Health Data Collaborative / World Health Organisation

Making the case for investing in Routine Health Information Systems (RHIS) to achieve the health-related SDGs

Work package 2 – Country studies

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REPORT OF FINDINGS

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Disclaimer

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ABBREVIATIONS

ANC	Antenatal Care
CRVS	Civil Registration and Vital Statistics
DALY	Disability-adjusted life years
EPI	Expanded Programme on Immunisation
FP	Family Planning
GDP	Gross Domestic Product
HIS	Health Information System
ICD	International Classification of Disease
ICER	Incremental Cost-Effectiveness Ratio
ICT	Information communication technology
IGAD	Intergovernmental Authority for Development (of the African Union)
IND	International Dollar
IS	Information Systems
LIS	Logistics Information System
LMIS	Logistics Management Information System
OPD	Outpatient Department
QALY	Quality-adjusted life years
QC	Quality of Care
QIP	Quality Improvement Project
RHIS	Routine Health Information System
ROI	Return of Investment
SAMRC	South African Medical Research Council
Swiss TPH	Swiss Tropical and Public Health Institute
VSL	Value of Statistical Life
VLW	Value of Lost Welfare
WHO	World Health Organisation
WP	Work package

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Executive summary

This is the report of findings of the country case studies, which constitutes the work package 2 of the work commissioned by the Health Data Collaborative (HDC) "Making the case for investing in Routine Health Information Systems (RHIS) to achieve the health-related SDGs". Throughout this work, we have adopted an operational definition of RHIS as the "conjoint of resources and activities, operating as a stand-alone functional structure, integrated within the wider national health system, which comprises all data management, analytical and use processes related to the data generated in and supporting every clinical care or public health event".

Despite the obvious importance of RHIS in supporting health care and in being the source of evidence to monitor health care indicators across the whole health sector in every country, the challenges that seriously jeopardise the very objectives of RHIS have been protracted for years. The surge of digital tools does not seem to have solved many of the challenges and it may have worsened some of them. Cognisant of this situation, the HDC has mandated a series of studies, one of which is to produce evidence from a series of countries that could support further investments in RHIS.

In conversations with WHO and the HDC, trying to have some diversity, and guided as well by opportunity, we have selected six countries and two sub-national areas: Colombia, Côte d'Ivoire, Nepal, Nigeria, Cross River state (Nigeria), South Africa, Western Cape (South Africa) and South Sudan. We have prepared a data collection tool that has been implemented in the eight areas by local experts, covering regulation, design, functionality and resources (including costs) of RHIS. We have carried out an economic analysis estimating the value of lost welfare comparing it with the level of investment on RHIS.

In the first section of our findings, we report on the legal, design and operational aspects of the RHIS in the countries. In general terms, RHIS are relatively well embedded in the structure and regulations of Ministries of Health. While the theory seems to be well established, is in the implementation where problems seem to arise. Common problems include, lack of coordination, duplicity of systems, fragmentation, poor data quality and very meagre use of data for decision-making.

We have described the size of the health systems in terms of tiers and health care delivery sites of different types across them, both in the governmental and private sectors, to illustrate the magnitude of the RHIS that is implemented in thousands of health care delivery points, every day of the year. Since RHIS support every single health care event, being it clinical or in public health, RHIS is inextricable from the health care events and, hence, have a quality of care dimensions, as found in some of the countries.

The availability and use of information sub-systems greatly varies across countries. More developed countries tend to have better systems, as reported by the experts. The logistics management information systems seem to be the least developed. The use of data in legal documents and in the mass media are the least prominent.

The funding of RHIS as a proportion of governmental health expenditure is quite meagre and less than 1%, except in South Sudan, due to the already very low governmental health expenditure. Most of the countries received external funding supporting a diversity of aspects of the RHIS, including infrastructure, training and software, among others.

The costs of the RHIS were in the millions in almost all counties and between 0.02 and 0.46 USD per capita. In terms of the number of hours health workers dedicate to the RHIS, the estimates ranged from 500,000 up to 52 million per year across the whole country; this is equivalent to approximately 100 to 500 hours per health worker of any category or positions and year used in RHIS. The larger burden of time use in RHIS happens in the periphery of the system, where most of the health care events take place.

The economic analyses suggest that the RHIS investments represent less than 1% of the value of the annual losses due to poor quality of care. Although we could not attribute a specific proportion of wellbeing (or loss of wellbeing) to the RHIS, these figures suggest that even a substantial investment in RHIS would still represent a rather small proportion of the value of lost wellbeing.

These case studies have made explicit the extraordinary burden of the RHIS as an integral part of health care, a fundamental human right. The RHIS encompasses the whole health system, everywhere and at all times; yet, RHIS seem ill conceived, relying on the efforts of health workers, likely at the expense of delivering good quality of care. This translates into a large economic burden, that is less patent given that health workers contributing costs are not directly imputed to the RHIS.

The limitations and prospects of the economic analyses are addressed in the discussion section. The return of investments calculations were not possible due to (i) the difficulties and arbitrariness to attributing health effects to the RHIS; and (ii) the lack of reliable comparisons that could support those attributions. Nevertheless, we believe that this does not remove any weight to the argument supporting renewed efforts to design and implement the RHIS of the future (see work package 3).

1 Background and objectives

Despite the extensive literature related to Routine Health Information System (RHIS), there does not seem to be a widely accepted and standard definition of RHIS. We have adapted the following functional description of RHIS: "RHIS collect health service data directly from the health facilities, by the health care workers. It provides frequent (e.g. monthly) and/or almost real-time information on service performance and quality at all levels of the health system, enabling regular progress monitoring and timely identification of problems and address them. RHIS creates an integrated environment for programme specific and cross-cutting data use"[1]. Our definition of RHIS is as follows:

> **A RHIS is the conjoint of resources and activities, operating as a stand-alone functional structure, integrated within the wider national health system, which comprises all data management, analytical and use processes related to the data generated in and supporting every clinical care or public health event.**

While the reporting aspects of the RHIS have been highlighted for years [2] and with this the importance of the quality of data [3], the use of the RHIS data for decision-making and quality improvement, while also often mentioned, has been less prominent [3, 4]. A good RHIS is rooted in data collected at service delivery points and, hence, should support and enhance the clinical work of the front-line health workers and management efforts to optimize such work, thus potentially having a large return on investment. Making the case for investment in RHIS is a useful approach to advocate for investments in RHIS by Ministries of Health defending their budgets, donors and the international health community. We understand the call from the World Health Organisation (WHO) on "Making the case for investing in Routine Health Information Systems (RHIS) to achieve the health-related SDGs" as a contribution "to develop and adopt a common framework and good data governance practices underpinned by a globally unifying set of principles that build on or adapt WHO's data principles" [5].

There is scant evidence on the links between availability of data and decision-making [2], and there are studies that did not find a clear link between data availability and decision-making [6]. Others point at the overload of indicators to governmental health information systems [7]. How the RHIS, especially the registers in the health facilities, can support health workers in their clinical work, public health work and managerial work is often overlooked but it is a paramount aspect of the RHIS - an aspect that has great potential to improve the quality of services, and, thus, reduce morbidity and mortality [8].

In order to inform the *Health Data Collaborative* and WHO on return of investments of RHIS, we have produced a scoping review, reported elsewhere; and, in this document, a series of country case studies. The case studies aim at providing evidence on programmatic, financial and economic aspects of the RHIS in a variety of countries to build the rationale supporting considerations on 'how much' and 'how' to invest in RHIS.

2 Methods

2.1 Countries selection

We carried out case studies in a number of countries of different backgrounds and contexts. The number of countries to be selected was agreed with WHO. The criteria to reach a decision on the countries to select were:

- a mix of income status (high-, middle-, low- and fragile countries);
- a mix of regions;
- a mix of health systems settings;
- with known investments in RHIS;
- willingness to participate in sharing data and information on the RHIS and outcomes.
- availability of secondary evidence e.g. evaluation studies

We did not attempt to differentiate between urban and rural settings, private and public settings, or particular settings such as army health services or any other factor that varies at sub-national level, since our unit of analysis was the whole system. However, where disaggregated information exists, we have captured it. Actually, we have included two sub-national settings: Cross River state in Nigeria and Western Cape in South Africa. Countries or areas that were approached but that did not engage in this study were: were Catalonia, Chad, Laos, the Philippines and Switzerland.

In each of the identified countries, we set up a team of experts. For each country, Memoranda of Understanding (MOU) between the Swiss TPH-led consortium and the country teams was signed.

The case studies were informed by the frameworks identified in WP1, the experience of the team, existing literature known to the research team and additional literature provided by stakeholders.

2.2 Data collection

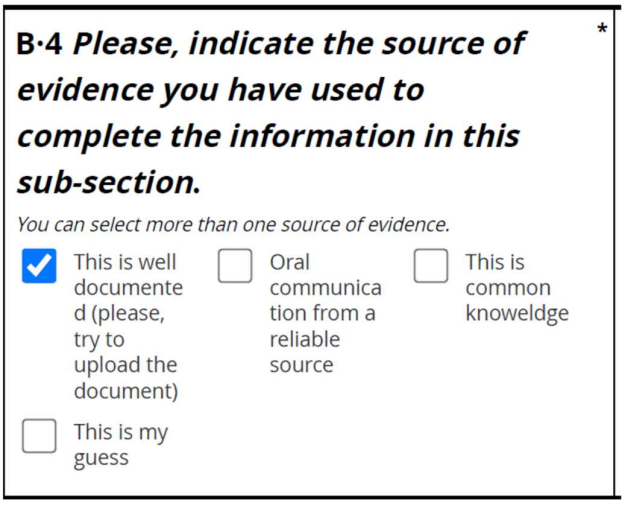
We have used our own experience and several sources [9, 10, 11] to list the data items required for this work. The methods used for data collection are: a desk review of relevant documents in the countries and gathering secondary data provided by partners and the Ministry of Health. We built a data entry XLSForm (details can be found in Annex 1), which was piloted in Nigeria and South Africa and further adjusted. The form was implemented for a computer web-browser. All data has been labelled and stored in 'csv' files.

