is based on a systematic evidence synthesis of published literature and a desk review of countries' strategic documentation on the subject of HDD available from the African Region. The authors determined and incorporated relevant published studies, considering articles covering the status of digital health data in Africa and the challenges and prospects for the digitalization of a fragmented network. The secondary data used were systematically obtained from various sources, including PubMed, Google Scholar, Scopus, the WHO Institutional Repository for Information Sharing (IRIS) and grey literature. We broadened the review by including sources in French and English.

The search terms were systematically developed to include various synonyms of specific keywords that could relate thematically to the study, ensuring a comprehensive review. They were generated using various combinations of keywords aligned with the objectives' themes, including "health data", digitalization", "digital health", "Africa", "digital data", "health information", and "electronic medical data". The authors reviewed the data using narrative synthesis and checked them for validity with an external reviewer. This methodological approach guaranteed the authors a thorough and standardized synthesis of evidence that could offer practical lessons on the strengths and weaknesses in the African Region's rapidly expanding digital health data landscape.

Classifying digital health interventions

WHO has developed a classification framework for digital health interventions (DHIs). DHIs implemented through information and communications technology (ICT) systems may address health system challenges (Fig. 2). The classification of DHIs reflects the wide range of functions in which digital and mobile technologies support health system needs. Until now, the various and varied communities working in digital health such as government stakeholders, technologists, clinicians, health intervention implementers, network operators, researchers, and donors did not have a common language to define and evaluate functionality in a mutually understandable way. It is important to define a common conceptual stack that enables mapping, determining gaps and overlaps, assessing efficacy and seeking parameters for evaluating multiple – and potentially all – DHIs. The main purpose of the classification is to offer a conciliatory and common language that health programme planners can use to describe the functionalities of DHIs. This classification framework includes four categories, one of which is the intervention for "Data Services".

Figure 2: Examples of how digital health interventions may address health system challenges implemented through ICT systems

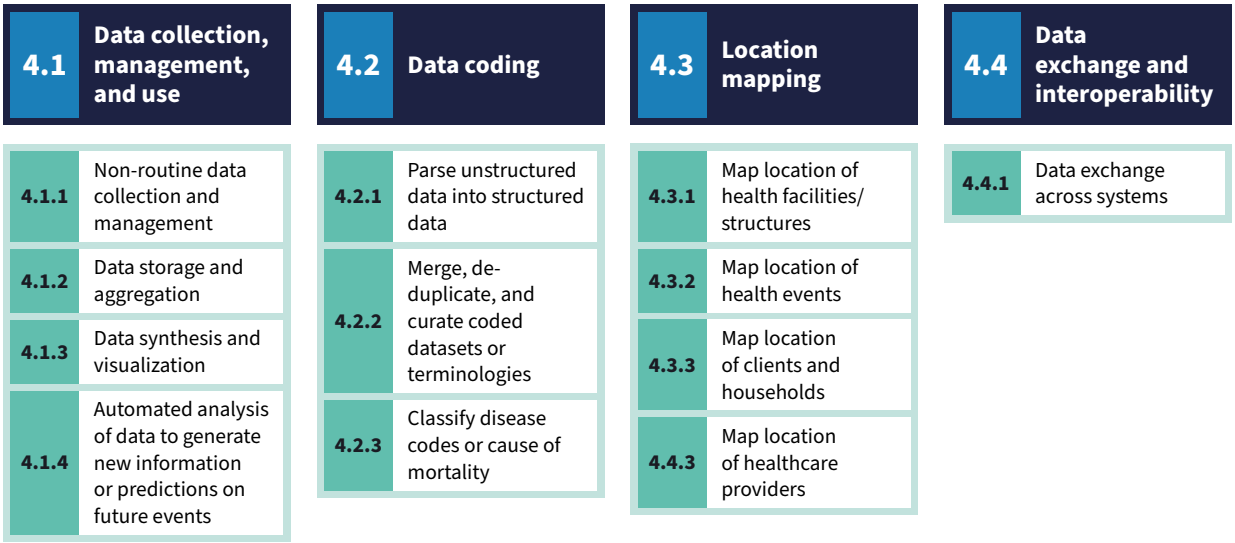


*Numbered interventions relate to WHO's Classification of digital health interventions

Source: WHO, 2018.

DHIs are grouped into categories based on whether the primary users they target are clients, health care providers, health systems or resource managers, or data services (Fig. 3). The data services category includes cross-cutting functionalities designed to support diverse activities related to data collection, management, use and exchange (WHO, 2018; Xiong S. & al, 2023).

Figure 3: Digital health interventions for data services according to the WHO classification



Source: WHO, 2018.

HDD stands at the core of the digital health ecosystem, serving as a foundational element that drives the efficiency, accuracy, and effectiveness of health service delivery. In fact, HDD is a pivotal component of the digital health ecosystem, underpinning advancements in health care accessibility, decision-making, innovation and collaboration, and patient outcomes. As health care systems worldwide continue to evolve, the role of digital health data will become increasingly significant in shaping the future of health services and public health strategies. Improving access to quality data through digitalization appears to be an effective way of ensuring that all stakeholders make optimal use of data to improve the health of populations, and that people can make informed and responsible contributions to data development.

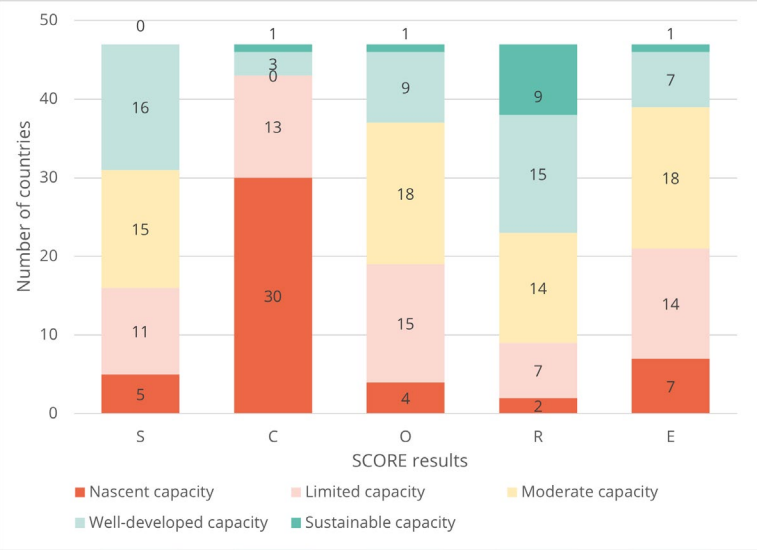
Assessing National Health Information Systems (NHISs)

To have a global reading or summary of the context of HDD in the Region, it is important to understand the environment in which countries are developing their NHISs. This proxy analyses the data continuum from acquisition to use for decision-making.

The WHO SCORE for Health Data Technical Package is a tool for assessing and strengthening NHIS performance in countries. The package comprises five components: Survey, Count, Optimize, Review, and Enable. The Survey component involves collecting data on the six core attributes of NHISs: availability, quality, timeliness, analysis, dissemination, and use. WHO conducted an overall assessment of NHIS performance using the SCORE package in 2020 (WHO, 2020) and the summary results for the African Region (Fig. 4) show that:

- The capacity of NHISs in the WHO African Region to promptly generate good quality data and use them to support decision-making is currently insufficient.
- Routine HISs are beset with data quality problems, particularly low completeness and high inconsistencies.
- The capacity to count births and deaths (civil registration and vital statistics) is the weakest, with up to 30 of the 47 Member States of the WHO African Region having almost no capacity.
- Household surveys and facility assessments are infrequent.
- The capacity to analyse and use data for decision-making is insufficient.

Figure 4: SCORE results for the WHO African Region (2020)



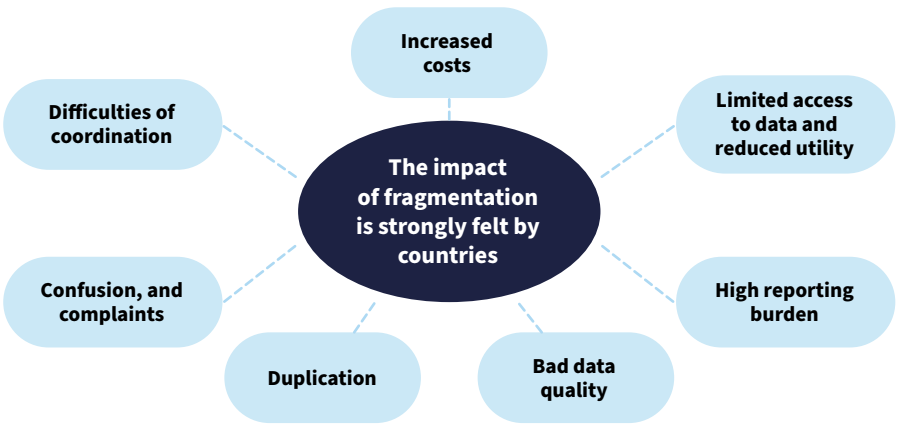
Source: WHO, 2020.

Underperforming NHISs

Several factors may explain the African Region's poor performing NHISs. Amongst the most relevant are the:

- weaknesses in governance of NHISs
- limited capacity of the NHIS workforce to generate and analyse health data and produce reports
- inadequate investments in NHISs
- use of paper-based systems for collection and reporting of data
- limited use of data and information
- fragmentation of HISs, the impact of which is as depicted in Fig. 5.

Figure 5: Impact of HIS fragmentation in the WHO African Region



Source: WHO Regional Office for Africa, 2021.

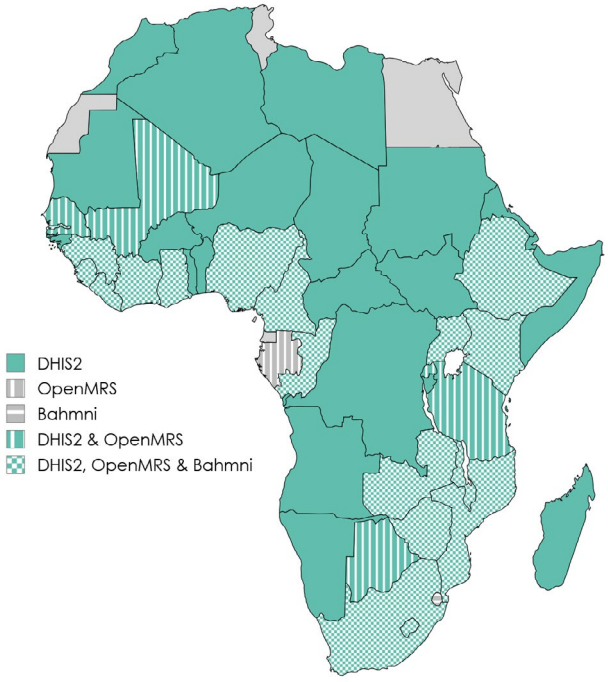
The complexity of NHISs resides in the wide variety of actors involved in their implementation. These actors need to work in a complementary manner for optimal performance. This involves the systematic collaboration of health care providers, patients, public health professionals, health administrators and managers, researchers and scientists, public health agencies, government agencies, nongovernmental organizations, pharmaceutical companies, insurance companies, medical device manufacturers, academic institutions, and IT companies.

Electronic Health Records (EHR) systems

HDD enables data to be analysed straight after collection to identify trends, outcomes, and patterns. This information can be used for research and development, to monitor patients' health, and in project implementation, especially in remote or underserved areas. Critical aspects of HDD include EHR systems, which generally include a digital version of patient information and other health-related data (medical supplies, finances, human resources, laboratory capacity etc.) that enable health care providers and public health managers to access and update data seamlessly and use them more confidently and with few errors to make their decisions.

Some of the current examples of these systems include EHRs, mobile health (mHealth), health information exchange, precision and personalized medicine, digital supply chains, real-time analytics for early detection and contact tracing in emergencies, as well as AI, and ML, and the IoT (Africa CDC, 2023). Electronic health data systems are implemented through several digital solutions or software packages, for example OpenMRS, District Health Information Software 2 (DHIS2) etc. (Fig. 6), whose aim is to make data available promptly. Another critical aspect of HDD is health information exchange (HIE), which involves securely sharing health information among different health institutions (Africa CDC, 2023). It also allows patients to access health-related information via dedicated platforms, empowering them to actively manage their health.

Figure 6: Commonly used EHR systems in Africa



Source: Arias et al., 2023.

Well-established EHR systems in Africa typically concentrate on particular diseases such as malaria, tuberculosis, or HIV/AIDS. Fig. 7 suggests there is a widespread acceptance of EHR systems in Africa, but it does not reveal the extent of these systems' deployment, the level to which health care professionals use them or the calibre of the data they include. These variables determine how effective an EHR system is. Usage and implementation of these systems differs greatly among the countries where they have been implemented (Arias et al., 2023).