In each of the countries we selected experts known within the extensive network of the Swiss TPH and the SAMRC. Criteria to consider experts included:

- knowledgeable and with first-hand experience in the health system and RHIS in the country;
- capacity to liaise with WHO, Ministries of Health and key stakeholders in the country;
- access to IT resources to efficiently manage online forms;
- known track record of producing good quality technical products related to health.

All sections in the XLSForms had a question to report on the sources used to address that section. A snapshot of this type of questions can be found in Figure 1.

Figure 1. Question to report on the sources of evidence in the XLS form.



2.3 Narrative and descriptive analyses

The unit of analysis is the country-system and we have reported subnational data where available. For each country-system, we offer a narrative description of the structure, organisation and size of the system. We will describe the overall investments by level of care (e.g. primary, secondary) and sub-system. We calculated summary estimates for quantitative data and carried out narrative syntheses for qualitative data.

Several data sources were used for population estimates [12], health expenditure [13] and health workforce [14].

2.4 Economic analyses

The economic analysis in this report draws on estimates from the literature [15], on the economic consequences of amenable mortality, using two economic approaches that include the value of lost output, which serves as an indication of gross domestic product (GDP) losses over the period between 2015-2030, and the value of lost welfare, reflecting losses within the 2015 year. In order to calculate amenable deaths, the authors extracted the number of cause-specific deaths by each country, age and sex from the 2015 estimates of the Global Burden of Disease study [16]. The number of unavoidable deaths was estimated by assuming that the lowest case-fatality rate at the regional level represented the best-case scenario that could be achieved in each country with regards to the access to health care services and the quality of care received. The preventable and unavoidable deaths were then subtracted from the total death estimates derived from the GBD study to reflect amenable mortality estimates.

Value of lost output estimates in the study were calculated using the WHO Projecting the Economic Cost of Ill-health (EPIC) tool that models the relationship between labour force and total available capital stock with projected GDP at the country level. The analytical approach focuses on the market-based components of the macroeconomic impact of disease and mortality, and

therefore has been argued in the literature to provide only a partial estimate of the full impact of disease or injury on economic welfare.

Conversely, the Value of Statistical Life (VSL) is an estimate of the monetary value individuals place on changes in their risk of mortality. Value of statistical life estimates for LMICs were calculated using the ratio of gross national income per capita (GNI) as a conversion factor to transfer VSL estimates from high-income countries where such empirical studies have been undertaken. A critical parameter for transferring VSL estimates is the "income elasticity of VSL" (IE-VSL), which reflects how VSL changes in proportion to the relative income of two countries. Increasing the IE-VSL results in decreased VSL estimates when transferring to low- and middle-income countries. Although IE-VSL's of 0.5 to 1.0 have traditionally been used when transferring estimates from high-income countries to LMICs, some have argued that an IE-VSL of up to 1.5 may be more appropriate for low-income countries. This study uses an IE-VSL value of 1.0. VSL was then applied to value years of life lost (YLL) due to amenable mortality at the country level.

For the value of lost output over the period 2015 to 2030, we calculated the average annual losses that would be incurred and compared it against current annual investments for health information systems in the country. No conversions were required between International Dollars and USD for this period. In order to compare the value of lost welfare due to amenable mortality, 2015 International dollars were converted to each country's local currency and inflated (according to each year's inflation year) to reflect 2022 values. Values were then reconverted back to International Dollars based on the average exchange rate for each country in the 2022 year and compared against current RHIS investments in each country. No conversion rates were required between International Dollars and USD, given the one-to-one exchange rate. The value of lost welfare due to amenable mortality was then compared against HIS investments. Whilst amenable mortality that could result from improvements in the receipt of high-quality care reflects a complex interplay across all health system building blocks, health information systems are hypothesised to play a key role in the identification of individuals in need of care and the facilitation of population access to adequate service delivery. We also calculated the per capita investments in HIS across the selected countries and explored the relationship between this and the Healthcare Access and Quality Index scores for each to determine whether countries reporting higher per capita investments reported higher index scores.

2.5 Ethics

There are no human participants involved in this research. All data collected in this study was retrieved from existing data-bases and documents. Data that related to health care delivery events was aggregated and no individual data was needed. The other types of data refer to the use of resources or processes descriptions. Hence, there are no subjects to provide consent to be approached for these studies. All data will be stored on Swiss-based servers, including the Swiss TPH server.

Nevertheless, we obtained ethical clearance from the WHO (ERC.0003876), South Africa (EC002-2/2023) and from South Sudan (no case number).

3 Findings

3.1 Health information systems settings and context

3.1.1 The legal framework supporting RHIS

Country experts were asked to report on the legal framework that may support information systems, including RHIS in the countries.

In Colombia, there are several laws and policies, including Law 9 of 1979, Law 100 of 1993, Law 1151 of 2007, and Law 1438 of 2011. Recently, in the framework of digital transformation, several documents were released, including the CONPES 3975 of 2019 National Policy for Digital Transformation and Artificial Intelligence, the National Policy for Data Exploitation (Big Data) (CONPES document 3920 of 2018) and the National Digital Security Policy (CONPES document 3854 of 2016).

In Côte d'Ivoire, the law 2013-537 verses on the organisation of the national statistical system

Nepal's National Health Policy of 2019 outlines the development and management of an integrated HMIS at all levels, strengthening of existing surveillance systems, and ensuring the security and privacy of health information.

Nigeria has the National Health Act 2014 and a single integrated but decentralised national routine database hosted at FMOH/DPRS on the DHIS platform and harmonized NHMIS (version 2013) tools for data collection and reporting.

South Africa has the National Health Act (Act 61 of 2003) that mandates the establishment, implementation, and maintenance of information systems at various levels. DHIS is an integrated aggregated service delivery information system used to monitor health sector performance and meet regular statutory reporting requirements. Particularly Section 74 of the National Health Act (Act No. 61 of 2003) states that the National Department of Health must facilitate and coordinate the establishment, implementation and maintenance by provincial departments, district health councils, municipalities and the private health sector of health information systems of the national, provincial and local levels in order to create a comprehensive national health information system. Every district health council and every municipality that provides health services must establish and maintain a health information system as part of the national health information system as contemplated in section 74. This also implies that District Health Information Committees must be established in districts and that a structured feedback mechanism between districts and provinces be established.

In South Sudan, there currently is no existing legal framework that supports RHIS. The MoH is working closely with the regional body to develop a legal framework for data and RHIS in the coming period.

3.1.2 The legal framework for data protection

Colombia's Law 1581 of 2012 defines personal data categories and principles for processing, with exceptions for national security and money laundering control. Also, within the framework of

population surveys, there is a guideline for the anonymization of data of the national system of population studies and health surveys of the Ministry of Health and Social Protection.

Côte d'Ivoire has a data protection law from 2013 (law 2013-450).

Nepal has the Privacy Act, 2018 (2075) and the Privacy Regulation, 2020 (2077), major laws that deal with the privacy of the person. The Information Technology Act is currently under development and will include clauses regarding the collection of digitized personal data and its security and protection. These are general laws and regulations not specific to health information. A comprehensive personal health specific data privacy and protection law that includes consent, notification requirement, formation of data protection authority, right of data subject, data localization, cross-border transfer of data, data protection officers and data beach penalty is required.

Nigeria has data protection provisions in the NHMIS Policy 2014, Nigerian constitution, Nigerian Medical Code of Ethics, and National Health Law 2014, with limited awareness and a need for education and capacity building.

South Africa's Constitution and Bill of Rights protect privacy, and data protection and privacy are governed by the Protection of Personal Information Act, 2013 and the National Health Act, 2003.

In South Sudan, there is currently no legal framework for data protection. MoH in collaboration with IGAD (the Intergovernmental Authority for Development of the African Union) has started the process of developing a legal framework. What is being used to protect data is the SOPs and other policy documents that spell out how to protect data. In addition, the MoH has now established the Review Ethical and Research Board (RERB) which also protects research data.

3.1.3 Historical hallmarks of the RHIS in the country

Countries experts were also requested to provide the recent historical hallmarks that may help to understand the current status of the RHIS, again without necessarily focusing on the RHIS, since key events are likely to involve several and related information sub-systems.

In Colombia, there have been several hallmarks, including the implementation of the Integrated Social Protection Information System (SISPRO) in 2007, the establishment of national health observatories in 2011, the adoption of the National Digital Security Policy in 2016, and the development of a National Policy for the Exploitation of Data (Big Data) in 2018. In 2019, Colombia established the National Policy for Digital Transformation and Artificial Intelligence, and a strategic plan for information technologies. In 2020, a Digital Transformation Plan and Quality Plan for the information component were created, and in 2021, Resolution 866 was implemented to improve medical record interoperability. In 2022, the country conducted its first medical record interoperability test (so-called ‘Conectaton’).

In Côte d'Ivoire, DHIS2 was launched in 2014 with rapid adoption and use of this DHIS2 software with scaling up to all health districts and regions by the end of 2015.

In Nepal, before 1994, health information was collected separately from each health program using over 100 registers and reporting forms. In 1994, the Health Management Information System

(HMIS) was established to collect data from public and private health facilities. Since 2013, online data entry using proprietary software was introduced, and subsequently migrated to the DHIS2 platform. The integrated HMIS (iHMIS) generates information for over 200 indicators. iHMIS is part of the Management Division in the Department of Health Services under the Federal Ministry of Health and Population, and produces annual reports based on iMIS data that form the primary means of disseminating HMIS information. In 2022, the iHMIS roadmap was endorsed, which outlines its future vision and course of action.

In Nigeria, the National Health Management Information System (NHMIS) was established in 1999 and reviewed in 2004 and 2014. The web-based DHIS2 was introduced in 2010 and by 2014, it was implemented in all 36 states. In 2013, the Federal Ministry of Health reviewed its progress on HMIS based on the World Health Organization's Framework and Standards for National Health Information Systems. In 2014, the Nigeria Health Information Policy and National Health Information Management System Strategic Plan (2014-2018) was formulated as a roadmap for strengthening the health information system. In 2015, the National Health ICT Strategic Framework (2015–2020) was released, which is the current national e-health strategy.

In South Africa, the use of DHIS for routine health management started in the year 2000. Between 2011 and 2014, the District Health Information System 1.4 (DHIS1.4) software was customised to meet South African Health Information System (HIS) requirements. Between 2014 and 2017, South Africa prepared for and initiated a transition of the DHIS1.4 routine health information system to a web-based version (DHIS2). The National Department of Health continued the webDHIS transition between 2017 and 2020, institutionalizing the skills to use the system and data within the sector. Since 2020, the focus has been on webDHIS hosting, maintenance, and configuration of the system. Automation of data processing, synchronisation of Provincial and National data files, custom software development, and Health Analytics dashboards were developed for NDoH Programmes, management, and decision-making.

In South Sudan, over the past ten years, MoH was running DHIS1.4 to manage data from facilities. It has many challenges, and these have created vertical reporting by programmes and donors and poor reporting through the DHIS1.4. Reporting from the health facilities was paper-based, and the reporting rate was also low. Around 2018 and 2019, the MoH started to migrate to DHIS2 and embarked on rolling it out. Currently, the MoH is working with the partners to ensure that HIS is integrated. The rollout has been going on to this date. There has been a distribution of tablets to health facilities across the whole country to facilitate reporting from facilities to the DHIS2. In 2022 and 2023, there have been increased resources to support and strengthen the data systems.

3.1.4 Integration of the RHIS in the health system and programmes

In Colombia, one of the problems of the routine health information system is the integration of its different components, since there are multiple sources of information and in many cases there is duplication in the data provided. Also, there are difficulties in integrating the different components of the routine health information system, particularly in peripheral territories with geographical challenges.

In Côte d'Ivoire, university hospitals and specialised institutes are not integrated into the DHIS2 database, and some health programs are not integrated. The army and police health sub-systems are partially integrated.

In Nepal, iHMIS is a DHIS2 based online platform that covers different health service programmes, with prescribed formats for reporting and a high rate of reporting from health facilities. Even for those health facilities that do not have online access, their data is entered through municipality or district health office on their behalf. iHMIS covers different health service programs (e.g., MCH, HIV, malaria, immunization). Some programs (e.g., TB, HIV) have vertical data collection systems, but they also populate the iHMIS with monthly reports online.

In Nigeria, all data are incorporated into the NHMIS except HIV data. There is a pathway for integration of data from the primary level to the federal level, but reporting rates from programs are low due to parallel program-specific systems. In Cross River State of Nigeria, all health facilities report to their LGA M&E office, where data are entered into the DHIS2 before day 15 of the month. State and federal M&E officers complete their report by day 26 of the month. The pathway for integration of data was described as follows: (i) at the primary level, at the periphery, data are produced by health facilities: Village Health Workers (VHW) and Community Health Extension Workers (CHEW) report monthly to the PHC centres. The PHC centres in turn submit a monthly report to the LGA; (ii) at the LGA level, digitalisation of data takes place; according to guidelines, data is entered into the DHIS2 platform by the LGA M&E officer; Entered data are saved on a server, with FMOH and NPHCDA having administrative access rights for all levels; the State has administrative access to all the data from the LGAs under it and the LGA has access to its own data in the server; (iii) the DHIS2 focal person at the SMOH (State Ministry of Health) sends twice a year reports to the Federal level, i.e. the DPRS (Department of Planning, Research and Statistics) receives summary data from the LGAs. Nigeria's reporting rates from programmes are low as a result of parallel program specific systems at play. Fragmentation of data systems due to parallel government and non-government supported programs has been a major impediment towards establishing a robust national and sub-national health data repository.

In the Cross River State of Nigeria, all health facilities (whatever their level - primary, secondary or tertiary) report to their LGA M&E office (by day 3) where data are entered into the DHIS 2 (before day 15 of the month). The state and federal M&E officers complete their report by day 26 of the month.

In South Africa, TB and HIV data are exchanged with TIER.Net and EDR through exports from the source systems and then manual importing to WebDHIS through the user interface. The importing of EDR.web data is done quarterly at the national level. For TIER.Net, TB data is exported and imported via the webDHIS Provincial Integrated database frontend at the sub-district level.

In South Sudan, integration across the different levels of health services has made progress. The PHCU (Primary Health Care Units), PHCC (Primary Health Care Centers), and county hospitals report through the county health department. The plan of the MoH is to have integrated programmes, and there has been documented achievement towards that. The eLMIS (electronic logistic management information systems) and the laboratory Information system are also working

on strengthening the routine information system and using interoperability to share and coordinate data integration. In the coming years, the plan is to integrate all of these. COVID-19 and other emergency epidemics are also integrated into the DHIS.

3.1.5 RHIS planning and coordination

In Colombia, data from different subsystems are provided by individual professionals and facilities at the peripheral level, then received by municipal, district, or departmental secretaries. The Ministry of Health and Social Protection makes strategic decisions at the national level, supported by the National Institute of Health.

In Côte d'Ivoire, coordination is based on three levels: (i) the national level, which defines the policy and strategies to be implemented for the animation of the HIS; (ii) coordination at the regional level with the coordination of health directors in charge of monitoring the HIS strategies; and (iii) the district level, which is the operational level in charge of the execution and implementation of the HIS strategies.

In Nepal, the RHIS (called HMIS in Nepal) is under the Management Division of Department of Health Services (DoHS) of the Ministry of Health and Population (MOHP). There is a team of twelve staff members at the national level and smaller teams at the province and municipality levels. Strategic decisions are made by DoHS/MoHP and the HMIS section makes technical decisions, with input from the provincial health directorate as necessary. HMIS section represents to national M&E Technical Working Group, where matters related to data, indicators and analysis requirements are discussed.

In Nigeria, the RHIS is coordinated by the Federal Ministry of Health/DPRS on the DHIS2 platform. The National Health Data Governance Council oversees the administration of the National HIS while state level HDGCs provide advisory support. At the LGA level, the LGA focal person collates data, and the data is entered into the national instance of the DHIS platform by the LGA M&E officer. The State M&E officer carries out validation of data entered on the DHIS and provides feedback to the LGAs and facilities. At the national level, data is analysed quarterly based on predetermined indicators.

A National Health Data Governance Council (HDGC) oversees the administration of the National HIS while state level HDGCs chaired by Commissioners of Health oversee the administration of the HIS at the state level and provide advisory support to the national HDGC. The state HDGC is also meant to design-in the interests of each state into the national HIS infrastructure.

The National Health Information Systems of South Africa (NHISSA) Committee plays a critical role in the implementation of RHIS initiatives in the country. It operates as a subcommittee of the Technical Advisory Committee of the National Health Council (Tech NHC). NHISSA helps to overcome implementation challenges and monitors the progress of provincial implementation of key interventions. It provides a platform for feedback on strategic projects presented to the NHC during conceptualization and implementation.

In South Sudan, the overall coordination is in Juba (the capital city) through a technical working group led by the MoH. Implementers and technical partners are all members. A similar structure is set up at the level of states, but this still remains to be strengthened.

3.1.6 Roles and responsibilities of key staff in relation to the RHIS

In Colombia, the Ministry of Health and Social Protection generates national health policies and strategic documents, while health secretariats conduct health situation analyses and territorial health plans. Health service providers are responsible for individual risk management and must comply with national guidelines.

In Côte d'Ivoire, healthcare providers are responsible for filling in the primary tools (registers) during consultations. In each facility, the data manager is responsible for preparing the monthly facility reports. The manager/head doctor then validates the monthly report of the facility for transmission of data to the district. In the district, the Epidemiological Surveillance Officer handles the data and makes sure they are sent to the higher level.

In Nepal, iHMIS directors at the federal level oversee operations and data entry, while statistical officers verify data, draw indicators, and communicate with the federal iHMIS. At the provincial level (Provincial Health Directorate) the information unit is responsible for all iHMIS activities for the province. One or more statistical officers are responsible for: (i) verification of data entered into the iHMIS by the health facilities at the province; (ii) drawing (disaggregated at province and district levels) indicators and relevant information and support to the program management; and (iii) communication with the federal iHMIS. At the municipality level the municipality reports are generated and monthly reports received from health facilities where online reporting is not possible are entered online.

At the hospital level, medical recorders are responsible for collecting and entering monthly reports online into iHIMS. They are also responsible for analysing the data at their respective facilities.

At the health service centres, there is no designated information person. These are very basic government centres with only three staff. A large number (more than 50,000) of Female Community Health Workers, FCHVs are there. Usually, the in-charge of the health facility prepares monthly reports of services and activities of the centre along with the data from the community level (Community Health Units and FCHVS) under its supervision. FCHVs and other community workers fill in the service registers.

In Nigeria, LGA M&E officers collate data from private health facilities, while a health worker or focal person completes tools and forms (such as monthly reports) at the facility level. M&E officers validate and analyse data at the state level and give feedback to decision-makers and partners. At the national level, DPRS staff analyse data and assess data quality, and feedback is given to the Commissioners of Health/Directors of Public Health/Directors of Planning, Research and Statistics in States' Ministry of Health every quarter.

Cross River State of Nigeria: health workers at facilities complete monthly summary forms and send them to the M&E officer in the LGA who validates and enters the data into the DHIS 2

platform. The state M&E officer analyses the data and provides feedback to decision-makers, partners, and the FMOH.

In South Africa, ownership of the DHMIS is divided among the national, provincial, and health district levels. The Director-General of the National Department of Health regulates access to DHMIS data and mobilizes resources for information management. The Head of Department and District Manager at the provincial and health district levels, respectively, regulate access to DHMIS data and are responsible for mobilizing resources for improving information management. DHMIS implementation progress and information trends are regularly discussed in District Management meetings and reported to the provincial DHMIS management unit.

In South Sudan, at the facility levels there are the data clerks whose roles are to capture data and enter into the DHIS. At the level of counties and state, the MoH staff roles include supervising the process. Analysis is done at the national level of the through DHIS.

3.1.7 Alignment of the RHIS with information international standards

Colombia's Ministry of Health is in the process of digital transformation and adheres to international health regulations. Its operational components include the International Family of Classifications, which includes ICD 11, the International Classification of Functioning - ICF, the International Classification of Health Interventions - ICHI, Other WHO Classifications, and the WHO Collaborating Centre in Colombia (which can be accessed from SISPRO).