Figure 7: EHR System country coverage in Africa

DHIS2	OpenMRS	Bahmni
District Health Information System 2 is the most widely deployed Health Information Management System platform. As of 2023, it can also be used for **disease surveillance**.	The **Open Medical Records System** allows the design of customised medical records systems tailored to various healthcare needs.	**Bahmni** is a comprehensive electronic medical record system and hospital solution designed for resource-constrained settings.
Used by Health Ministries of 80 low and middle-income countries, **impacting 40% of the world's population**	This can include **HIV/AIDs, non-communicable diseases, drug-resistant Tuberculosis, primary care** and **oncology**.	It **consolidates** and **enhances** existing open-source products, including **OpenMRS**, as well as products for medical images, laboratory management, inventory, billing, and financial accounting.
First implemented at the national level in 2012 in countries like **Ghana**, **Rwanda**, and **Kenya**.	Well-rated, with a score of **79%** by the Digital Impact Exchange, highlighting its utility, design and community support.	Can operate independently from the internet, ensuring usability at the point of care with **minimal training requirements**.
In 2022, **Rwanda** achieved a milestone in interoperability by integrating a vaccine registry and electronic birth systems.	Possesses the ability to **interface with DHIS2**, with ongoing development of an HL7 FHIR system.	Addresses issues including incomplete patient histories, unifying patient records, user-centricity, and **can provide access to teleconsultation**.
South Africa continued innovation in 2023 by integrating **Human Resources for Health** using DHIS2 and FHIR.	Deployed in 40 countries, across more than 8000 sites and with 17 million patients.	Used as part of the **EndTB project**, which tested Bedaquiline and Delamanid.

Source: Arias et al., 2023.

Policies and guidelines

Regional policies and guidelines have been developed to regulate the implementation of digital health solutions in Africa. These include WHO's resolutions from the World Health Assembly and the Regional Committee for Africa's sessions such as the Sixtieth session of 2010, Sixty-second session of 2012, Sixty-third session of 2013, Sixty-eighth session of 2018, Seventieth session of 2020, Seventy-second session of 2022 and Seventy-third session of 2023. Others are the guidelines and standards on HIE from the African Union (Africa CDC, 2023; African Union, 2023). Beyond these global and regional commitments, some countries in the Region have created an enabling environment for digital health. About 42 countries have developed national plans for, or including, eHealth/ICT (Africa CDC, 2023). However, implementing these plans and strategies remains limited for different reasons, among which is poor stakeholder collaboration.

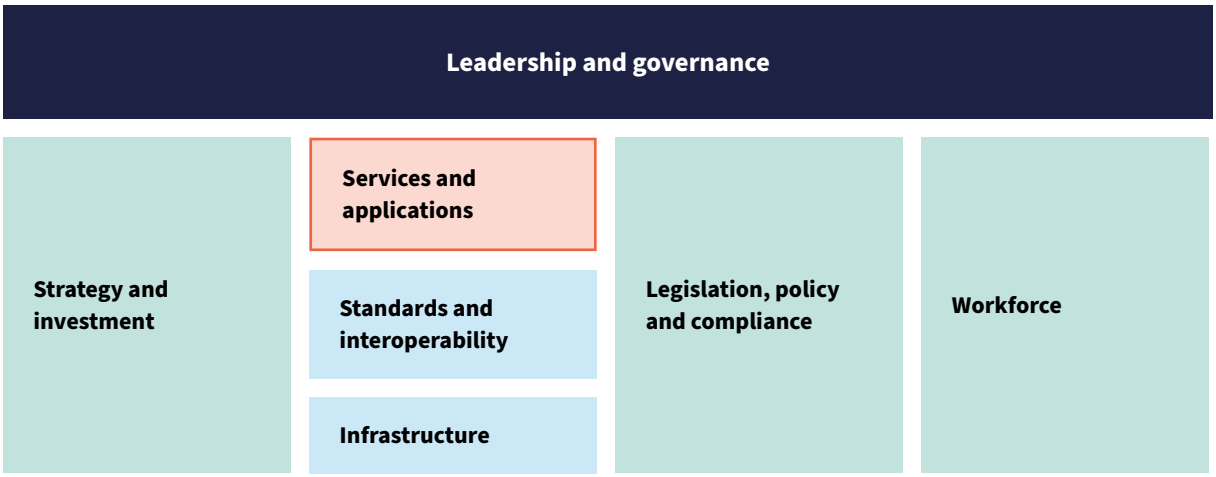
Indicators for digital health development showed progress between 2016 and 2022 and the countries with digital health policies and strategies to have increased from 20 to 36 out of 47 countries in the WHO African Region. The percentage of countries with established digital health applications and monitoring and evaluation tools also rose from 50% to 100% (WHO, 2023). Development of digital tools is continuously growing and opportunities are emerging from the private sector, which brings unique strengths in the areas of innovative technologies and capacities to advance solutions that are central to success (Ibeneme et al., 2020).

Some digital health resources and maturity models are considered essential tools in the global effort to strengthen health data systems. They help assess the current maturity level of digital health systems in regard to human resources, business processes, technology, and organizational capabilities. This assessment enables users to set goals for future maturity levels and informs the creation of improvement plans in advancing towards a more robust digital health system. The tools are developed by MEASURE Evaluation and include:

- the Digital Health Investment Review Tool
- the Global Digital Health Monitor (GDHM), previously called the Global Digital Health Index
- the Health Information Systems Interoperability Maturity Toolkit and
- the Digital Health Atlas (MEASURE Evaluation, 2018).

GDHM is an innovative tool designed to evaluate and benchmark the maturity and progress of digital health systems across countries. The complete framework provided by GDHM informs strategic investments and policy decisions. It assists stakeholders in identifying the gaps and strengths in their digital health ecosystems. The seven pillars (Fig. 8) that support the GDHM methodology are each essential to a strong digital health system.

Figure 8: Digital health key pillars



Source: WHO, 2018.

The services and applications pillar, which covers the implementation and use of digital health solutions, is one of the components of the GDHM. This pillar evaluates how digital tools and apps are incorporated into health care services to improve care quality, efficiency, and accessibility. It assesses how much each nation uses technology to make health care available to everyone, including vulnerable populations and those living in remote and underserved areas. The GDHM methodology for assessing the services and applications pillar involves a multi-step process that includes data collection, scoring, benchmarking, validation, peer review and reporting, and recommendation provision. The assessment of the services and applications pillar through GDHM has far-reaching implications for global digital health. GDHM helps countries develop targeted strategies to improve their digital health services by identifying best practices and pinpointing gaps.

The GDHM index on services and applications can be used as a good proxy to measure the level of HDD, as one of the key objectives of most, if not all, of the tools is to collect data for different purposes. Table 1 presents the disaggregated score from phase 1 to phase 5 in 2023 for all the indicators defined to measure the GDHM index for services and applications for 48 African countries, 43 of which belong to the WHO African Region. High-scoring countries in this pillar have strong digital health ecosystems marked by extensive telemedicine use, integrated EHR systems, and cutting-edge mHealth applications. These nations set an example of how digital health may change how health care is provided.

Table 1: GDHM services and applications scores for African countries (2023)

Country	Indicator 19: Nationally scaled digital health systems	Indicator 20: Digital identity management of service providers, administrators, & facilities for digital health, including location data for GIS mapping	Indicator 21: Digital identity management of individuals for health	Indicator 22: Secure patient feedback systems	Indicator 23: Population health management contribution of digital health	Services and application index
Algeria	Not Available	Not Available	Not Available	Not Available	Not Available	**Not Available**
Angola	Not Available	Not Available	Not Available	Not Available	Not Available	**Not Available**
Benin	Phase 2	Phase 3	Phase 1	Phase 3	Phase 4	**Phase 3**
Botswana	Not Available	Not Available	Not Available	Not Available	Not Available	**Not Available**
Burkina Faso	Not Available	Not Available	Not Available	Not Available	Not Available	**Not Available**
Burundi	Phase 2	Phase 2	Phase 2	Phase 2	Phase 5	**Phase 3**
Cameroon	Phase 2	Phase 3	Phase 1	Phase 1	Phase 3	**Phase 2**
Cape Verde	Phase 2	Phase 1	Phase 2	Phase 2	Phase 2	**Phase 2**
CAR*	Phase 2	Phase 2	Phase 1	Phase 1	Phase 2	**Phase 2**
Chad	Phase 3	Phase 1	Phase 1	Phase 1	Phase 3	**Phase 2**
Comoros	Phase 2	Phase 3	Phase 1	Phase 1	Phase 2	**Phase 2**
Congo	Not Available	Not Available	Not Available	Not Available	Not Available	**Not Available**
Côte d'Ivoire	Phase 2	Phase 2	Phase 1	Phase 1	Phase 2	**Phase 2**
DRC	Phase 3	Phase 2	Phase 1	Phase 1	Phase 3	**Phase 2**
Egypt	Phase 3	Phase 3	Phase 3	Phase 3	Phase 3	**Phase 3**
Ethiopia	Phase 4	Phase 3	Phase 2	Phase 2	Phase 3	**Phase 3**
Gabon	Phase 1	Phase 1	Phase 1	Phase 1	Phase 1	**Phase 1**
Gambia	Not Available	Not Available	Not Available	Not Available	Not Available	**Not Available**
Ghana	Phase 3	Phase 1	Phase 1	Phase 1	Phase 4	**Phase 2**
Guinea	Phase 3	Phase 4	Phase 4	Phase 5	Not Available	**Phase 4**
GB*	Phase 1	Phase 1	Phase 1	Phase 1	Phase 2	**Phase 2**
Kenya	Phase 1	Phase 2	Phase 2	Phase 1	Phase 3	**Phase 2**
Lesotho	Not Available	Not Available	Not Available	Not Available	Not Available	**Not Available**
Liberia	Phase 2	Phase 2	Phase 2	Phase 1	Phase 3	**Phase 2**
Libya	Not Available	Not Available	Not Available	Not Available	Not Available	**Not Available**
Madagascar	Phase 2	Phase 1	Phase 1	Phase 1	Phase 5	**Phase 2**
Malawi	Phase 3	Phase 4	Phase 3	Phase 1	Phase 5	**Phase 4**
Mali	Phase 3	Phase 2	Phase 1	Phase 2	Phase 3	**Phase 3**
Mauritania	Phase 2	Phase 1	Not Available	Phase 1	Phase 2	**Phase 2**
Mauritius	Not Available	Not Available	Not Available	Not Available	Not Available	**Not Available**
Morocco	Phase 2	Phase 3	Phase 1	Phase 1	Phase 1	**Phase 2**

Table 1. continued

Country	Indicator 19:	Indicator 20:	Indicator 21:	Indicator 22:	Indicator 23:	Services and application index
Mozambique	Phase 4	Phase 2	Phase 2	Phase 2	Phase 3	**Phase 3**
Namibia	Phase 3	Phase 3	Phase 1	Phase 1	Phase 3	**Phase 3**
Niger	Phase 2	Phase 4	Phase 1	Phase 1	Phase 4	**Phase 3**
Nigeria	Phase 1	Phase 2	Phase 2	Phase 1	Phase 2	**Phase 2**
Rwanda	Phase 3	Phase 2	Phase 2	Phase 1	Phase 4	**Phase 3**
STP*	Phase 2	Phase 2	Phase 2	Phase 1	Phase 2	**Phase 2**
Senegal	Phase 2	Phase 2	Phase 1	Phase 2	Phase 4	**Phase 3**
Sierra Leone	Phase 4	Phase 3	Phase 2	Phase 1	Phase 4	**Phase 3**
South Africa	Phase 4	Phase 3	Phase 2	Phase 1	Phase 1	**Phase 3**
South Sudan	Not Available	Not Available	Not Available	Not Available	Not Available	**Not Available**
Sudan	Not Available	Not Available	Not Available	Not Available	Not Available	**Not Available**
Tanzania	Phase 5	Phase 4	Phase 2	Phase 2	Phase 5	**Phase 4**
Togo	Phase 2	Phase 1	Phase 1	Phase 1	Phase 2	**Phase 2**
Tunisia	Not Available	Not Available	Not Available	Not Available	Not Available	**Not Available**
Uganda	Not Available	Phase 3	Phase 3	Phase 2	Phase 2	**Phase 3**
Zambia	Phase 3	Phase 3	Phase 1	Phase 1	Phase 3	**Phase 3**
Zimbabwe	Phase 3	Phase 1	Phase 1	Phase 1	Phase 4	**Phase 2**

Source: GDHM Report, 2023. * CAR: Central African Republic, DRC: Democratic Republic of the Congo, GB: Guinea-Bissau, STP: Sao Tome and Principe.