Côte d'Ivoire's RHIS is based on the district approach formulated by WHO.

Nepal's HMIS uses ICD-10 codes and DHIS2 platform. It collects data as per WHO recommendations in specific disease surveillance and data to measure progress towards health-related SDG goals.

Nigeria's NHMIS uses WHO-recommended tools and techniques to monitor the performance of the HIS (such as DHIS2 and WHO Data Quality App and Analytical Packages).

South Africa has developed its own eHealth standards, the HNSF, updated in 2021. It provides guidelines for interoperable eHealth systems, and its RHIS standards are based on WHO's Framework and Standards for Country Health Information Systems.

In South Sudan, IGAD is supporting the country to align some of the key indicators with international standards of information and data management.

3.1.8 Effects of the COVID-19 on the RHIS

In view of the pandemic, in Colombia, both the generation of data at the peripheral level (reporting of cases) and the flow of information to the central level (reporting times, processing speed, new data collection strategies such as mobile apps) were reinforced, including capacity to respond to increased consumption of health resources and distribution of human resources. It also led to investment in health sector and development of applications such as MiVAcuna and coronaapp. However, other health events ceased to be reported in a timely manner.

With the advent of COVID-19, the HIS in Côte d'Ivoire was confronted with the creation of another database managed by an entity other than the DIIS and also other than the Ministry of Health, to manage the COVID-19 data, thus creating a parallel system and weakening the functioning of the HIS.

In Nepal, COVID-19 led to the establishment of an Information Management Unit (IMU) to strengthen and operationalize integrated information management. IMU software was developed and rolled out nationwide to facilitate reporting of COVID-19 related information. MoHP used local companies' services, and has increased faith in IT and emerging technology.

In Nigeria, according to the WHO country report on Nigeria 2021, COVID-19 drastically affected the uptake of the revised NHMIS version 2019 tools. However on the whole, COVID-19 has not modified any aspect of the RHIS and it is yet to be captured on the NHMIS.

In South Africa, COVID-19 led to major disruptions in provision of routine essential health services. Supply side and demand side factors were key considerations, and risk adjustments to Continuity of Essential Health Services mandates were made to avoid system collapse.

In South Sudan, at the onset of the pandemic, the facilities managing cases of COVID-19 recruited additional data clerks for COVID-19 and were entering and recording COVID-19-specific data. As COVID-19 is no more priority, the move is to integrate it into the existing reporting system. Currently, COVID-19 vaccination data are also integrated into the DHIS2 data.

3.1.9 RHIS sub-systems

Colombia has multiple sub-systems including RUAF, SiHO, REPS, SIPE, ReTHUS, MIPRES, MiVAcuna, Massive Survival Consultation, RUAFND, ICD 11, ICF, ICHI, WHO Collaborating Centre, and the Public Hospital Alerts and Monitoring System. These systems cover areas such as affiliations, hospital management, health service provider registries, economic benefits, human talent in health, prescription reporting, vaccination registration, vital statistics, hospital monitoring, and classifications.

Côte d'Ivoire has various sub-systems including monthly SIG reports, logistic order reports, community reports, DHS2, ESIGL, OPEN Elis, SIGDEP, MSupply, and MAGPI. For the partners, there is DATIM (DHS2) for PEPFAR and COMCARE for the community component of PEPFAR.

Nepal has various health information systems including IMU (COVID-19 system), eLMIS, eTB register, and SORMAS (Surveillance Outbreak Response Management and Analysis System) (under piloting), as well as systems for laboratory management, disease surveillance, health insurance and health facility information.

Nigeria and Cross River State also use the DHIS2 platform for electronic data collection, as well as maintaining health workforce and facility registries. NGOs and donors are expected to integrate their data with the RHIS system. At the level below LGA, electronic records are used in tertiary facilities but in general paper-based health facility registries and paper-based monthly reports are used.

South Africa uses the District Health Information System to collect data on public health services.

In South Sudan, the RHIS is managed at the national level by the MoH. Reports are received directly from the health facilities into the system and are digitalized (have moved out from paper-based reporting). There is a technical working group led by MoH that meets regularly to discuss issues related to data. The ministry currently has plans for 2024 to roll out health human resource information systems (currently, the human resource information system is a national one being managed by the Ministry of Labour). Currently, there are no electronic medical registries, but plans exist for this in the main hospitals.

3.1.10 Technical standards

Colombia has a quality plan for information components with continuous monitoring and validation of data quality through various dimensions completeness, accuracy etc.).

Côte d'Ivoire sets a minimum completeness of 90% and a desired accuracy of 100% (+/- 10%) for RHIS data.

Nepal has a guideline for routine data quality assessment and sets quality standards.

Nigeria and Cross River State of Nigeria have technical standards for the RHIS described in their Standard Operating Procedure and NHMIS instructional manual guidelines on training.

South Africa uses the South African Statistical Quality Assessment Framework (SASQAF) for RHIS standards.

South Sudan has technical guidelines that include: (i) reference Indicators guidelines; (ii) SOPs for different programmes and activities; and (iii) the RHIS strategy. The SOPs clearly define how each of the systems should work.

3.1.11 The technical support mechanisms for RHIS

The Colombian government received advice and training from the Pan American Health Organization during the development of the information system.

In Côte d'Ivoire, the DIIS (Direction de l'Informatique et de l'Information Sanitaire) benefits from the technical support of HISP CI, and the hosting of the DHS2 server is done by SNDI under financing from the Global Fund. Measure Evaluation provides support for the evaluation of the SIS with the PRISM tool, while PEPFAR and the Global Fund support supervision missions, data consolidation meetings, and quality control. The World Bank provides financial support for the production of the annual health report.

In Nepal, there is an online RDQA system [http://rdqa.mohp.gov.np/resources]. This activity is supported by External Development Partners especially by UKAID through its NHSSP (Nepal Health Sector Support Program) project. It has training videos as well.

Nigeria and Cross River State of Nigeria: *Management Sciences for Health* through Presidential Malaria Initiative, Family Health Initiatives 360, Global Fund, WHO, UNFPA, and UNICEF provide various forms of support, including monthly data validation, funds quarterly DQA, integrated data management meetings, data situation room, RHIS evaluation and meetings, scorecards, capacity building, and training.

The South African RHIS gets CDC support through NDOH information systems partner, Health Information Systems Programme (HISP). The main areas supported include provincial database maintenance and data quality assurance.

In South Sudan, an increasing number of donors has shown interest in supporting and strengthening data and the RHIS. These are the Global Fund, PEPFAR, Health Pooled Funds (HPF) and the World Bank.

3.1.12 RHIS indicators dictionary

In all examined countries, a document that can be called RHIS indicators dictionary is available. In Colombia, the information is presented in national figures and disaggregated by departments and districts, in five groups of indicators:

1. Demographic, socioeconomic, mortality, morbidity, risk factors, supply of health services and social security, mortality indicators: 123 indicators.
2. Morbidity indicators: 86 indicators.
3. Socio-economic indicators: 17 indicators.
4. Demographic indicators: 23 indicators.
5. Indicators of risk factors, supply of services and health determinants (universal coverage, health status, social inequalities, regional differences): 49 indicators.

The indicator dictionary of Côte d'Ivoire contains 437 indicators (routine and survey indicators).

Nepal has an iHMIS indicators booklet (of 2016] with more than 200 indicators (the exact number could not be retrieved). There are, to present a few examples, 36 indicators on “safe motherhood”, 17 on immunization and 24 on HIV/AIDS.

In Nigeria, a national health indicator list and dictionary has been developed and approved by the Health Data Governance Council. The number of indicators could not be retrieved. The monthly reporting form used in Nigeria has 233 data entries.

In South Africa, the National Department of Health uses the National Indicator Data Set (NIDS), which is a minimum group of indicators introduced by the National Department of Health that every public health facility is expected to collect, use and report on. The number of indicators in NIDS is unknown, and the NIDS is revised every two years according to DHMIS policy.

In South Sudan, the indicator booklet contains 200 indicators. It is currently undergoing review.

3.1.13 Initiatives targeting RHIS

Colombia has multiple initiatives including the clinical history interoperability project, the Digital Transformation Plan, and the Strategic Plan for Information Technologies.

In Côte d'Ivoire three initiatives were reported: (i) a project to scale up the computerised patient file, (ii) a project for the interoperability of HIS applications, and (iii) splitting of the DIIS into two directorates (in accordance to a decree of 8 September 2021).

Nepal is working on integrating various sub-systems into iHMIS and establishing an interoperability lab.

Nigeria has several initiatives: (i) Basic Healthcare Provision fund that provides dedicated funds for health; (ii) scale up out of NHIS; (iii) introduction of new vaccination e.g. malaria vaccine requiring data updates or new data tools; (iv) digitalisation of tools and transition to electronic medical records in some tertiary institution; (v) brain drain and excess migration of already trained personnel including IT staff.

In South Africa, the HIV/AIDS Programme, due to its size and the number of indicators and data elements, may have an influence on the costs and performance of the RHIS.

In South Sudan, there is a plan to roll out the electronic medical records next year as a pilot project in big hospitals and gradually roll it out across the country. In addition, currently, there is the electronic recording and reporting of long-lasting insecticide-treated Nets (LLINs) distribution campaigns across the country, a new initiative happening for the first time. There is a cost implication, and initial reports show good results.

Noteworthy is that most initiatives focus on ICT interventions.

3.1.14 Reports on what worked and what did not work

In the table below, we have synthesised statements that point at positive features and challenges of RHIS in the countries. Despite that these statements have some degree of subjectivity, taken as a whole in each country are informative about what seems to work and what doesn't. Evidence on what works is better gathered from robust evaluations using research methods.

Table 1. RHIS aspects that work and aspects that do not work well in countries.

Country	Works	Does not work
Colombia	• The legal framework for supporting RHIS is updated[a] • A clear approach to RHIS planning and coordination • Technical support mechanisms • RHIS indicators dictionary	• The legal framework for data protection is not updated[b] • Integration of the RHIS in the health system and programmes: duplication happens
Côte d'Ivoire	• A clear approach to RHIS planning and coordination • Technical support mechanisms • RHIS indicators dictionary	• The legal framework for supporting RHIS is not updated • The legal framework for data protection is not updated • Integration of the RHIS in the health system and programmes: duplication happens

[a] The last update was not longer than seven years ago.

[b] The last update was longer than seven years ago.

Country	Works	Does not work
Nepal	• The legal framework for supporting RHIS is updated • The legal framework for data protection is updated • Integration of the RHIS in the health system and programmes: duplication is avoided • A clear approach to RHIS planning and coordination • Technical support mechanisms • RHIS indicators dictionary	• However, a mission of January 2023 found that some partners continue to support fragmented approaches. This can lead to increased reporting burdens, poor data and isolated unsustainable projects.
Nigeria and Cross River State	• A clear approach to RHIS planning and coordination • Technical support mechanisms • RHIS indicators dictionary	• The legal framework for supporting RHIS is not updated • The legal framework for data protection is not updated • Integration of the RHIS in the health system and programmes: duplication happens
South Africa	• Integration of the RHIS in the health system and programmes: duplication is avoided • A clear approach to RHIS planning and coordination • Technical support mechanisms • RHIS indicators dictionary	• The legal framework for supporting RHIS is not updated • The legal framework for data protection is not updated
South Sudan	• Integration of the RHIS in the health system and programmes: duplication is avoided • A clear approach to RHIS planning and coordination • Technical support mechanisms • RHIS indicators dictionary	• There currently is no existing legal framework that supports RHIS • The legal framework for data protection currently does not exist (but SOPs exist)

3.2 Overall measures of the health systems structure

One of the main features of RHIS is that it spans across the whole health system: from the health care delivery points, where clinical and public health events take place, up to the national level, through the intermediate health system tiers that, in terms of RHIS, are reporting levels.

We enquired about the 'size' of health systems tiers and the amounts of institutions delivering health care across the tiers. Figure 2 depicts several plots, one plot for each country, with three 'towers' in each: the first represent the health systems tiers, the second the distribution of health facilities in the governmental sector and the third one in the private sector. The numbers in the plot represent the amount of each corresponding entity described in the labels. In Côte d'Ivoire (second plot from top left corner) for example, the health system is structured in three tiers: central, regional and districts, with one national level, 33 regions and 113 districts. In the governmental sector, there are seven health care institutions of national scope, 20 regional hospitals, 102 general hospitals and 2,490 PHC centres. In the private sector, there are 12 hospitals and 947 PHC centres.

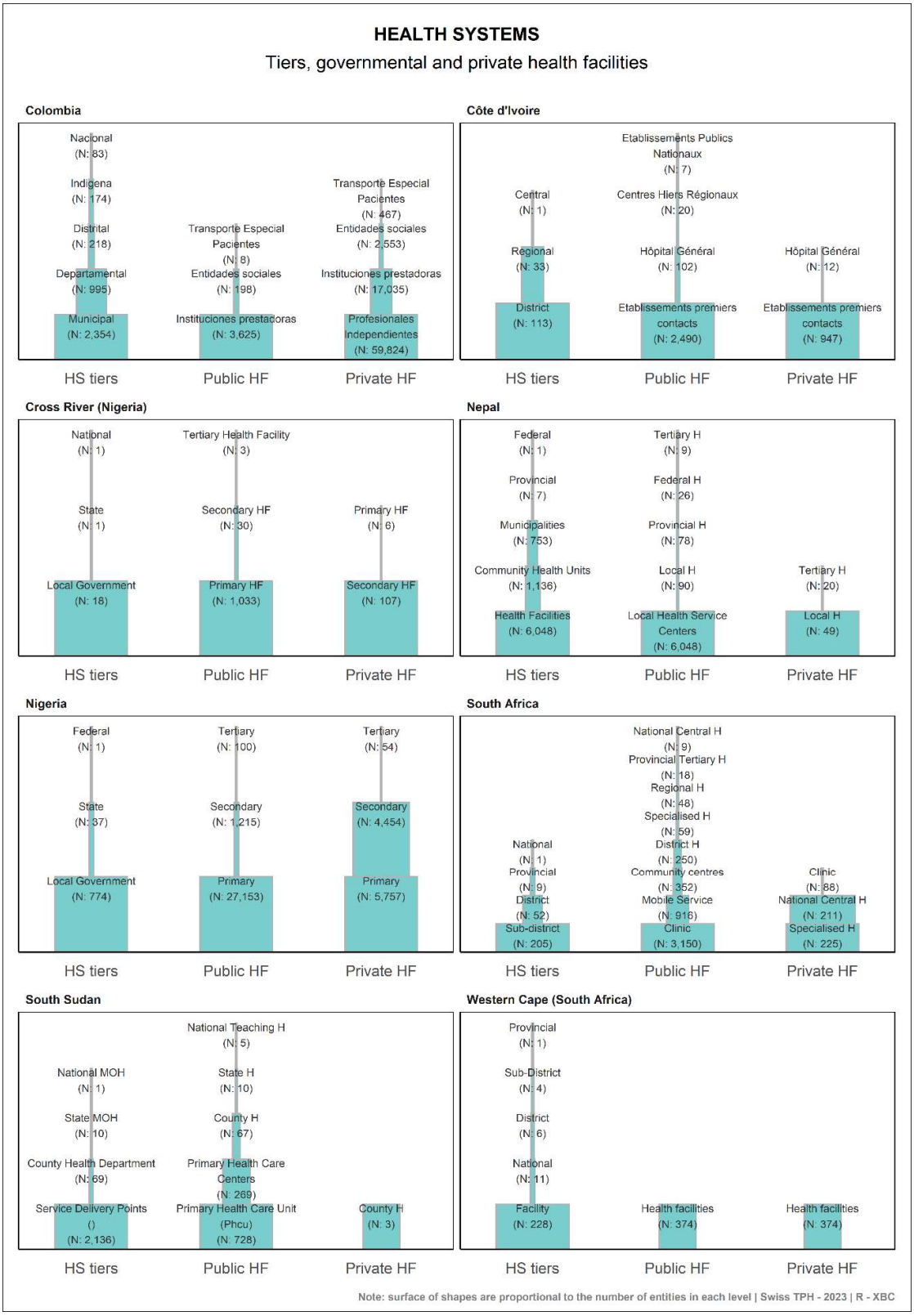
Countries typically have three tiers in the health system, except for Colombia and South Africa (in South Sudan we included the service deliver points). Colombia has the highest number of the most peripheral entities (2,354) representing a further peripheral tier around municipalities. It also has the particularity of a somehow parallel health care system, defined with the term 'indigenous'.

The types of health facilities do not necessarily reflect the whole scope of different types in each country because experts were requested to simplify and aggregate 'similar' types. The different interpretation of this instruction may explain the differences between countries, particularly in South Africa, where there were eight types of health facilities, from nine national central hospitals up to 3,150 clinics. Cross River state has much lower numbers because this is actually in itself a sub-national level in Nigeria, and Nigeria the largest number of PHC facilities (more than 27,000).

Interestingly and as expected, the least developed private health sector was found in South Sudan, a fragile state, with only three private county hospitals).

In summary, these numbers provide the foundations to interpret all other findings related to the RHIS: everything that is related to RHIS happens in thousands of entities, being tiers of the health system or health facilities providing care. Besides, although not explicitly described here, RHIS in countries are functional every day of the year without interruption.

Figure 2. Health systems tiers and health facilities by country and level.



3.3 Quality of care and information systems

Consistently with international initiatives, quality of care has been found to be a central issue in the health systems of the countries.

Nepal's Health Sector Strategy-Result Framework has as outcome 2 "Improved Quality of Care at Point-of-delivery" (as mentioned in the DOHS's Annual Report 2020/21). Nepal's Health Sector Strategy 2015 to 2020 has a whole chapter on quality of care, and also mentions the outcome 2.

The National Development Plan of South Africa (issued in 2015) outlined actions to improve the life expectancy and mentioned among other things (such as treating HIV/AIDS) improving the quality of care, health worker morale and leadership and innovation. South Africa's National Strategic Health Plan 2020/2021 to 2024/2025 acknowledges the importance of quality of care: "The Lancet Global and South African commissions have argued that high coverage (or access to care) is necessary but not sufficient to shift morbidity and mortality patterns. Better health outcomes and impact can only be achieved by ensuring that a high proportion of people receive care (coverage) that is effective (delivered at high quality). An effective health system is measured by its ability to provide reliable clinical care, and one that complies with norms and standards adopted by the system". The same document also acknowledges the importance of quality of care from the patients' perspective and states that various tools to monitor patient experience of care were implemented. Among the 5-year strategic goals of the Department of Health is "Improve the quality of care by setting and monitoring national norms and standards, improving systems for user feedback, increasing safety in health care, and by improving clinical governance" (Document National Strategy for integrated Monitoring and Evaluation, 2015).

In South Sudan's National Health Policy Plan 2016 to 2026, one objective is to "Institutionalize Quality of Care and Safety measures in health service delivery in all health facilities". Furthermore, the Ministry of Health was tasked to "Establish quality assurance and continuous quality improvement mechanisms to ensure compliance with set quality standards and improve quality through innovation".

The relation between quality of care and information systems was also found in several documents. On one hand, HIS are conceived as tools to measure quality in South Africa: the policy bill related to national health insurance (2019) mentions the need to collate the utilisation data and implement information management systems to assist in monitoring the quality and standard of health care services.

On the other hand, we found some indications that the information system can play a role in improving quality of care; for example, in Nigeria's "National Health ICT Strategic Framework 2015 to 2020", it is stated that the successful use of Health ICTs contributes to UHC achievements in Nigeria: "Improved quality of care through the effective use of ICT for decision support within the continuum of care ". The National Development plan from South Africa also formulates as a goal that: "Information systems are responsive to local needs to enhance data use and improve quality of care".

3.4 Availability and use of information sub-systems

In order to put the RHIS in the context of the data and evidence sources that are relevant to health care, we enquired about the availability and use of information.

In terms of sub-systems or data tools, we enquired about demographic data (e.g. population estimates), CRSV, master facility list, human resources information system, LIS, disease surveillance systems, dictionary with indicators, International Classification of Diseases, dashboards and a variety of data dissemination products.