Table 1 notes

Phase	Indicator 19:	Indicator 20:	Indicator 21:	Indicator 22:	Indicator 23:
1	National priority areas are not supported by digital health at any scale.	Health system registries of uniquely identifiable providers, administrators and public facilities (and private facilities, if applicable) are not available, accessible and current.	No secure registry or master patient index exists.	No secure patient feedback system exists.	No contribution from any digital health initiative to routine reporting or for data-based decision-making for population health management.
2	Few national priority areas are supported by digital health, and implementation is initiated in < 25% priority areas.	Health system registries of uniquely identifiable providers, administrators and public facilities (and private facilities, if applicable) are being developed but are not available for use.	A secure registry exists but it is incomplete/ partially available, used and irregularly maintained.	A secure patient feedback system exists for some health services, but is incomplete/ partially available or used, and irregularly maintained.	Digital systems used at district/state levels contribute to only country public health reporting and decision-making for population health management.
3	Some national priority areas are supported by scaled digital health systems (25–50% of priority areas).	Health system registries of uniquely identifiable providers, administrators and public facilities (and private facilities, if applicable) are available for use but are incomplete, partially available, used sporadically and irregularly maintained.	A secure registry exists, is available and in active use and includes <25% of the relevant population.	A secure feedback system exists, is available and in active use and includes data from <25% of the relevant health services and/or geographic locations. It is available to some of the population.	Digital systems are used at facility or community levels and contribute to the country's public health reporting and decision-making for population health management.
4	The majority but not all national priority areas (50–75% of priority areas) are supported by scaled digital health systems.	Health system registries of uniquely identifiable providers, administrators and public facilities (and private facilities, if applicable) are available, used and regularly updated and maintained. The data are geo-tagged to enable GIS mapping.	A secure registry exists, is available and in active use and includes 25–50% of the relevant population.	A secure feedback system exists, is available and in active use and it includes data from 25–75% of the relevant health services and/or geographic locations. It is available to most of the population.	Digital systems are used at facilities or communities and by individuals and contribute to the country's public health reporting and decision-making for population health management.
5	All nationally prioritized areas supported by national-scale digital health systems (>75%) with monitoring and evaluation systems and results.	Geo-tagged health system registries of uniquely identifiable providers, administrators and public facilities (and private facilities, if applicable) are available for all transactions, systematically used and regularly updated, maintained, monitored and evaluated.	A secure registry exists, is available and in active use and it includes >75% of the relevant population. The data are available, used and curated. Strategies are being implemented to include missing data and ensure fully representative datasets are available.	A secure feedback system exists, is available in accessible formats and in active use and it includes data from >75% of the relevant health services and/or geographic locations. It is available to 100% of the population.	Digital systems are used at all levels, including by individuals, contribute to timely country public health reporting and decision-making for population health management.

Innovations and projects

Digital health is rapidly evolving in the African Region with innovations and projects continually emerging. Initiatives in digital health often address specific health issues such as maternal and child health, infectious diseases, and noncommunicable diseases. Examples of such innovations include MomCare, COVID-19 management, DHIS2, and mHealth apps.

MomCare

MomCare is a digital platform that women across sub-Saharan Africa use to track their maternal health journey to help observe the standards of service delivery and provide data for building resilient, quality, focused health systems (Devex Partnerships, 2021). This solution has improved the monitoring and care of pregnant women and children in several health districts and regions, positively impacting maternal and neonatal mortality indicators.

COVID-19 management

HDD demonstrated its importance in pandemic management by playing a critical role in preparedness for and surveillance of COVID-19, helping to track, monitor, and control the spread of infection in several countries (Whitelaw et al., 2020). The solutions used during the COVID-19 pandemic were also extended to facilitate continuity of other health care services by enabling remote access to health care, health data and information for decision-making.

During the pandemic, a rise in citizens' inquiries about correct information on COVID-19 was noted. The Nigeria Centre for Disease Control and Prevention applied digital tools that could communicate with thousands of callers simultaneously to provide them updates. Ethiopia developed a data-driven health information portal with a rapid response component for citizens' questions using call centres (Mogessie, et al., 2021).

DHIS2

DHIS2 is used for collecting, reporting, and analysing health data. It is an open-source HIS for data management and reporting at the point of service or health facility at subnational and national levels. Of the 114 countries globally that use the software, 46 are in the WHO African Region. The solution covers more than 3.2 billion people or 40% of the world's population (DHIS2, n.d.).

In most countries that use DHIS2 within the Region, data are collected by the health districts or subnational units based on the manual reports such as monthly activity reports and monthly statistical reports sent by the health facilities for encoding. The system creates significant risks for data quality and workload for the health district, where much time is spent on data entry instead of health service supervision and data analysis. This means that much effort is put into data collection and ensuring their direct input into the electronic system. Eliminating the paper-based phase of data collection requires substantial investment and a skilled workforce at the point of data production. Therefore, DHIS2 is an ecosystem that needs to be built over the HDD technologies deployed. Aspects such as health professionals' routines and incentives need to be analysed and a culture of data generation and use cultivated over time.

mHealth apps

With the high level of mobile phone penetration in Africa and affordable access to the Internet via the mobile phone, many digital health data solutions use mobile phones to facilitate information collection, sharing and dissemination. These mHealth applications facilitate provision of health information, making appointments, sending out medication reminders, and delivery of telemedicine services. mHealth apps aim to improve health care access, especially in rural and remote areas.

Many more efforts are being made across Africa to digitize health data and improve health care delivery. Some such efforts are highlighted in Table 2.

Table 2: Examples of digital health data solutions in the African Region

Country	Digital solution	Description	Health policy area and purpose	Reference
Burkina Faso	Integrated electronic diagnosis approach (IeDA)	Digital health solutions that support primary health care workers in improving the quality of care of newborns and children and their mothers	Service delivery and maternal and child health: Improve quality of care at the primary health care facility, as well as supervision and decision-making at district and central levels	Karl et al., 2016; Karl, Sanon, Sarrassat, and Somé, 2023; Sarrassat et al., 2021.
Ghana	Mobile technology for community health (MOTECH) - mHealth	Mobile phone-based voice messages on maternal, newborn and child health, and system-managed appointment reminders and alerts for essential care visits	Service delivery: Improve knowledge and utilization of services	Willcox et al., 2019; AfDB, 2014.
Kenya*	Integrated Human Resources Information System (iHRIS)	An open-source human resources information system used to manage health workforce data	Health workforce: Empowering the health workforce	IntraHealth International, 2020.
	Smart health facilities program – Smart Health App	Guides community health workers through routine diagnostics and processes	Service delivery: Improve the quality of health care services	Examplars in Global Health, 2021.
Rwanda*	RapidSMS system	Sending health alerts and facilitating communication between community health workers and clinics	Maternal and child health: Monitoring to prevent maternal and under-five deaths	UNICEF, 2022; Global South E-health Observatory, 2023.
	National EHR system	A health information technology innovation based on converting from paper-based information to a paperless electronic record	Service delivery: Improve efficiency and increase effectiveness of health care delivery	Uwambaye et al., 2017; Fraser et al., 2022.
Senegal*	mDiabete	Managed by the Disease Control Department/ MoHSA, mDiabete is a diabetes prevention platform	Diseases: Data collection and case management	MSAS, 2021.
	Electronic Point-of-Care Tool (ePOCT)	Managed by the Mother and Child Health Department/MoHSA. An electronic tool for managing childhood illnesses		
	IMCI Computerized Adaptation and Training Tool (ICATT)	Managed by the Mother and Child Health Department/MoHSA: An electronic tool for integrated management of childhood diseases		
	Enterprise Resource Planning X3 (ERPX3)	Managed by the Pharmacy and Medicines Department/MoHSA, ERPX3 is a medication management software package	Medicines: stock management	MSAS, 2021.
	Dirpharm	Managed by the Pharmacy and Medicines Directorate, Dirpharm is an online medicines database		

Table 2. continued

Country	Digital solution	Description	Health policy area and purpose	Reference
Senegal*	**Software managed by the MoHSA Prevention Department**			
	DVTMT	Collects vaccination data	Immunization and epidemic surveillance: Data collection and support tools Response to epidemics	MSAS, 2021.
	mInfoSant/RapidPro	Sends free SMS messages to communicate with health workers and report information in real time		
	Parsyl	Monitors the performance of refrigeration equipment for vaccine conservation and generates performance reports		
	Coach2PEV (C2P)	Measures the performance of the Expanded Programme on Immunization services and provides personalized coaching to staff according to their needs		
	DannCovid	Manages COVID-19 alerts	Immunization and epidemic surveillance: data collection and support tools Response to epidemics	MSAS, 2021.
	Teranga	Connecting stakeholders during outbreak response: field investigation teams, laboratories for diagnosis, treatment centres, MoH disease surveillance team, airport authorities and decision-makers to facilitate information sharing during health crises (e.g. epidemics)		
South Africa	MomConnect	The mHealth initiative functions as a pregnancy registry, allowing for health service planning and informative health messages targeted at mothers	Service delivery: Improve health services (antenatal and maternal health)	Jahan, Zou, Huang, & Jibb, 2020; Jembi, 2014.
Tanzania	OpenMRS platform	EHRs allow health care providers to manage and access patient data electronically	Health Information: Strengthening health information	Rweikiza & Machuve, 2019; Tierny, et al., 2010.
Uganda	mTrac system	An mHealth strategy that uses mobile phones to track the availability of essential medicines and supplies at health facilities, helping to ensure their timely availability	Health Information & health products supply: Strengthening HIS and surveillance	AfDB, 2014; WHO, 2014.

Note: *AHOP countries.

Digital solutions and toolkits

Many other digital health solutions and toolkits are used and promoted in the Region, such as:

Auto-visual AFP detection and reporting (AVADAR)

Acute flaccid paralysis (AFP) is the main indicator of polio. AVADAR is a mobile-based application to perform real-time polio surveillance. It enables the health system to notify any suspected AFP cases by community informants and to share community-level AFP surveillance information (WHO, 2022).

Geographic information systems (GIS)

Geospatial technology allows for the spatial representation of data, enhancing public health planning and decision-making (WHO, n.d.). GIS solutions can be crucial in addressing polio and immunization challenges by providing spatial analysis, mapping, and data visualization of immunization coverage and vaccine management.

Integrated disease surveillance and response (IDSR)

A strategy that enables countries to detect, monitor, and respond to various diseases and health events. It integrates multiple disease surveillance systems into a unified framework to enhance early detection and response capabilities. Electronic data systems play a significant role in modernizing and streamlining IDSR processes. Timely and accurate data collection and visualization are critical for effective response and decision-making during emergency outbreaks. Several real-time data collection and transfer solutions are used, including mobile data collection tools.

Integrated supportive supervision

A process designed to enhance the delivery of quality services for optimal outcomes. It emphasizes improved communication, fostering team spirit to address identified issues, and mentoring to motivate health workers in supervising, monitoring, and improving both individual and collective performance (Umar, et al., 2021). The integrated supportive supervision platform integrates several checklists that health partners use when conducting integrative supportive supervision, making those data easily accessible. This web-based tool can be used through an application from a simple mobile device (Asangansi, n.d).

Standards-based, machine-readable, adaptive, requirements-based and testable (SMART) guidelines

The WHO SMART guidelines are a comprehensive set of reusable digital health components. They include interoperability standards, code libraries, algorithms and technical and operational specifications. The guidelines streamline the health intervention adaptation and implementation process, ensuring its fidelity and accelerating adoption. They improve analytics, monitoring, and evaluation and strengthen the evidence base for better clinical care and more robust health systems. SMART guidelines are a new approach to systematize and accelerate the consistent application of recommended, life-saving interventions in the digital age. They also reduce the risks associated with digital investments (WHO, n.d.).

Digital adaptation kits

Operational, software-neutral, standardized documents that distil clinical, public health, and data usage guidance into a format easily integrated into digital systems. A part of the SMART guidelines initiative, digital adaptation kits contain data and health content aligned with WHO's antenatal care recommendations, making them broadly applicable to various digital systems (WHO, 2021a).

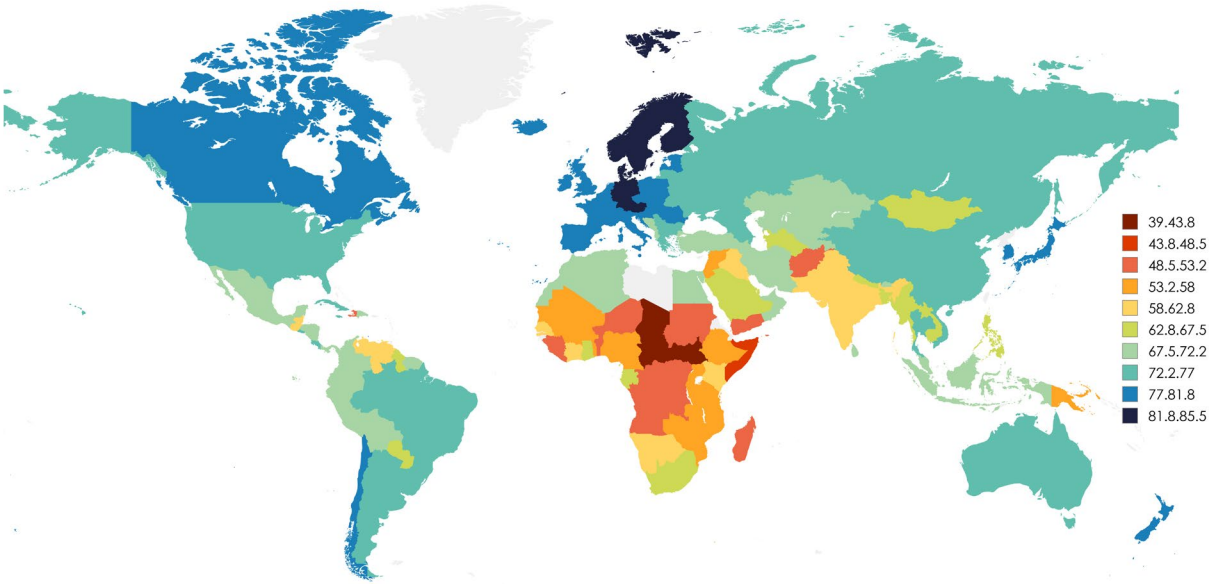
Challenges to HDD in Africa

While HDD offers numerous benefits, there are various challenges that must be addressed to ensure its successful implementation and impact.Indeed, digitalizing health data is not a trivial process, a fact demonstrated by the failure of several high-quality solutions deployed in countries in the African Region to generate adequate results or acquire ownership from key stakeholders. Other solutions have remained at the pilot stage. Some of the challenges facing HDD in the Region are described below.