Figure 3 depicts one plot per country and the corresponding expert opinion on the status of each sub-system or tool. All items at least existed in all countries, except the LMIS in Colombia and Human Resources in South Sudan. The LMIS was the least developed, being inexistent in Colombia and of unknown status in Nigeria and in Cross River state.

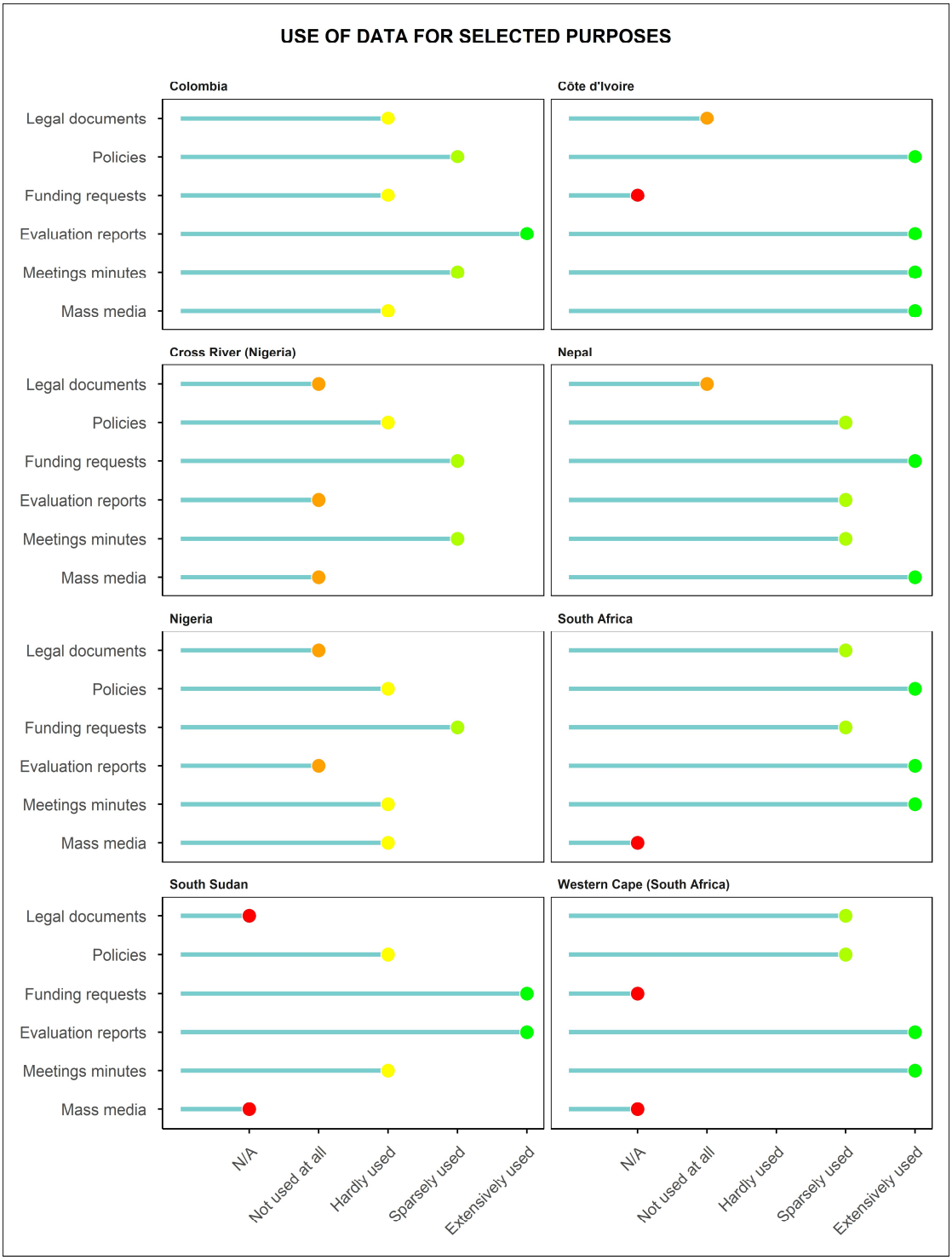
Demographic information is a crucial source of data to feed into estimates in many health information subsystems, providing denominators as well as other demographic data used to estimate population based indicators in health but also in many other sectors. Demographic information was 'very good' only in South Africa and Nepal and 'hardly usable' in Nigeria (including Cross River state) and South Sudan.

In terms of data use, we enquired about the presence of data in different types of documents: legal, policies, funding requests, evaluation reports, minutes of meetings and mass media. Figure 4 shows the expert opinion on data use, by country, showing a great variety of situations. Data seems very little used in legal documents across most of the countries, as well as in mass media. Only in one third of the observations was the use of information labelled as 'extensively used'.

Especially important is the data use in policy documents, to the extent that they define the types and distribution of services populations can benefit from. In half of the cases, data in policy documents was hardly used: Colombia, Nigeria (both in Cross River state and at national level) and South Sudan.

Figure 3. Expert opinion on the status of health information sub-systems by country.

Figure 4. Expert opinion on the use of data for selected purposes, by country.



3.5 Funding of the routine health information system

The data on budgets dedicated to RHIS and governmental expenditure on RHIS from the countries was limited. Yet, the available data provides some relevant findings. Table 2 shows the government health expenditure, collected from the Global Health Expenditure database and the budget dedicated to RHIS and external support to RHIS, both from the country responses. The annual budgets for RHIS reported ranged from 309,000 USD (Cross River state) up to 34 million USD (Colombia); this represents 0.1 to 0.2% of the government health expenditure, except for South Sudan, where a larger proportion of expenditure on RHIS was reported (7.84%). This large proportion in South Sudan seems to be more related to the paucity of governmental health expenditure (e.g. four time lower than in Nigeria and more than 100 times lower than in Colombia), rather than to large absolute investments in RHIS.

Likely budget figures do not contemplate the share of salary costs of health care providers of the time spent in the RHIS, which we estimate later on.

Table 2. Government health expenditure and governmental and external funding of routine health information systems.

Country	Government health expenditure (x 1,000 USD)[a]		Governmental budget RHIS (x 1,000 USD)		External support to RHIS (x 1,000 USD)	
	Absolute figure	Per capita	Absolute figure	As proportion of health expenditure	Absolute figure	As a proportion of RHIS total
Colombia	17,770,781	342.6	34,891	0.196%	N/A	N/A
Côte d'Ivoire	849,888	29.9	N/A	N/A	6,483	N/A
Cross River (Nigeria)	N/A	N/A	309	N/A	104	N/A
Nepal	520,428	17.0	N/A	N/A	800	N/A
Nigeria	2,201,788	10.1	2,309	0.105%	967	29.5%
South Africa	17,982,958	296.7	800	0.004%	200	20.0%
South Sudan	28,315	2.6	2,220	7.84%	3,820	172.0%

The reports on annual external support varied a lot between countries, without an obvious relationship with the overall government health expenditure, size of the health system or population, maybe reflecting reporting issues. The amounts ranged from 200,000 USD to more than six million in Côte d'Ivoire. Interestingly, the proportion of external support to RHIS was similar in Nigeria and South Africa (20% and 30%), and much higher in South Sudan, probably reflecting the current dependency on external support in the health sector, related to the fragility of the state.

Experts also reported some detail on the items being funded from external sources, which are listed in Table 3. There was a great variety of mixed or different items, including direct financial

[a] WHO Global Health Expenditure. Update 2022. https://apps.who.int/nha/database. Last updated: April 3rd, 2023.

support. Infrastructures and equipment stuff tended to be the largest contributors; training was also represented although within smaller amounts.

Table 3. External funding for routine health information systems, by type of items funded.

Funded items	Amount (USD)
Infrastructure, Software, Financial	5,167,993
Financial	1,640,722
Infrastructure, Software	543,500
Equipment, Software, Training, Financial	300,000
Equipment, Training, Financial	200,000
Software, Training, other	130,870
Software, Training	100,000
Equipment, Software, Training	55,451
Supplies, Incentives	54,350
Training	43,480
Training, other	35,870
Infrastructure, Equipment, Software, Supplies, Incentives, Training, other	32,610
Equipment, Training	21,740
Infrastructure	6,522

We also asked experts to provide a list of institutions that are known to provide support to the RHIS in the countries. These are listed in Table 4 and include the WHO in several countries. The largest donors reported in the case studies were the World Bank (Nepal) and The Global Fund in South Sudan. Of course, these also depend on the length of the funding among other factors.

Table 4. Examples of entities providing external funding for routine health information systems and amounts, by country.

Country	Organization	Amount (USD)
Colombia	No external support reported.	
Côte d'Ivoire	President's Emergency Plan for AIDS Relief	317,767
	Organisation des Nations Unies pour la Lutte contre le SIDA	23,186
	Fond Mondial	973,669
	Banque Mondiale	5,167,993
Cross River (Nigeria)	*Management Sciences for Health* through the Presidential Malaria Initiative	32,610
	World Health Organisation	21,740
	UNICEF	10,870
	United Nations Population Fund	10,870
	Resilience System Strengthening grant for health through the Global Fund	21,740
Nepal	Word Health Organization	120,000
	GIZ's Support to Health Sector Program	55,451
	Various USAID health projects in nutrition, supply chain, system strengthening of better health, Adolescent Reproductive and Sexual Health etc.)	300,000
	UKAID's Nepal Health Sector Support Program	150,000
	Various UN programs	50,000
	Japan International Cooperation Agency	25,000
	HIV/AIDS Programs of the Global Fund	100,000
Nigeria	Health Information Systems Programme Nigeria/Global Fund	543,500
	Global Fund	54,350
	World Health Organization/Global Fund/ United States Agency for International Development -Integrated Health Program	43,480; 326,100
South Africa	CDC Provincial DHIS support	200,000
South Sudan	The Global Fund	3,817,792
	World Health Organisation	N/A
	World Bank	N/A
	PEPFAR/USAID	N/A
Western Cape (South Africa)	No external support reported.	

3.6 Costs of the routine health information system

We asked experts to seek for or estimate the costs of the RHIS in their countries, across several categories or domains. We estimated total costs as outlined in the methods sections. Costs include staff, infrastructures, equipment and supplies, across the whole system and all governmental health facilities.

Total annual RHIS by country and range are shown Table 5 in thousands of USD. The mid-point estimates ranged from 290,000 USD in Cross River state (i.e. a subnational entity) up to 23 USD millions in Colombia. As explained in the methods we allowed a wide range of estimates in each domain, which is even more reflected in the totals, as shown in the table.

Table 5. Total annual costs of routine health information systems, by country and range (x 1,000 USD).

	Minimum	Mid-point	Maximum	Per capita (of mid-point)
Colombia	16,270	23,840	31,420	0.46
Côte d'Ivoire	9,960	11,560	13,150	0.41
Cross River (Nigeria)	210	290	360	0.07
Nepal	2,770	6,110	9,460	0.22
Nigeria	3,240	5,300	7,360	0.02
South Africa	3,800	8,220	12,640	0.13
South Sudan	260	280	310	0.03
Western Cape (South Africa)	37.670	37,890	38,120	6.3

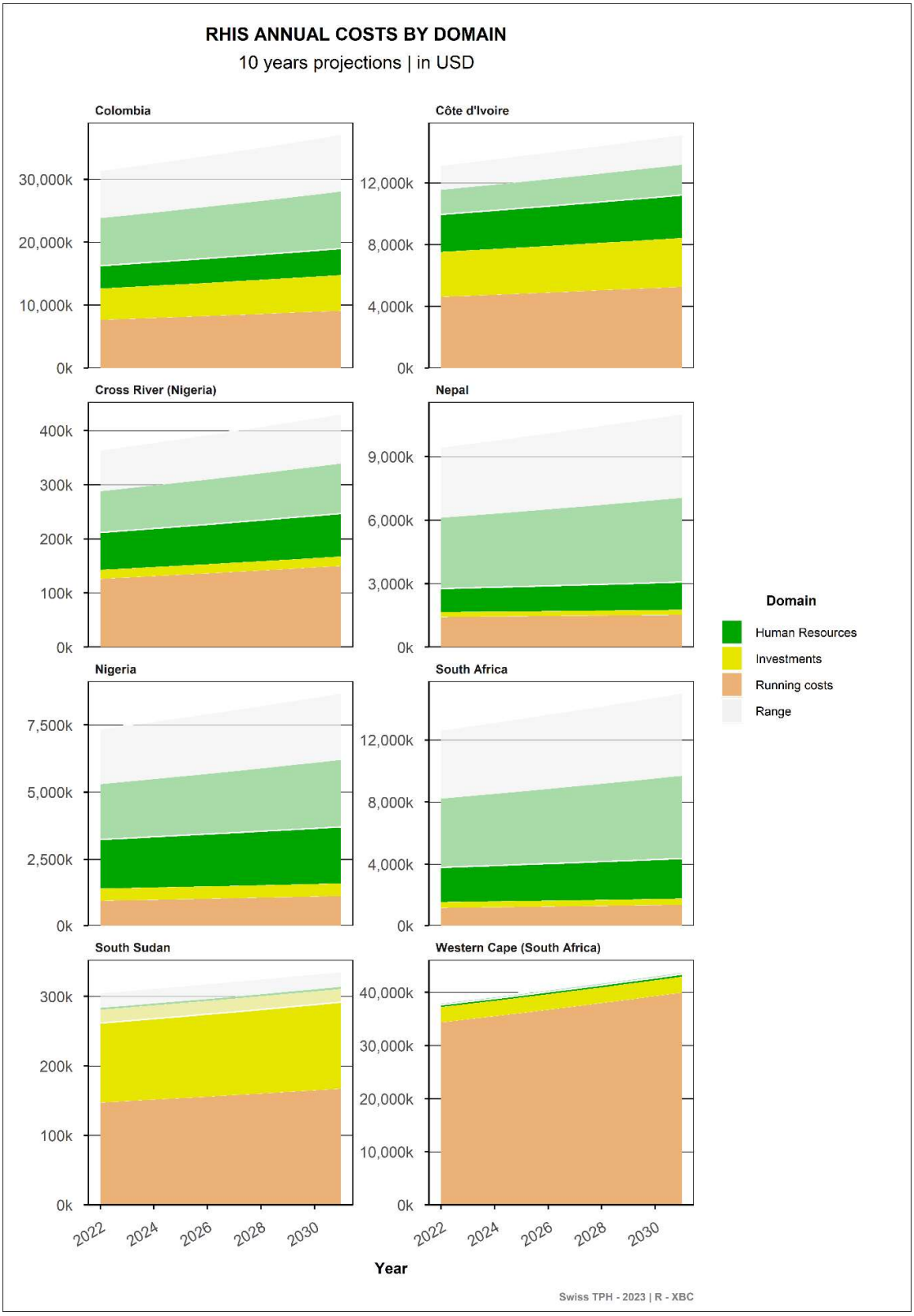
Looking at specific domains, in general human resources get the greatest share of costs, particularly in Nepal, Nigeria and South Africa. Figure 5 depicts costs across domains and countries, with 10-year projections.

Several data items do not seem to follow to overall trends. We briefly discuss them in the following paragraphs.

- Human resources account for a small proportion of RHIS costs in South Sudan and in Western Cape. In the case of South Sudan, this is due to the extremely low salary costs reported, which make the human resources costs almost negligible compared with the running costs, which count on external support as well. In the case of Western Cape, this is due to the extremely large amount of RHIS running costs reported.
- The overall costs for the whole Nigeria seem too low when compared with much smaller countries, such as Côte d'Ivoire. This is largely due to the smaller costs in Nigeria for human resources (i.e. salary costs are five times lower), investments and running costs reported.

Note that in Figure 5, the semi-transparent grey zone represents the minimum and maxim costs values for each country (the grey zone turn green into pale green in the overlapping areas).

Figure 5. Annual costs of the routine health information systems by domain and country.



The total annual number of hours estimated to be spent in the RHIS varies between countries and it is counted in the millions: from 19 to 33 million in Colombia and from half a million to one million in South Sudan. Looking at the number of hours per person and year spent in RHIS, it varies from almost 10[a] till 300 (median 115 hours).

We also estimated the salary total salary costs attributable to the time spent in the RHIS, shown in the last column of Table 6. These costs ranged from 2,300 USD in South Sudan up to more than 10 million USD in Colombia and South Africa. As discussed above, the low figures in South Sudan are attributable to the extremely low number of health workers and very low salary costs.

Table 6. Annual time (in hours) spent in the routine health information system across the whole system and per person and total annual salary costs share, by country.

	Health workforce (year)[b]	Total annual number of person-hours (x 1,000) spent in RHIS		Annual hours per person spent in RHIS		Annual salary costs attributable to time spent in the RHIS
		Minimum	Maximum	Minimum	Maximum	
Colombia	196,300 (2021)	19,288	33,080	100	170	11,000,000
Côte d'Ivoire	21,100 (2019)	6,997	9,849	330	470	3,950,000
Cross River (Nigeria)	N/A	1,302	1,949	N/A	N/A	142,500
Nepal	130,900 (2021)	7,298	10,944	55	85	4,370,000
Nigeria	418,000 (2021)	34,866	52,262	80	130	3,843,000
South Africa	335,500 (2018 and 2021)	3,054	7,916	10	25	6,580,000
South Sudan	4,137 (2018)	508	1,019	120	250	2,300
Western Cape (South Africa)	N/A	524	779	N/A	N/A	613,000

Looking at the time spent by types of staff (Table 7), nurses tend to spend more time than physicians. Data managers spend substantially less time in RHIS than physicians and nurses in Côte d'Ivoire, Nigeria, Nepal and South Africa, reflecting the unequal distribution of staff across the health system tiers: countries with more staffing constraints have less staff specialised in data management in the periphery of the system, where precisely the load of the RHIS is greater.

[a] Note that the high range of difference is attributable to the different denominators used in the calculations. To estimate the annual number of hours, we have used the average number of staff per health facility reported by the data collectors; in this table, we use the WHO database of health workforce.

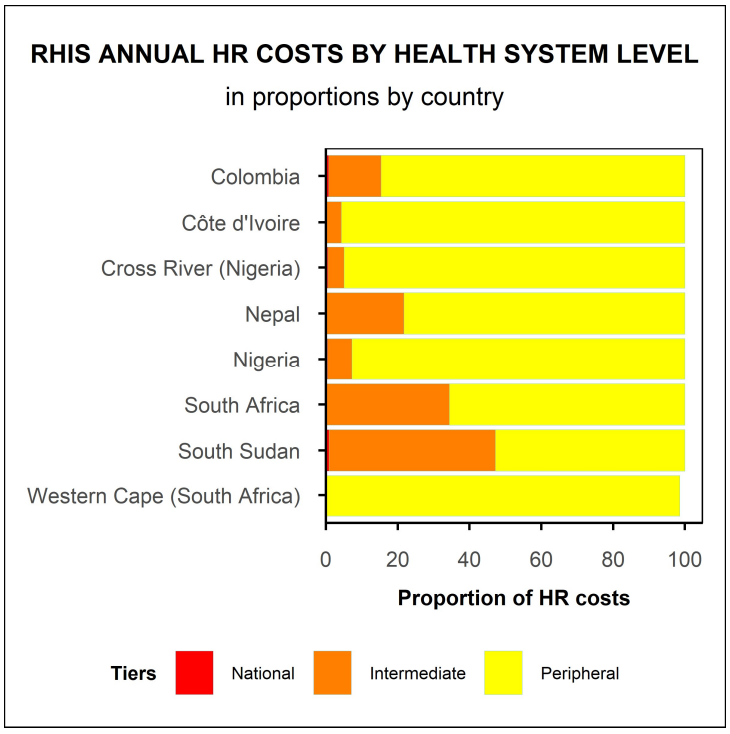
[b] https://www.who.int/data/gho/data/themes/topics/health-workforce. Medical doctors and nurses.

Table 7. Monthly time (in hours) spent in the routine health information system across the whole system, by type of health staff and country.