Regulatory frameworks

Despite the economic value that data represent and the gains they may assist the continent acquire, the lack of a regulatory framework has been associated with the loss of their control and processing on the African continent (UN, 2019). For instance, DHIS2, which is widely used in Africa, enables health care facilities to produce digital data uploaded to the system. However, in many countries, the system is hosted abroad rather than locally. The state of data governance based on data quality, availability, timeliness, and protection regulations is shown in Fig. 9, which also highlights the amount of work to be done conceptually and definitionally on data governance (Hassani & MacFeely, 2023).

Figure 9: Data governance worldwide map (2023)



Source: Hassani & MacFeely, 2023.

Although DHIs have shown efficiency in African countries and many of them have developed and adopted digital health/ eHealth technology strategies, their effective implementation has been constrained by several factors. These constraints include inadequate digital health governance and legal frameworks and weak institutional capacity to plan, implement, supervise, monitor, evaluate, and sustainably fund such strategies (Olu, Karamagi, & Okeibunor, 2023).

In many African countries, digital health regulations are often disorganized, with multiple bodies exerting control without clearly defined responsibilities. This fragmentation can hinder the effective use of digital health technologies, leading to potential health risks and market inefficiencies. These include disorganized regulation, regulatory complexity owing to the diversity of digital health tools, insufficient data protection laws, and lack of technical expertise among regulatory staff (Al Meslamani, 2023). However, some countries have started developing regulations for data protection and sharing. For example, in Senegal, law no. 2008-12 of 25 January 2008 on personal data protection contains fundamental principles. In addition, the “Procedures manual for the health

and social information system" published in August 2022 emphasizes that the head of the Health and Social Information System Division must protect personal data. There is also a Personal Data Protection Commission within MoHSA that helps to ensure that data management legislation is considered. However, the situational analysis of the Digital Health Strategic Plan (2018–2023) revealed a lack of regulatory texts specifically related to digital health in Senegal.

Scale and sustainability

Over the past few years, hundreds of millions of dollars (Digital Square, 2022) have been poured into digital health projects in sub-Saharan Africa (Jousset, et al., 2023). While there have been successes such as in digitally enabling community health workers and provision of telehealth in the hardest-to-reach areas, evidence of broader impact at the national level is sparse. Few digital interventions have scaled with wide adoption and even fewer have been translated into measurable population health outcomes (Nsengimana & Stake, 2023). The challenge is in transforming these initiatives to achieve large-scale and long-term sustainability that can deliver health care to most Africans (Kibu, et al., 2021).

This challenge comes from a lack of a structural alignment of donor-driven projects with local community needs in a systemic approach. Instead of relying on standard aid-based contracts, we must establish a road map for digital health sovereignty, enabling country governments to decide how to procure and manage digital health initiatives (Nsengimana & Stake, 2023). In many settings the focus has been more on tools than on holistic processes, that is business operations, hindering digital health data solutions' scalability, sustainability, and impact. The approach to health care digitalization in Africa must be standardized, integrated, and inclusive. That encompasses the alignment of sectoral policies and regulations, coordination frameworks, and a scale-up plan for investments and resources within the countries' existing context and environment (Abou-Zeid, 2021).

Moving from fragmented systems to a cohesive framework for HDD requires a multifaceted approach that prioritizes system interoperability and standardization and stakeholder collaboration. Interoperability ensures that different systems can communicate and share data seamlessly. This involves adopting common data standards and protocols that facilitate the integration of various HISs (Deloitte, 2020). Standardization of data formats and definitions is essential to maintain consistency and accuracy across platforms (ISO, 2017). Engaging stakeholders from government, health care providers, technology vendors, and patients is vital to address the diverse needs and ensure the system meets broad-based requirements (WHO, 2021b). Additionally, robust governance frameworks must be established to oversee the implementation and maintenance of integrated systems, ensuring data privacy and security (HIMSS, 2021).

Investing in capacity-building initiatives to train health care professionals on new digital tools and processes is critical in the successful transition from fragmented to cohesive health data systems (OECD, 2021). For example, to facilitate the exchange, sharing, and processing of data, Senegal will need to address the challenge of creating a reference framework for standardization and interoperability of its HISs. This basic reference framework will compile all the principles and standards that must be complied with to securely exchange health data. As part of its Strategic Plan for Digital Health, Senegal has prioritized setting the standards needed to ensure interoperability of applications and data.

As a further example on addressing these challenges, the Kenya Ministry of Health, as part of the implementation of its eHealth strategy, developed guidelines for digital health solutions in the public sector, for which among other requirements was interoperability with the DHIS2 platform in use for national data reporting and analysis. Moreover, Kenya has recently enacted new legislation, the Digital Health Act, 2023, to consolidate under one law previously fragmented digital health regulations and guidelines on data collection, ownership, and sharing.

Creation of national digital health information architecture is still an aspiration in Nigeria. Although DHIS2 is the government-approved and adopted web-based platform for reporting aggregate health data from health facilities, various systems and platforms are still being used by vertical disease programmes, and the integration of indicators into the national DHIS2 is incomplete. Moreover, DHIS2 is yet to be fully centralized, since population-based health data are still archived in other government and nongovernment repositories.

ICT infrastructure

Development and use of ICT in the African Region have accelerated in the last decade. From 2008 to 2020 the penetration ratio of mobile telephony increased from 32.2% to 83.2%, mobile broadband penetration rate from 1.7% to 33.1% and the rate of individual Internet users from 4% to 30% (WHO Regional Committee for Africa, 71, 2021). Even so, infrastructure remains a primary challenge in many African countries, where access to reliable Internet, electricity and technology devices can be limited, hindering the widespread adoption of digital health solutions. Nearly 300 million Africans live more than 50 kilometres from a fibre or cable broadband connection (Abou-Zeid, 2021), and less than half of the population of sub-Saharan Africa has access to electricity, which is a major limitation in implementing and exploiting digital health services (Kibu, et al., 2021).

Besides the insufficient digital infrastructure, several other technical barriers have limited the impact of digital health solutions, such as digital tool fragmentation, lack of clear interoperability standards, and an over-indexing of a narrow set of digital public goods. A major obstacle in enhancing data quality and utilization has been the lack of consistent access to routine health information owing to HMIS infrastructure challenges such as shortages of checklists and data collection/compilation tools, and unreliable Internet connectivity (Tilahun et al., 2022). A study in Ethiopia (Tilahun et al., 2022) reported inadequacy of infrastructure such as electricity and equipment such as power generators and computers to adversely affect generation and use of health data at the facility level.

The first challenge to tackle in digitalizing health data in Senegal is ensuring that all health structures are interconnected. The second challenge will be to develop cross-disciplinary platforms supporting all existing and future services and applications. The third challenge will be to secure data backup, requiring a data centre or cloud-type infrastructure. It will also be necessary to set up a HIS for all health structures and an electronic archiving system for health records. To address this challenge, the Government of Kenya has embarked on an ambitious programme dubbed the National Digital Superhighway that aims to increase fibre connectivity across all 47 counties by 2027 and provide all public health facilities in the country with Internet connectivity.

In Nigeria, the most recent countrywide assessment of availability of ICT infrastructure at all levels showed that most primary health care (PHC) facilities lacked ICT infrastructure, including access to reliable electricity (FMoH, 2015). Comprehensive data on the distribution of ICT infrastructure by state and geographic zone are lacking and disparities between rural and urban areas are clear. Forty-one percent of urban areas have Internet coverage compared with just 20% of rural areas, and in 2018 only 6.45% of the health facilities had Internet connectivity (Gillwald et al., 2018).

Data security and quality

As a perpetually innovative and evolving area, HISs in Africa are many as are the EHR platforms piloted, but the linkages amongst them are poor as they are not designed to capture robust data across multiple programmatic areas (Ibeneme, et al., 2022). These solutions must be able to communicate and exchange data and guarantee their security and privacy. Variability in data standards and formats can also impede interoperability and exchange of health data between different health facilities and systems. Concerns about data breaches and unauthorized access to sensitive health information slow down digital health adoption. Weak data protection regulations and enforcement can exacerbate these concerns, and this is a challenge posed by the lack of a uniform data governance framework (Smidt, 2021).

Data quality is a real problem in Senegal. To improve the quality and comparability of data at national and international levels, a data audit is carried out every six months by the Health and Social Information System Division at the central level. The audit helps to reduce the risk of errors and inconsistencies between the data recorded by the service delivery points and the activity reports they produce. However, the data quality audit exercise suffers from irregularities, and difficulties arise in implementing the related recommendations. The results of the latest data quality audit showed that difficulties had been encountered, particularly the unavailability of activity reports and certain registers for recording primary data, data non-reporting in the DHIS2 software and lack of mastery of the instructions for filling in health data in the software. The recommended solution was to build the capacity of staff to use data management tools (MSAS, 2019).

To facilitate the exchange, sharing and processing of data, it is imperative to create a reference framework for standardization and interoperability of HIS's in Senegal. But that is a challenge. The reference framework will compile all the principles and standards that must be complied with to securely exchange health data.

In Nigeria, the limited deployment of DHIS2 at the facility level has necessitated the continued use of paper-based tools and the physical transmission of data from facilities to local government authorities, which is highly error prone and not cost-effective. Data quality is compromised during the aggregation process and when data are transferred from paper format to the electronic platform.

Workforce capacity

African countries benefit less from new technology and innovations than do other countries because only a small portion of their population has the relevant digital skills (GetBundi, 2023). Moreover, lack of data literacy has been acknowledged as an inhibitor of increased usage of open data or data in general (Van Belle et al., 2018). Many individuals are not yet familiar with digital technologies, which affects their ability to navigate and benefit from digital health solutions. There is a need for training and capacity-building programmes to equip health care professionals with the skills required to use digital health tools and manage EHRs effectively. However, the countries have varying digital skills requirements and face distinct challenges in developing these skills, depending on the development level of their digital environment. For instance, while a few more advanced countries in southern Africa may have the necessary infrastructure, even in primary schools, many other African countries are unlikely to meet the minimum requirements for conducting digital skills training (Bhorat et al., 2023). African countries score between 1.8 and 5 on the Digital Skills Gap Index, which is significantly below the global average of 6. Among the world's 20 countries with the weakest digital skills, 12 are in Africa, and only 11% of tertiary education graduates in Africa have received formal digital training. To meet the continent's demand for digital services, 650 million workers need to be trained or retrained in digital skills by 2030 (Dupoux et al., 2022).

The results of the latest data quality audit in Senegal showed digital difficulties, particularly a lack of mastery of health data collection tools (MSAS, 2019). Therefore, there is a need to develop a training plan to raise awareness on HDD and build the capacity of human resources in the health sector in its execution.

Nigeria's health workforce has limited digital skills and inadequate numbers of health records officers and statisticians. In 2018 there were 7146 registered health records officers, translating into 3.48 per 100 000 population. In 2018, 27 247 health records technicians were registered, translating into 13 per 100 000 population (FMoH, 2019). There is high staff turnover and attrition in this cadre of health workers at all levels of government. Moreover, investments in the training of health records officers on software and database maintenance are yet to effectively translate into optimal availability of skilled officers (FMoH, 2015).

Data ownership

Monopolization and monetization of digital data associated with the private upscaling of broadband by large multinational firms increase the risk that Internet neutrality may be lost, presenting an issue for data ownership on the African continent (Advisory Council on International Affairs, 2020). The key challenges to private sector engagement include the sector's overreliance on substandard, costly products, scarcity of entities serving rural communities in the sector, unsustainable commercial models and the nascent, unclear, and complex regulatory landscape for digital transactions in emerging markets (Nathan, 2022).

In Senegal, the private sector will play a fundamental role in developing a digital health care system through its technological expertise and ability to participate in developing sustainable business models. Developing HDD will require close collaboration between the private and public sectors. However, there is a lack of mechanisms for coordinating the two sectors to facilitate investment in digital health. Currently, private sector data are not fully integrated into DHIS2, a situation that can partly be explained by a lack of the obligation to share data, a lack of training in using DHIS2 for most private health structures, and a lack of harmonization of data collection tools.

Kenya also has had challenges in ensuring that private health providers routinely report data through DHIS2. The recently enacted health laws in the country and the related regulations currently being developed aim to address this significant challenge.

Although private hospitals account for up to 60% of Nigeria's health facilities, most of them do not report health data. A recent study in Lagos State showed that only 44% of the private hospitals in the state were reporting data to DHIS2 (Ohiri et al., 2023). There are no penalties for private health facilities failing to do this.

Planning and funding

Despite its benefits, HDD still suffers from weak or insufficient planning and budgets to scale up digital solutions. There is a significant funding gap for digital health innovation and scale-up in Africa. Indeed, countries lack adequate financial resources to boost the potential of DHIs and achieve an effective impact (Kibu, et al., 2021). Private sector funding is often greater than that of the public sector, particularly in the initial phases of projects. The lack of coordination between the two sectors in securing long-term financial support for initiatives constitutes a big challenge (Arias et al., 2023). African digitalization enterprise start-ups raised US$ 158 million in 2020, less than half of what fintech start-ups raised (Elo, 2021). Moreover, a lack of financial incentives and priorities appeared to be one of the big issues in implementing digital health innovations during the COVID-19 pandemic (Mogessie, et al., 2021). In 2014, the first phase of the Ghana Open Data Initiative was challenged by both funding and consistent stakeholder engagement gaps (Van Belle, et al., 2018).

In the context of budget limitations, determining the optimal level of domestic investment for digitalization and introducing digital health tools require a strategic and phased approach. Governments should prioritize foundational investments that build the infrastructure necessary for digital health such as robust Internet connectivity, data storage capabilities, and cybersecurity measures (WHO, 2019). Initial funding should focus on creating interoperable systems that integrate with existing HISs, and ensuring their scalability and sustainability (OECD, 2021). Once solid infrastructure is in place, incremental investments can be made in specific digital health tools that address the most pressing health needs and demonstrate clear cost-effectiveness (World Bank, 2023). Policy-makers should leverage PPPs to supplement domestic funding while drawing on private sector expertise and resources (Deloitte, 2020). Furthermore, prioritizing capacity building for health care workers to effectively use digital tools ensures that investments translate into tangible improvements in health outcomes (McKinsey, 2021). Even within constrained budgets, strategic and well-planned investments can significantly advance digital health and optimize resource utilization.

In Senegal, the absence of a government budget for the Digital Health Coordination Unit is a significant challenge. However, the potential for collaboration with the private sector to facilitate investment in digital health is promising. It is recommended that a coordination and validation mechanism be set up for all digital health projects and initiatives with a strong emphasis on private sector involvement. This will harmonize efforts and ensure that funding is appropriate, fostering a collaborative approach to digital health.

In Nigeria, financial investments to strengthen DHIS2 integration, including by providing digital infrastructure and training health records officers, have yet to yield noticeable improvements in HDD. There are inefficiencies in the management of funds, including in their allocation and use, and poor resource accountability.

Culture and behaviour

Resistance to change, cultural beliefs and a lack of digital literacy among patients and health care providers can impede the adoption of digital health solutions. The local culture should be considered, and digital health solutions must be designed to accommodate diverse languages, cultural norms and health care practices. Digitalization through value-laden technology is complicated because different cultures might interpret the same value differently. For instance, privacy is often viewed as an individual good in North America and Europe, whereas in African and Asian cultures it is more related to the community, such as a family's privacy, rather than individual privacy. Therefore, computer scientists and development agents must consider African philosophical perspectives on privacy. Ethical challenges include the risk of imposing foreign values on African societies through "computer-mediated cultural imperialism" (Schelenz & Schopp, 2018). These challenges must be carefully addressed to ensure that the benefits of digital health data are realized while safeguarding patient privacy and maintaining ethical standards, as well as to ensure the ownership of the data by the African countries. In Senegal, the challenge is to encourage health care workers to change their behaviour in data management by investing in their education in ICT.

Enablers of HDD in Africa

Several enablers support HDD in Africa, helping to overcome the challenges and facilitate the implementation of digital health solutions. These enablers play a crucial role in promoting the adoption and integration of technology into health systems. Advances in smartphone connectivity, data management policies, and data infrastructure are starting to change how health systems work in Africa.

Digital health initiatives

Several governments have been strongly committed to strategic planning for and promotion of digital health initiatives in the past decade. About 76% of the countries in the WHO African Region have developed digital health strategies using the WHO National eHealth Strategy Toolkit (WHO, 2023). Many countries in the Region have developed open data initiatives. The example of Kenya shows that its open data initiative was accelerated by the country's intent and commitment to open government partnership in 2011. In addition, the country enacted a few enabling laws such as the Kenya Access to Information Act of 2016, which have assisted in resolving some of the bureaucracy issues in data regulation (Van Belle, et al., 2018).

HIE

HIE policies and standards must be established to best move from siloed applications to interoperable eHealth solutions. A systematic review of existing practices in Africa shows that countries have paid attention to developing, improving, adopting, and implementing HIE architecture for interoperability and standards (Mamuye, et al., 2022). Several standardization and interoperability projects or initiatives have been implemented in African countries but are still in the pilot phase. As a result, the Africa Centres for Disease Control and Prevention (Africa CDC) developed an African Union HIE policy and standards document to guide the development of HIE in Africa (Africa CDC and the African Union, 2023). In addition to the issues associated with the infrastructural landscape, technical support for implementing digital solutions in Africa is provided by a wide range of actors, including private companies, national governments, nongovernmental organizations and international organizations such as WHO and the International Telecommunication Union (ITU).

Demographic potential

Despite the generally low digital literacy skills on the continent, a report by ITU indicates that in 2020 young people in Africa were 1.47 times more likely to connect to the Internet than the rest of the population. This trend is promising for connectivity in regions with a predominantly young demographic such as the least-developed countries, where half the population is under 20 years old (ITU, 2021). This large proportion of young people in the continent who are eager users of smartphones stands as an opportunity to accelerate the digitalization process in Africa (Holst, et al., 2020). The young population is undoubtedly a potential workforce base for digital health tools work and will ultimately boost skilled human resources.

Digital economy

In several African countries, digital economy is emerging as a key driver of growth, contributing over 5% of GDP. New and emerging mobile-enabled platforms fuelled by the exponential growth of mobile telephony have disrupted traditional value chains across various economic sectors. Investments in digitalization, particularly through PPPs, can harness significant downstream benefits and further stimulate growth (Songwe, 2020). In a 2019 survey, the majority of respondents (30%) in the private business sector in sub-Saharan Africa indicated they would allocate 3% to 5% of their overall investments to digitalization, while 25% expressed a willingness to invest more than 5% (Statista Research Department, 2023).

Funding opportunities

Many funding opportunities exist for digital health data solutions, although their prices are quite high. The DHIS2 project, for example, was initially funded by the Norwegian Agency for Development Cooperation (Norad), the University of Oslo, and the Research Council of Norway. Later, many other organizations such as the United States President's Emergency Plan for AIDS Relief (PEPFAR), the Global Fund to Fight AIDS, Tuberculosis and Malaria, UNICEF, the United States Centers for Disease Control and Prevention, GAVI, and the Bill & Melinda Gates Foundation (BMGF) came on board to provide support for its development and the expansion of its footprint. Other partners such as Digital Impact Alliance, GIZ, and United States Agency for International Development (USAID) have also joined the list of DHIS2 donors (DHIS2, n.d.).

For digital health to thrive in sub-Saharan Africa, the enabling environment must be reinforced with a strong foundation rooted in the local context. This effort should be driven by the specific needs of African countries, endorsed by decision-makers such as national governments, and supported by global key players like the UN and WHO (Holst, et al., 2020).

Way forward

Digitalization offers access to a vast, untapped network of big data with significant benefits for society and the environment. By developing innovative intelligence connected to the IoT, we can create unique opportunities to strategically tackle the challenges defined in the SDGs, promoting a more equitable, environmentally sustainable, and healthy society (Mondejar, et al., 2021).

International data governance

The digital health platform proposed by the WHO Regional Office for Africa aims to streamline different HDD solutions to form a cohesive whole. Using an approach bringing multiple platforms together will prevent verticalization of information, harnessing digital solutions to improve health care delivery in Africa and thereby advancing universal health coverage and monitoring of the SDGs (Ibeneme, et al., 2022). Indeed, HDD presents numerous opportunities to transform health systems, enhance patient care and outcomes, and drive research for health. HDD solutions also offer platforms to enhance disease surveillance and response management through early disease detection and response coordination for outbreaks and other diseases prevalent in the Region. The resulting improvement in data accessibility and sharing means more effective data management for real-time health care monitoring and appropriate data-driven health policy and planning.

Geospatial data and techniques are an adequate example of tools for monitoring progress and providing a solid basis for policy-making to achieve the WHO Thirteenth General Programme of Work's Triple Billion targets (WHO, n.d). In addition, support platforms for data governance have been put in place, such as the Health Data Collaborative (HDC). HDC represents a joint effort by multiple global health partners to work alongside countries to improve the quality of their health data by promoting the alignment of partners in investments for better data systems. It brings together 220 partner organizations with over 800 members from seven constituencies that combine technical expertise and financial means (Health Data Collaborative, n.d). Many more funding and technical support opportunities exist with donors and international organizations such as WHO, ITU, African Union and Africa CDC (AfDB, 2014; Africa CDC, 2023; Arias et al., 2023; DHIS2, n.d.).

Fostering growth of a digital landscape

Moving forward with HDD in countries requires a supportive environment and a series of successful initiatives for implementation to facilitate adoption of digital solutions. African governments' strong political will and commitment to HDD initiatives are the baseline for building an attractive and encouraging environment. Such a commitment was recently made by the ministries of health in the Region during the Seventy-third session of the WHO Regional Committee for Africa (2023) by endorsing recommendations to use digital health solutions to develop national health systems (WHO, 2023).

Some countries have put in place a national HDC. The Cameroon HDC, launched in 2016, replicates the global HDC's mission while also addressing the country level needs (ONSP - MINSANTE, n.d.). Governments responded to the May 2018 WHO Resolution WHA71.7 on digital health by committing to accelerate the adoption of digital health services. These frameworks and mid-term strategies are examples of enablers in expanding HDD in the Region (WHO, 2023). Furthermore, while governments are driving formal digital health strategies, consumers are taking advantage of the increased access to mobile connectivity by increasingly using their smartphones to seek health services (Vodafone Africa.connected, n.d.).

The development of digital health in Senegal represents an extraordinary opportunity. From an economic point of view, it will improve the efficiency of health care provision and reduce costs for the state, providers and patients. The country's commitment to HDD is a reality and is reflected in its strategy in MoHSA policy documents on planning, monitoring and evaluation, governance, disease control, health system strengthening, etc. Many recommendations are highlighted in the digital health strategic plan to

ensure that digital health is better integrated into health policies, such as adopting a law organizing the practice of digital health in the country, updating legislation and regulations on personal data and data security, defining a legal framework for EHRs, creating an accreditation system for national private hosts and developing the legislation needed for new digital health tools such as connected medical devices.

In regard to the digital landscape, a study on eHealth solutions in Senegal identified many initiatives and projects, estimated at around 50. However, it also identified fragmentation and insufficient coordination within the digital health ecosystem. This means, for example, that the health data generated by these projects cannot be analysed because the systems are not interoperable. It was also noted that in most cases the digital solutions had not been extended. To ensure that successful pilot projects are taken to scale and to decompartmentalize the work of MoHSA responsibility centres, the Strategic Plan for Digital Health set up the Digital Health Organizational Development Scheme. Similarly, the Nigeria Health Sector Renewal Investment Initiative (2023) envisions a digitized health system in which decision-making is backed by data (FMoH, 2023).

Leveraging COVID-19 digitalization

Beyond its numbers, the COVID-19 pandemic has been a significant catalyst for advancing HDD. The challenges encountered by some African countries in tracking, transferring, integrating, and accessing laboratory data and other surveillance components during the pandemic highlighted the need for improved real-time data collection and management during epidemics. This underscored the necessity for a platform that integrates and transmits real-time data from all response components in an outbreak emergency.

In South Africa, the pandemic spurred a growing interest in telemedicine services, with patients increasingly using platforms like WhatsApp and phone calls for consultation. This shift towards telehealth led the Health Professions Council of South Africa to develop new guidelines to ensure ethical and legal compliance to health care standards. Published in December 2021, the guidelines address critical issues such as patient consent and confidentiality, and data protection, quality, and safety. They also caution against using social media for telehealth services and providers' offering of exclusive telehealth services. The regular updates to these guidelines, reflecting the evolving COVID-19 landscape and regulatory environment, have provided additional assurance to PHC providers. By clarifying legal boundaries and establishing the fundamentals of good telehealth practice, these guidelines have bolstered the confidence of health care professionals in delivering telehealth services (O'Brien et al., 2023).

All telemedicine solutions have provided opportunities for electronic data collection, sometimes unsystematized, but, above all, they are very specific and not connected to the global environment so that the information can be used on a wider scale. Yes, the pandemic created a demand for HDD and it even increased the use of electronic solutions that could facilitate HDD. Still, examples have shown that the absence of clearly defined interoperability frameworks has curtailed the scaling up of solutions which data can't be connected with other systems.

Private sector opportunities

The private sector plays a crucial role in digital health development across Africa by creating opportunities and expanding the digital health ecosystem. Partnerships between governments and private entities like digital health partners and mobile network and platform providers are vital in focusing on building strong national digital health frameworks and stimulating market demand for digital health services (Vodafone Africa.connected, n.d.). As digital solutions are being developed, global regulatory institutions are developing or regularly updating regulatory frameworks. These frameworks allow aligning of new solutions and tools to international standards to ensure the practical utility of the products. Digital solutions' development trends have shifted from licensed solutions to open source software. This allows replication and improvement to continuously better the solutions and for their integration of new standards and requirements.

The impact of HDD in Africa is still minimal at the national level. However, several subnational and health facility experiences have clearly shown a specific added value when the data are used in decision-making processes and service delivery. In many cases fragmentation is usually driven by partners who seek short-term programmatic results and are unwilling to invest in long-term, more sustainable effects that often require greater involvement. The end result are systems with limited interoperability, undermining the effect of scale to support HDD of the national health system. However, the potential of HDD remains intact. By improving access to essential health services and patient data, digital health technologies take health care closer to the people and strengthen health systems' resilience, boosting the ability to identify, respond to and recover from health threats (Jousset, et al., 2023). While there is still much work to be done to fully realize the potential of HDD in Africa, there is evidence that it can have a positive impact on the performance of health systems with effects on each of their pillars, as follows.

Leadership and governance

HDD can enhance data-driven decision-making by providing the data needed for informed policy and governance decisions. Successful decision-making initiatives in Africa that were driven by digital health data include the three African Health Initiative (AHI) partnership projects in Ethiopia, Ghana and Mozambique. In that situation strategies were implemented to improve the quality and evaluation of routinely collected data at the PHC level and stimulate their use in evidence-based decision-making (AHI Partnership Collaborative for Data Use for Decision Making, 2022). Digital records and data tracking also promote accountability in health by fostering transparency and data governance, privacy, and security and making it easier to monitor performance of health institutions and health care providers. Open Government Data projects in Africa are among the most promising ways to increase transparency and accountability (Van Belle, et al., 2018).

Service delivery

Digital health records improve the efficiency of health service delivery by streamlining patient management, reducing administrative burdens, and enabling health care providers to focus more on patient care (HealthIT.gov, n.d.). Furthermore, health data analytics through dashboards and clinical decision-support systems provide real-time guidance to health care professionals, improving treatment decisions. In a survey of doctors on the use of EHRs, 94% of them reported that the EHR system made patient records easily accessible during consultation. Additionally, 88% of providers experienced clinical benefits from using the EHR system, and 75% indicated that the system allowed them to offer improved patient care (Ahmed, 2023). The use of digital technology to enhance service delivery was evident also during the COVID-19 pandemic, where it supported sexual and reproductive health services, mental health interventions, management of noncommunicable diseases, and improvements in PHC services (Karamagi et al., 2022).

Workforce efficiency

EHRs and digital systems reduce paperwork and administrative tasks, allowing health care workers to allocate more time to patient care. A WHO study shows that the use of mobile technologies, telemedicine, and other digital tools intended to support clinical decisions has improved health workers' performance, skills and competencies. The study shows that health care workers who use digital health technologies report increased accuracy and efficacy during decision-making processes (WHO-Europe, 2023). In fact, these technologies improve clinical practice and management, enhance health care workers' mental health, and improve workers' skills, motivation, and empowerment (Borges do Nascimento, et al., 2023).

Monitoring and evaluation

Digitalization enhances data collection by enabling real-time input and integration of data from various health care providers. It facilitates health data management, that is their organization, storage, and retrieval, making them more accessible and secure. Interoperable data systems improve the sharing of data between different health levels and facilities. This also helps enhance public health surveillance, enabling authorities to monitor and respond to health threats more effectively. Digital technologies can improve the efficiency of data utilization in support of health systems. Leveraging routinely collected EHRs for research enables conducting of large-scale, high-quality studies that can address questions that are difficult to answer through randomized clinical trials or traditional cohort studies that require specialized data collection (Farmer, et al., 2018).

Finance and administration

Digital health records can reduce administrative costs and improve resource allocation, making health financing more efficient. Projections suggest that transitioning to paperless data records could account for significant efficiency gains by 2030, reaching up to 30% or around US$ 700 million for Kenya, 26% or approximately US$ 900 million for Nigeria, and 30% or about US$ 3.3 billion for South Africa (Jousset et al., 2023). By increasing the adoption of digital health tools, African health systems could achieve up to 15% rise in efficiency gains by 2030 and use the savings to enhance health care access and outcomes (Jousset, et al., 2023). Moreover, improved data tracking and reporting through digitalization supports transparency in health spending, making it easier to allocate resources effectively.

Prescription and diagnosis

The successful implementation of laboratory information management systems in African countries has helped in addressing the challenges to timely access of quality laboratory health data. Zimbabwe saw a significant improvement in turnaround time for results, which dropped from 10–21 days in 2013 to only three days in 2017. In terms of data quality, the number of untested clinical samples reduced drastically over that period and laboratory information management, workflow, and results reporting improved (Sembajwe et al., 2018).

Digital health systems can also support pharmacy management by providing more efficient management of drug inventory and prescriptions, reducing medication errors. With e-prescribing systems, digital drug prescriptions are sent to pharmacies in real time, which helps lower administrative costs and minimize prescribing errors. When combined with EHRs, digital prescriptions can aid in preventing adverse drug events by providing physicians with comprehensive insights into potential drug interactions and a patient's medical history (Jousset, et al., 2023). E-prescribing can also help create a database that can be used to monitor prescriptions and drug use. Medical devices can be integrated with digital health systems, improving patient monitoring and diagnostic capabilities.

ICT infrastructure

Digital health records eliminate the need for paper-based medical records, reducing the physical storage requirements and the costs associated with paper. In addition, digitalization requires data centres to be developed to store and back up EHRs, which can serve as a repository for other health system needs. HDD requires a convenient electronic and connectivity environment. Therefore, reliable Internet connectivity is essential for exchanging EHRs, telehealth services, and health information sharing. Improving data digitalization implies improving connectivity. The COVID-19 pandemic obliged countries to increase their use of electronic devices and improve connectivity for information exchange. In Cameroon, weekly updates to the Minister of Health by the 10 regional delegates of public health were held every Wednesday via teleconferencing to share the most recent information from their regions. Key partners were also involved, putting all the key actors in the response at the same level of information. These online remote meetings greatly contributed in improving of Internet connectivity in the country and its use for health purposes.

Conclusion

African health systems are generally weak and unable to respond effectively to health crises or provide adequate health care services to the populations partly because of the poor quality of their health data (Africa CDC, 2023).

HDD in the WHO African Region presents unique opportunities and challenges owing to the diversity of the health care landscape, the varying levels of technological infrastructure, and the socioeconomic factors. Its successful implementation requires a robust policy environment with an integrated strategy, accurate planning and a collaborative effort involving governments, international organizations, technology companies and health care providers. The HDD solutions should be contextually relevant, considering countries' unique challenges and strengths while prioritizing data security, patient information privacy, and health care access equity. However, infrastructure limitations, data security concerns, and digital health literacy disparities still need to be addressed to ensure the successful, equitable, and effective implementation of HDD on the continent.

Policy implications

It is now well established that data insufficiency hinders effective decision-making on resource allocation to improve health and help people live longer, healthier, and more productive lives. According to evidence, HDD has proven application in improving the production of and access to quality health data and, therefore, in improving health systems and the health of populations. In addition, as demonstrated by its major contribution to containing the global COVID-19 crisis, HDD enables better preparation, planning, and response to major public health crises such as epidemics and pandemics. Innovative and effective HDD initiatives, which often are on a small scale, are increasingly being successfully implemented in Africa. However, their progress and scaling up are slow owing to challenges related to their implementation or specific technical and environmental requirements relating to their development process and the level of compliance of African countries with these specificities. Advancing HDD in Africa will require addressing the challenges faced by the fast-growing digital health environment in the Region and will include increasing sustainable investments in the digitalization of health to achieve the following goals:

Establish regulatory frameworks

- Develop intersectoral policies that clearly define the roles and responsibilities for health data governance and stewardship within each sector, ensuring accountability for data management.
- Consider compliance with national and international standards, including compliance with data protection, security regulations, and ethics.
- Build a secure and seamless HIE system that allows health professionals to share health data securely while ensuring their privacy.
- Establish interoperability standards and regulations that ensure different health system entities can manage and exchange data.

Strengthen ICT infrastructure

- Prioritize ensuring of reliability of Internet connectivity and electricity, especially in underserved and rural areas.
- Provide adequate equipment and digital solutions at all levels of the health system.
- Invest in data storage capabilities and cybersecurity measures.

Build health care worker capacity

- Develop a human resource training programme for HISs focusing on how to use digital health tools, EHRs, and HDD.
- Integrate classifications for digital health data jobs and define a career profile in health sector human resource plans.

Encourage collaboration and partnership

- Foster partnerships among governments, nongovernmental organizations, international organizations and private entities.
- Develop common investment plans to strengthen HISs, including harmonized HDD as already initiated by the HDC.

Promote research and development

- Replicate and scale up successful HDD initiatives and projects.
- Conduct an evidence-based review of the current state of HDD in Africa.

Fund digital health development

- Develop a diversified funding strategy that reduces dependence on specific donors.
- Promote a more inclusive approach to funding digital health initiatives.
- Establish a road map for digital health sovereignty, enabling country governments to de-cide how to procure and manage their digital health initiatives.

References

Abou-Zeid, A. (2021). Now is the time for Africa's digital transformation. World Bank (https://www.worldbank.org/en/news/feature/2021/01/11/interview-now-is-the-time-for-africas-digital-transformation, accessed 26 October 2023).

Adams, H. (2022). saving lives: the role of the health information exchange (https://www.itweb.co.za/article/saving-lives-the-role-of-the-health-information-exchange/O2rQGMAEZBYMd1ea, accessed 20 August 2023).

Advisory Council on International Affairs. (2020). Digitalisation and youth employment in Africa: advisory report to the Government of the Netherlands. Amsterdam: Government of the Netherlands.

Afarikumah, E. (2014). Electronic health in Ghana: current status and future prospects. Online Journal of Public Health Inform, 5(3).

AfDB. (2014). Innovative e-Health solutions in Africa Award (https://www.afdb.org/en/documents/document/innovative-e-health-solutions-in-africa-award-48731, accessed 30 August 2023).

Africa CDC. (2023). Africa CDC digital transformation strategy (https://africacdc.org/download/digital-transformation-strategy/, accessed 16 October 2023).

Africa CDC and the African Union. (2023). African Union Health Information Exchange guidelines and standards (https://africacdc.org/download/african-union-health-information-exchange-guidelines-and-standards/, accessed 24 October 2023).

AHI Partnership Collaborative for Data Use for Decision Making. (2022). Barriers and facilitators to data use for decision making: the experience of the African Health Initiative partnerships in Ethiopia, Ghana, and Mozambique. Global Health: Science and Practice, 10 (Supplement 1), e2100666. doi:10.9745/GHSP-D-21-00666.

Ahmed, A. (2023). Use of electronic health records is improving patient care (https://www.carecloud.com/continuum/electronic-health-records-improving-patient-care/, accessed 25 October 2023).

Akinyemi, O. O., Owopetu, O. F., & Agbejule, I. O. (2021). National Health Insurance Scheme: perception and participation of federal civil servants in Ibadan. Annals of Ibadan Postgraduate Medicine, 19(1).

Al Meslamani, A. Z. (2023). Technical and regulatory challenges of digital health implementation in developing countries. Journal of Medical Economics, 26(1), 1057–1060. doi:10.1080/13696998.2023.2249757.

Arias, A., Wright, A., & Waszak, J. (2023). Digital health systems in Africa: a convergence of opportunities (https://www.iqvia.com/-/media/iqvia/pdfs/mea/white-paper/iqvia-digital-health-system-maturity-in-africa.pdf, accessed 26 October 2023).

Asangansi, I. (n.d). Integrated supportive supervision (https://innov.afro.who.int/page/120-integrated-supportive-supervision, accessed 30 August 2023).

Barron, P., Peter, J., LeFevre, A. E., Sebidi, J., Bekker, M., Allen, R., Parsons, A. N., Benjamin, P. & Pillay, Y. (2018). Mobile health messaging service and helpdesk for South African mothers (MomConnect): history, successes and challenges (https://gh.bmj.com/content/3/Suppl_2/e000559, accessed 30 August 2023)

Basajja, M. (2021). Information flows within hospitals in Uganda/Africancountries, Presentation at VODAN-Africa research team meeting. Leiden University.

Basajja, M. (2021). Information streams in health facilities: the case of Uganda. Data Intelligence 2022; 4 (4): 882–898. doi: https://doi.org/10.1162/dint_a_00177.

Bhorat, H., Signé, L., Asmal, Z., Monnakgotla, J., & Rooney, C. (2023). Digitalization and digital skills gaps in Africa - an empirical profile. Brookings (https://www.brookings.edu/wp-content/uploads/2023/05/Bhorat-et.-al-May-2023-Digitalization-and-digital-skills-in-Africa-2.pdf, accessed 26 October 2023).

Bocas, J. (2022). Advantages and challenges of digitization in healthcare (https://digitalsalutem.com/advantages-and-challenges-of-digitization-in-healthcare/, accessed 16 October 2023).

Borges do Nascimento, I. J., Abdulazeem, H. M., Vasanthan, L. T., Martinez, E. Z., Zucoloto, M. L., Østengaard, L. & Novillo-Ortiz, D. (2023). The global effect of digital health technologies on health workers' competencies and health workplace: an umbrella review of systematic reviews and lexical-based and sentence-based meta-analysis. The Lancet Digital Health, 5(8), e534-e544. doi:10.1016/S2589-7500(23)00092-4

Chindoza, K. (2021). Regulatory framework for e-health data policies in zimbabwe: measuring FAIR equivalency. Data Intell.

Darnis, J. P., & Mazzucchi, N. (2020). COVID-19 et instruments numériques: la délicate gestion des données. Fondation pour la recherche stratégique. Note N°12 (https://www.frstrategie.org/sites/default/files/documents/publications/notes/2020/202012.pdf, accessed 30 August 2023).

Deloitte (2020). Radical interoperability in health care. Measuring the impacts on care, cost, and growth (https://www2.deloitte.com/us/en/pages/life-sciences-and-health-care/articles/interoperability-in-healthcare.html, accessed 17 July 2024).

Devex Partnerships. (2021). Leveraging digital solutions for quality maternal health care (https://www.devex.com/news/sponsored/leveraging-digital-solutions-for-quality-maternal-health-care-99701, accessed 14 October 2023).

DHIS2. (n.d). Our Vision & Partners - DHIS2 as a global public good (https://dhis2.org/vision-and-partners/, accessed 25 October 2023).

DHIS2. (n.d). Worldwide map: DHIS2 in action (https://dhis2.org/in-action/#map, accessed 22 August 2023).

Digital Health Week. (2022). Digital health in West Africa: what key factors to consider for the strengthening of ecosystems promoting digitalization? Speak Up Africa (https://www.speakupafrica.org/digital-health-in-west-africa-what-key-factors-to-consider-for-the-strengthening-of-ecosystems-promoting-digitalization/).

Digital Square. (2022). Digital Square investing $800K in innovators to advance digital health public good technologies (https://digitalsquare.org/blog/2022/4/28/digital-square-investing-800k-in-innovators-to-advance-digital-health-public-good-technologies, accessed 26 October 2023).

Dupoux, P., Dhanani, Q., Oyekan, T., Rafiq, S., & Yearwood, K. (2022). Africa's opportunity in digital skills and climate analytics. BCG Global (https://www.bcg.com/publications/2022/africas-opportunity-in-digital-skills, accessed 26 October 2023).

Elo, U. (2021). Digital transformation in Africa requires homegrown solutions. The Habari Network (https://www.thehabarinetwork.com/digital-transformation-in-africa-requires-homegrown-solutions, accessed 26 October 2023).

European Union. (2018). Annex 7 Main Senegal eHealth policies and activities (https://health.ec.europa.eu/system/files/2018-09/ev_20180515_co22_en_0.pdf).

Examplars in Global Health. (2021). Smart Health in Uganda: community health workers use app to provide critical health services during COVID-19 pandemic (https://www.exemplars.health/emerging-topics/epidemic-preparedness-and-response/digital-health-tools/smart-health-in-uganda, accessed 30 August 2023).

Farmer, R., Mathur, R., Bhaskaran, K., Eastwood, S. V., Chaturvedi, N., Smeeth, & Liam, S. (2018). Promises and pitfalls of electronic health record analysis. Diabetologia, 61(6), 1241-1248. doi:10.1007/s00125-017-4518-6.

FMoH. (2015). Nigerian Health ICT Phase 2 Field Assessment Findings. Abuja, Nigeria (https://ehealth4everyone.com/wp-content/uploads/2016/01/nigeria-health-ict-phase-2-assessment.pdf).

FMoH. (2019). Nigerian Health Workforce Profile 2018.

FMoH. (2023). Nigerian Health Sector Renewal Program.

Fraser, H. S., Mugisha, M., Ngenzi, J. L., Richards, J., Santas, X., Naidoo, W. & Umubyeyi, A. (2022). User perceptions and use of an enhanced electronic health record in Rwanda with and without clinical alerts: cross-sectional survey. JMIR Medical Informatics, 10(5).

GetBundi. (2023). Digital skills gap in Africa (https://getbundi.com/blog/Digital-Skills-Gap-In-Africa, accessed 26 October 2023).

Gillwald, A., Mothobi, O., & Rademan, B. (2018). The state of ICT in Nigeria 2018. (https://researchictafrica.net/research/the-state-of-ict-in-nigeria-2018/, accessed 17 July 2024).

Global South E-health Observatory. (2023). RapidSMS Rwanda (https://www.odess.io/en/initiative/rapidsms-rwanda/, accessed 30 August 2023).

Hassani, H. & MacFeely, S. (2023). Driving excellence in official statistics: unleashing the potential of comprehensive digital data governance. Big Data Cogn. MDPI.

Health Catalyst Editors. (2018). The digitization of healthcare: why the right approach matters and five steps to get there. Health Catalyst (https://www.healthcatalyst.com/insights/digitization-healthcare-5-keys-progress, accessed 16 October 2023).

Health Data Collaborative. (n.d). Working together for health and sustainable development. About the Health Data Collaborative (https://www.healthdatacollaborative.org/, accessed 30 August 2023).

HealthIT.gov. (n.d.). What are the advantages of electronic health records? (https://www.healthit.gov/faq/what-are-advantages-electronic-health-records, accessed 25 October 2023).

HIMSS. (2021). Healthcare Interoperability Standards: Tools and Resources, Healthcare Information and Management Systems Society (https://www.himss.org/resources/interoperability-healthcare, accessed 17 July 2024).

Holst, C., Sukums, F., Radovanovic, D., Ngowi, B., Noll, J. & Winkler, A. S. (2020). Sub-Saharan Africa—the new breeding ground for global digital health. The Lancet Digital Health, 2(4), e160-e162. doi:10.1016/S2589-7500(20)30027-3.

Ibeneme, S., Karamagi, H., Muneene, D., Goswami, K., Chisaka, N. & Okeibunor, J. (2022). Strengthening health systems using innovative digital health technologies in Africa. Frontiers in Digital Health. 4. doi:10.3389/fdgth.2022.854339

Ibeneme, S., Ongom, M., Ukor, N. & Okeibunor, J. (2020). Realigning health systems strategies and approaches: what should African countries do to strengthen health systems for the Sustainable Development Goals? Front. Public Health, 8(372). doi:10.3389/fpubh.2020.00372.

IntraHealth International. (2020). Kenya now uses iHRIS Software to manage PEPFAR health workforce (https://www.intrahealth.org/news/kenya-now-uses-ihris-software-manage-pepfar-health-workforce, accessed 30 August 2023).

ISO. (2017). Health informatics – Electronic health record – Definition, scope, and context, International Organization for Standardization (https://www.iso.org/obp/ui/#iso:std:iso:tr:20514:ed-1:v1:en, accessed 17 July 2024).

ITU. (n.d.). Information and Communication Technology Evolution (https://www.itu.int/ITU-D/tech/FORMER_PAGE_IMT2000/Revised_JV/IntroducingIMT_item1.html, accessed 17 July 2024).

ITU Publications. (2021). Measuring digital development 6 Facts and figures 2021 (https://www.itu.int/en/ITU-D/Statistics/Documents/facts/FactsFigures2021.pdf, accessed 25 October 2023).

Jahan, R., Zou, P., Huang, Y., & Jibb, L. (2020). Impact of MomConnect Program in South Africa: a narrative review. Online Journal of Nursing Informatics (https://www.himss.org/resources/impact-momconnect-program-south-africa-narrative-review).

Jembi. (2014). South African Programme: MomConnect (https://www.jembi.org/Project/momconnect, accessed 30 August 2023).

Jousset, O., Kimeu, M., Müller, T., Sforza, G., Sun, Y., Ustun, A., & Wilson, M. (2023). How digital tools could boost efficiency in African health systems. McKinsey & Company (https://www.mckinsey.com/industries/healthcare/our-insights/how-digital-tools-could-boost-efficiency-in-african-health-systems, accessed 15 August 2023).

Karamagi, H. C., Muneene, D., Droti, B., Jepchumba, V., Okeibunor, J. C., Nabyonga, J., Asamani, J. A., Traore, M., & Kipruto, H. (2022). eHealth or e-Chaos: The use of Digital Health Interventions for Health Systems Strengthening in sub-Saharan Africa over the last 10 years: A scoping review. Journal of global health, 12, 04090 (https://doi.org/10.7189/jogh.12.04090).

Karl, B., Lewis, J. J., Pozo-Martin, F., Satouro, A., Somda, S., Ilboudo, P., & Cousens, S. (2016). A mixed methods protocol to evaluate the effect and cost-effectiveness of an integrated electronic diagnosis approach (IeDA) for the management of childhood illnesses at primary health facilities in Burkina Faso. Implementation Science, 11(1), 111. doi:https://doi.org/10.1186/s13012-016-0476-5.

Karl, B., Sanon, V. P., Sarrassat, S. & Somé, A. S. (2023). Realistic evaluation of the integrated electronic diagnosis approach (IeDA) for the management of childhood illnesses at primary health facilities in Burkina Faso. International Journal of Health Policy and Management, 12, 6073. doi:https://doi.org/10.34172/ijhpm.2022.6073.

Kibu, O. D., Asahngwa, C., Ngwa, W., Bongfen, C., Gobina, R., NKengafack, F. & Foretia, D. (2021). The promise of digital health in Africa. Nkafu Policy Institute (https://nkafu.org/wp-content/uploads/2021/03/The-Promise-Of-Digital-Health-In-Africa.pdf, accessed 26 October 2023).

Kipruto H, Muneene, D., Droti, B., Jepchumba, V., Okeibunor, C. J., Nabyonga-Orem, J., Karamagi, H. C. (2022). Use of digital health interventions in sub-Saharan Africa for health systems strengthening over the last 10 years: a scoping review protocol (https://pubmed.ncbi.nlm.nih.gov/35601887/, accessed 15 August 2023).

Mamuye, A. L., Yilma , T. M., Abdulwahab, A., Broomhead, S., Zondo, P., Kyeng, M. & Tilahun, B. C. (2022). Health information exchange policy and standards for digital health systems in africa: A systematic review. PLOS Digital Health, 1(10), e0000118. doi:10.1371/journal.pdig.0000118.

Mbondji, P. E., Kebede, D., Soumbey-Alley, E. W., Zielinski, C., Kouvividila, W. & Lusamba-Dikassa, P.-S. (2014). Health information systems in Africa: descriptive analysis of data sources, information products and health statistics. National Library of Medicine (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4109358/).

McKinsey. (2021). Digitization in healthcare: The CHF 8.2 billion opportunity for Switzerland (https://www.mckinsey.com/ch/our-insights/digitization-in-healthcare, accessed 6 August 2024).

MEASURE Evaluation. (2018). Global Digital health resources and maturity models: a summary (https://www.measureevaluation.org/resources/publications/fs-18-305.html, accessed 27 October 2023).

Mogessie, Y. G., Ntacyabukura, B., Mengesha, D. T., Musa, M. B., Wangari, M. C., Nsabimana, C. & Lucero-Prisno III, D. (2021). Digital health and COVID-19: challenges of use and implementation in sub-Saharan Africa. The Pan African Medical Journal, 38(240). doi:10.11604/pamj.2021.38.240.27948.

Mondejar, M. E., Avtar, R., Baños Diaz, H. L., Dubey, R. K., Esteban, J., Gómez-Morales, A. & Garcia-Segura, S. (2021). Digitalization to achieve sustainable development goals: steps towards a smart green planet. Science of the Total Environment, 794(148539). doi:10.1016/j.scitotenv.2021.148539.

MSAS. (2019). Audit de la qualité des données de routine (https://anads.ansd.sn/index.php/catalog/201/study-description, accessed 17 July 2024).

MSAS. (2021). Plan Directeur Informatique (PDI) 2021-2025 du Ministère de la Santé et de l'Action Sociale (https://www.sante.gouv.sn/sites/default/files/Plan%20Directeur%20Informatique%20MSAS_0.pdf, accessed 17 July 2024).

Nathan, T. (2022). Africa needs smarter investment in digital infrastructure strategies for enticing the private sector (https://www.brookings.edu/articles/africa-needs-smarter-investment-in-digital-infrastructure-strategies-for-enticing-the-private-sector/, accessed 26 October 2023).

Nsengimana, J. P. & Stake, A. (2023). Opinion: Rebooting digital health in Africa. Devex. (https://www.devex.com/news/sponsored/opinion-rebooting-digital-health-in-africa-106013, accessed 26 October 2023).

O'Brien, N. et al. (2023). Strengths, Weaknesses, Opportunities, and Threats Analysis of the Use of Digital Health Technologies in Primary Health Care in the Sub-Saharan African Region: Qualitative Study. Journal of medical Internet research, 25, e45224 (https://doi.org/10.2196/45224).

OECD. (2021). Empowering the health workforce to make the most of the digital revolution (https://www.oecd.org/en/publications/empowering-the-health-workforce-to-make-the-most-of-the-digital-revolution_37ff0eaa-en.html, accessed 17 July 2024).

Ohiri, K., Makinde, O., Ogundeji, Y., Mobisson, N., & Oludipe, M. (2023). Strengthening routine data reporting in private hospitals in Lagos, Nigeria. Health policy and planning, 38(7), 822–829 (https://doi.org/10.1093/heapol/czad035, accessed 17 July 2024).

Olu, O. O., Karamagi, H. C. & Okeibunor, J. C. (2023). Harnessing digital health innovations to improve healthcare delivery in Africa: progress, challenges and future directions. Editorial. Frontiers in Digital Health, 5. doi:https://doi.org/10.3389/fdgth.2023.1037113.

ONSP - MINSANTE. (n.d.). Cameroon Health Data Collaborative (http://onsp.minsante.cm/en/cameroon-health-data-collaborative, accessed 27 October 2023).

Rinke de Wit, T. F. et al. (2022). Digital health systems strengthening in Africa for rapid response to COVID-19. Frontiers in Health Services, 2, 987828 (https://doi.org/10.3389/frhs.2022.987828).

Rweikiza, G. & Machuve, D. (2019). Development of medical records exchange system – a case of OpenMRS and Care2X. International Journal of Advanced Technology and Engineering Exploration, 6(52).

Sarrassat, S., Lewis, J. J., Some, A. S., Somda, S., Cousens, S. & Karl, B. (2021). An integrated EDiagnosis approach (IeDA) versus Standard IMCI for assessing and managing childhood illness in Burkina Faso: a stepped-wedge cluster randomised trial. BMC Health Services Research, 21(1), 354. doi:https://doi.org/10.1186/s12913-021-06317-3.

Schelenz, L., Schopp, K. (2018). Digitalization in Africa: Interdisciplinary perspectives on technology, development, and justice. International Journal for Digital Society, 9(4), 1412-1420. doi:10.20533/ijds.2040.2570.2018.0175.

Sembajwe, R., Shamu, T., Machingura, F. & Chidawanyika, H. (2018). Implemention of a laboratory information system in Zimbabwe. Online J Public Health Inform, 10(1), e46. doi:10.5210/ojphi.v10i1.8909.

Smidt, N. (2021). Upon a data governance framework which uses data categorization. (https://studenttheses.uu.nl/bitstream/handle/20.500.12932/483/Upon%20a%20data%20governance%20framework%20-%20Nick%20Smidt..pdf?sequence=1, accessed 27 October 2023).

Songwe, V. (2020). The role of digitalization in the decade of action for Africa. UNCTAD (https://unctad.org/news/role-digitalization-decade-action-africa, accessed 25 October 2023).

Statista Research Department. (2023). Willingness to invest in digitalization among private businesses in Africa 2019 (https://www.statista.com/statistics/1279786/willingness-to-invest-in-digitalization-among-private-businesses-in-africa/, accessed 25 October 2023).

Stroetmann, K. A. (2018). Digital health ecosystem for African countries a guide for public and private actors for establishing holistic digital health ecosystems in Africa (https://www.researchgate.net/publication/337332336_Digital_Health_Ecosystem_for_African_countries_A_Guide_for_Public_and_Private_Actors_for_establishing_holistic_Digital_Health_Ecosystems_in_Africa, accessed 15 August 2023).

Thakker, A. N. (2021). Nowhere is digital health more needed than in Africa (https://echalliance.com/nowhere-is-digital-health-more-needed-than-in-africa/).

Tierny, W. M., Achieng, M., Baker, E., Bell, A., Biondich, P. & Braitstein, P. (2010). Experience implementing electronic health records. Medinfo.

Tilahun, H., Abate, B., Belay, H., Gebeyehu, A., Ahmed, M., Simanesew, A. & Wondarad, Y. (2022). Drivers and barriers to improved data quality and data-use practices: an interpretative qualitative study in Addis Ababa, Ethiopia. Global health, Science and Practice, 10(Suppl 1), e2100689 (https://doi.org/10.9745/GHSP-D-21-00689).

Umar, A. S., Bello, I. M., Okeibunor, J. C., Mkanda, P., Akpan, G. U., Manyanya, D. & Fussum, D. (2021). The effect of real time integrated supportive supervision visits on the performance of health workers in Zambia. Journal of immunological sciences, Spec Issue(2), 1114 (https://doi.org/10.29245/2578-3009/2021/S2.1109).

UN. (2019). Conference on Trade and Development. Digital economy report 2019: Value creation and capture—implications for developing countries; New York: UN.

UNICEF. (2022). Terms of reference - for capacity building, implementation, maintenance and troubleshooting of community health information system in Rwanda (https://www.unicef.org/rwanda/media/4121/file, accessed 30 August 2023).

Uwambaye, P., Njunwa, K., Nuhu, A., Kumurenzi, A., Isyagi, M., Murererehe, J. & Ngarambe, D. (2017). Health care consumer's perception of the electronic medical record (EMR) system. Rwanda Journal Series F:Medicine and Health Sciences, 4(1), accessed 30 August 2023).

Van Belle, J. P., Lämmerhirt, D., Iglesias, C., Nuhu, H., Hlabano, M., Nesh-Nash, T. & Chaudhary, S. (2018). Africa Data Revolution Report 2018: The status and emerging impact of open data in Africa (http://webfoundation.org/docs/2019/03/Africa-data-revolution-report.pdf, accessed 17 October 2023).

Vodafone Africa.connected. (n.d.). Meeting in the middle: harnessing the post COVID-19 rise of digital public health engagement in sub-Saharan Africa (https://www.vodafone.com/sites/default/files/2021-08/vodafone-africaconnected-ehealth-paper.pdf, accessed 27 October 2023).

Wang, H., Tesfaye, R., Ramana, G. N. & Tesfaye Chekagn, C. (2016). Ethiopia Health Extension Program: an institutionalized community approach for universal health coverage (https://openknowledge.worldbank.org/server/api/core/bitstreams/f2af5fd9-d266-5fa0-8d2d-92f931683c71/content, accessed 30 August 2023).

Whitelaw, S., Mamas, M. A., Topol, E. & Van Spall, H. G. (2020). Applications of digital technology in COVID-19 pandemic planning and response. The Lancet Digital Health, 2(8), e435-e440. doi:10.1016/S2589-7500(20)30142-4.

WHO. (n.d). SMART guidelines. World Health Organization (https://www.who.int/teams/digital-health-and-innovation/smart-guidelines, accessed 30 August 2023).

WHO. (n.d). WHO GIS Centre for Health. World Health Organization (https://www.who.int/data/GIS, accessed 30 August 2023).

WHO. (2009). Framework for the implementation of the Ouagadougou Declaration on Primary Health Care and Health Systems in Africa (https://www.afro.who.int/sites/default/files/2017-06/framework-for-implementation-ouaga-9-4-10.pdf, accessed 29 August 2023).

WHO. (2014). Strengthening accountability (https://apps.who.int/iris/bitstream/handle/10665/184997/WHO_RHR_14.38_eng.pdf?sequence=1, accessed 30 August 2023).

WHO. (2016). Monitoring and evaluating digital health interventions: a practical guide to conducting research and assessment (https://apps.who.int/iris/bitstream/handle/10665/252183/9789241511766-eng.pdf?sequence=1&isAllowed=y, accessed 20 August 2023).

WHO. (2016). More than numbers: how better data is changing health systems (https://www.who.int/news-room/feature-stories/detail/more-than-numbers-how-better-data-is-changing-health-systems, accessed 16 October 2023).

WHO. (2017). mHealth. Use of appropriate digital technologies for public health. Report by the Director-General (https://apps.who.int/gb/ebwha/pdf_files/EB142/B142_20-en.pdf, accessed 17 July 2024).

WHO. (2018). Classification of Digital Health Interventions v1.0: a shared language to describe the uses of digital technology for health (https://apps.who.int/iris/bitstream/handle/10665/260480/WHO-RHR-18.06-eng.pdf, accessed 17 August 2023).

WHO. (2019). WHO guideline: recommendations on digital interventions for health system strengthening (https://apps.who.int/iris/bitstream/handle/10665/311941/9789241550505-eng.pdf?ua=1, accessed 17 August 2023).

WHO. (2020). SCORE for health data technical package: global report on health data systems and capacity. Geneva: World health Organization.

WHO. (2021). Digital adaptation kit for antenatal care: operational requirements for implementing WHO recommendations in digital systems. World Health Organization, Geneva (https://www.who.int/publications/i/item/9789240020306, accessed 30 August 2023).

WHO. (2021). Global strategy on digital health 2020-2025 (https://www.who.int/docs/default-source/documents/gs4dhdaa2a9f352b0445bafbc79ca799dce4d.pdf).

WHO. (2022). Enhancing active acute flaccid paralysis surveillance in South Sudan. World Heath Organization - South Sudan (https://www.afro.who.int/countries/south-sudan/news/enhancing-active-acute-flaccid-paralysis-surveillance-south-sudan, accessed 30 August 2023).

WHO-Europe. (2023). Digital tools positively impact health workers' performance, new WHO study shows. https://www.who.int/europe/news/item/27-07-2023-digital-tools-positively-impact-health-workers--performance--new-who-study-shows#:~:text=The%20study%20shows%20that%20health,real%2Dtime%20data%3B%20more%20knowledge, accessed 25 October 2023).

WHO Regional Committee for Africa. (2009). Framework for the implementation of the Algiers Declaration on Research for Health in the African Region. Report of the Regional Director (https://apps.who.int/iris/handle/10665/1646, accessed 29 August 2023).

WHO Regional Committee for Africa. (2013). Utilizing eHealth solutions to improve national health systems in the African Region. WHO Regional Office for Africa (https://apps.who.int/iris/handle/10665/94311, accessed 29 August 2023).

WHO Regional Committee for Africa, 71. (2021). Framework for implementing the global strategy on digital health in the WHO African Region: report of the Secretariat. WHO Regional Office for Africa (https://iris.who.int/handle/10665/345393).

WHO Regional Committee for Africa. (2023). Progress report on utilizing eHealth solutions to improve national health systems in the African Region: information document. WHO Regional Office for Africa (https://apps.who.int/iris/handle/10665/372400, accessed 30 August 2023).

WHO Regional Office for Africa. (2023). Progress report on utilizing eHealth solutions to improve national health systems in the African Region: information document. WHO Regional Committee for Africa (https://apps.who.int/iris/handle/10665/372400, accessed 30 August 2023).

Willcox, M., Moorthy, A., Mohan, D., Romano, K., Hutchful, D., Mehl, G. & LeFevre, A. (2019). Mobile technology for community health in Ghana: is maternal messaging and provider use of technology cost-effective in improving maternal and child health outcomes at scale? Journal of Medical Internet Research, 21(2).

Wit, R. D. et al. (2022). Digital health systems strengthening in Africa for rapid response to COVID-19. Frontiers in Health Services, 2.

World Bank. (2023). Digital-in-Health: Unlocking the Value for Everyone (https://documents1.worldbank.org/curated/en/099081723223033632/pdf/P17507505033520b109f180abcad94cfd14.pdf, accessed 6 August 2024).

Xiong S., L. H. et al. (2023). Digital Health interventions for non-communicable disease management in primary health care in low- and middle-income countries (https://www.nature.com/articles/s41746-023-00764-4, accessed 17 August 2023).

The WHO Regional Office for Africa

The World Health Organization (WHO) is a specialized agency of the United Nations created in 1948 with the primary responsibility for international health matters and public health. The WHO Regional Office for Africa is one of the six regional offices throughout the world, each with its own programme geared to the particular health conditions of the countries it serves.

Member States

Algeria
Angola
Benin
Botswana
Burkina Faso
Burundi
Cabo Verde
Cameroon
Central African Republic
Chad
Comoros
Congo
Côte d'Ivoire
Democratic Republic of the Congo
Equatorial Guinea
Eritrea
Eswatini
Ethiopia
Gabon
Gambia
Ghana
Guinea
Guinea-Bissau
Kenya
Lesotho
Liberia
Madagascar
Malawi
Mali
Mauritania
Mauritius
Mozambique
Namibia
Niger
Nigeria
Rwanda
Sao Tome and Principe
Senegal
Seychelles
Sierra Leone
South Africa
South Sudan
Togo
Uganda
United Republic of Tanzania
Zambia
Zimbabwe

World Health Organization

Regional Office for Africa

Cité du Djoué
PO Box 6, Brazzaville
Congo

Telephone: +(47 241) 39402
Fax: +(47 241) 39503
Email: afrgocom@who.int
Website: https://www.afro.who.int/