	Medical doctors		Nurses		Data managers	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Colombia	344,790	919,440	344,790	919,440	917,760	917,760
Côte d'Ivoire	207,344	362,936	362,852	436,184	12,857	21,626
Cross River (Nigeria)	810	1,290	106,180	158,820	1,470	2,340
Nepal	159,865	239,707	336,961	505,300	111,312	166,968
Nigeria	32,375	51,600	2,830,650	4,227,750	42,510	75,780
South Africa	19,430	36,570	203,452	580,428	31,620	42,660
Western Cape (South Africa)	7,480	14,960	11,220	14,960	25,000	35,000
South Sudan	8,648	17,430	10,710	21,420	22,970	46,045

Indeed, Figure 6 shows the proportion of RHIS costs by health system tier. Taking into account that most of the RHIS costs are attributable to the health workforce (Figure 5), Figure 6 suggests that the heavier load of the RHIS is being carried by health staff working at the periphery of the system, in the primary health care facilities, to a lesser extent in secondary care facilities and marginally at national level.

Figure 6. Annual costs of the routine health information systems by health system tier and country.



3.7 Economic analyses

The economic analyses findings are shown in Table 8 and Table 9 by country excluding the sub-national entities (i.e. Cross River state in Nigeria). Table 8 shows the foregone GDP in absolute and relative terms and the percentage of RHIS investments reported by countries; and Table 9 reflects the value of lost welfare in absolute terms in 2022 relative to the percentage of RHIS investments by countries. It should be mentioned that these are different economic approaches to measure potential economic losses due to poor health, and therefore data in each table should be explored independently.

There is a great variability of the annual[a] absolute *value of lost output* due to amenable mortality across countries (Table 8); from 679 million in South Sudan and 1.2 billion in Nepal to 18.1 billion in Nigeria. The *value of lost welfare* in 2015 (Table 9) ranged from almost 2 billion USD in South Sudan to 182 billion in Nigeria which represents between 5% and 26% of GDP across the countries. The estimates of the percentage of RHIS costs reported by countries in relation to the value of lost welfare were all below 1%, and really small in Nigeria and South Africa. In other words, the relative investments in routine health information systems across countries reflect very small proportions of the total value of amenable deaths that could be achieved through improvements in health services, e.g. improvements in the quality of care. Whilst quality of care is a reflection of broader health system functions beyond health information systems, current investments in health information systems appear to be inadequate to avoid all potential deaths and the resulting costs incurred in countries from lost welfare and will likely require increased investments in conjunction with improved services.

It should be noted that these analyses only look at lost output and welfare due to mortality, and do not account for all the morbidity effects of conditions and poor management, which will likely increase welfare losses substantially across modelled conditions.

[a] Annual average from 2015 to 2030.

Table 8. Value of Lost Output due to amenable mortality: Cumulative GDP foregone during 2015-2030 (millions, 2015 IND); Proportion of potential GDP lost due to amenable mortality in 2030.

Country	Foregone GDP during 2015-2030 (USD; millions)	% of GDP lost in 2030	Average annual losses (USD; millions)	2022 RHIS investments (USD; millions)	% RHIS vs foregone GDP
Colombia	54,270 (41,874 to 73,331)	0.6% (0.4% to 0.8%)	3,618	23.84	0.66%[a]
Côte d'Ivoire	42,728 (17,111 to 95,890)	2.7% (1.2% to 5.9%)	2,489	11.56	0.41%
Nepal	17,976 (7,604 to 29,508)	2.1% (0.9% to 2.8%)	1,198	6.57	0.51%
Nigeria	271,675 (131,948 to 591,789)	1.8% (1.0% to 3.8%)	18,112	5.3	0.03%
South Africa	262,308 (215,654 to 339,034)	2.4% (2.5% to 2.9%)	17,487	7.95	0.05%
South Sudan	10,180[b]	N/A	679	0.82	0.12%

Table 9. Value of Lost Welfare (VLW) due to amenable mortality (millions, 2015 IND) using baseline Value of Statistical Life (VSL) assumptions; VLW expressed as equivalent proportion of 2015 GDP and Value of Lost Welfare in 2022 USD.

Country	Value of Lost Welfare 2015 (USD; millions)	% of GDP	Value of Lost Welfare 2022 (USD; millions)	Cost of RHIS 2022 (USD; millions)	% RHIS vs foregone welfare
Colombia	35,419 (28,578 to 45,426)	5.4% (4.4% to 6.9%)	41,912	23.84	0.057%
Côte d'Ivoire	17,249 (9,730 to 29,942)	22.2% (12.5% to 38.6%)	21,161	11.56	0.055%
Nepal	8,755 (4,919 to 14,463)	12.3% (6.9% to 20.3%)	11,247	6.11	0.058%
Nigeria	182,022 (111,440 to 318,036)	17.0% (10.4% to 29.8%)	295,535	5.30	0.002%
South Africa	125,031 (103,540 to 148,511)	17.6% (14.6% to 20.9%)	147,427	8.2	0.005%
South Sudan	5,273 (1,716 to 15,190)	26.1% (8.5% to 75.2%)	1,832	0.82	0.045%

[a] i.e. Colombia made an HIS investment that is merely 0.66% of what it lost in GDP due to amenable deaths.

[b] This is an extrapolated figure.

Table 10 examines the relationship between the expenditure per capita on RHIS and the HAQ (Health Access and Quality) index score in the five countries.

Table 10. Expenditure per capita on RHIS vs. HAQ index score

Country	RHIS expenditure per capita (2022)	2019 HAQ index score overall (all ages)
Colombia	0.47	61.1
Côte d'Ivoire	0.42	34.3
Nepal	0.22	38.8
Nigeria	0.02	31.6
South Africa	0.14	44.6
South Sudan	0.76	29.1

HAQ: Health Access and Quality.

While there is not a perfectly linear relationship between per capita investments in routine health information systems and the HAQ index score, countries that do report higher per capita investments generally report better quality of care and lower rates of amenable mortality. Columbia, reporting the highest per capita investments in routine health information systems does report the highest HAQ index score, and Nigeria, which has been estimated to have the lowest per capita investments in routine health information systems reports the lowest HAQ index score.

4 Discussion

RHIS encompass the whole health system in countries, across all tiers and types of health facilities, and operates daily throughout the years. The RHIS is connected and connects health care delivery points with reporting and managerial levels. Any problem in the RHIS has the potential to propagate across the whole health system and any solution will need to be scaled across the whole system, as well. Understandably, RHIS represents an extraordinary heavy load and it is likely the most substantial information resource in the health sector.

While most of the countries showed their information sub-systems and tools in, at least, a reasonable status, as reported by experts, the use of data seemed to be less extended. This partially reflects that pernicious fact that use of data and information systems designs are hardly aligned. This is also consistent with empirical evidence documenting the disconnect between the availability of data and their use in decision-making [17].

Particularly appealing was the finding of the poor status of demographic information, which necessarily impacts on many other sub-systems that require demographic data to estimate indicators, as in the health sector use of population denominators. In the same line, the cases suggesting data in policy documents was hardly used were striking, since this fact has potentially important consequences in the delivery of health services to the extent that are precisely the health policies what dictates the scope, depth and distribution of health services in the populations.

The amount of time that the health workforce spends on RHIS is extraordinary, and in the millions of person-hours for all countries included in this study, even considering the more conservative estimates. This heavy staff load is concentrated in the periphery of the system, precisely where most of the clinical and public health care events take place and where data management staff is scanty or absent in many settings. This is also reflected in the system distribution of costs, where typically more than 80% of the RHIS costs are incurred in the periphery of the system. A recent paper reporting HIS studies in Cambodia, Ghana, Mozambique, Nigeria and Tanzania [18] reported figures in a consistent scale as ours: the mean time to complete monthly reports by service area ranged from 10 to 65 hours per month, or 6 to 78 hours per 1,000 patients or 4 to 15 hours per health worker. The paper also reported that the number of registers averaged 34 (range 16 to 48; 77% of them used) and that 33% of total consultation time (median range 15% to 67%) was used on data systems in highly used registers (OPD, ANC, FP and EPI).

The costs of the RHIS vary largely between countries and are likely to vary as well depending on what items or domains are considered as part of the RHIS. However, our findings suggest that (i) RHIS costs are high; yet (ii) they represent quite a small proportion of the overall expenditure in health. In addition, the largest contributor to the overall RHIS costs are those related to human resources, which are critical resources in the health system. This may translate into a rather fragile status of the RHIS in the countries, in which RHIS may be considered as optimally funded by just dedicated RHIS staff at marginal cost among of funding and/or are actually draining resources from other health care areas, particularly in terms of human resources time spent on the RHIS. If the

RHIS were largely run by specialised staff, all those staff costs would have to shift to the RHIS, substantially increasing its budget.

In the absence of controlled trials to evaluate the potential impact of health information systems[a] on facilitating increased access to care and in turn the receipt of appropriate services for which to model the potential returns on investments, this analysis drew on the available literature exploring the potential impact of high quality and appropriate service delivery within LMIC settings. Increasingly, in the literature, the concept of avoidable mortality, defined as unnecessary deaths resulting from conditions for which appropriate interventions or medical treatment exist, has been used a proxy for health system performance [19, 20, 21, 22, 23]. These avoidable or amenable deaths (i.e. deaths that could be avoided through effective and timely health care) are made up of both deaths that could be prevented through public health interventions or macro-level regulatory policies and those that are amenable through the receipt of appropriate care.

Recently, the Global Burden of Disease Collaborators developed a composite measure, the Healthcare Access and Quality Index across 195 countries based on amenable mortality [19]. This index score allows for a comparative assessment of health system performance across country settings and serves as an indicator for potential health care improvements that can be achieved globally. In addition to the potential of increased public investments in health system strengthening towards universal health coverage on reducing amenable mortality, there exists significant macro-economic consequences within countries resulting from limited access to high-quality care. Multiple pathways exist through which economic growth can result from improved population health including increases in the labour force, productivity levels, increased savings and resulting investments as a consequence of improved life expectancy and growth in human capital as a result of improved access to education of children, to name a few.

The qualitative findings related to the historical hallmarks, integration, structure and functions suggest that a number of basic requirements for information systems to work may not be in place. It was appealing the most of the historical hallmarks referred to IT developments in contrast to 'data use' events that could have become game changers. Similarly, the reported initiatives related to RHIS focused on IT, with almost complete absence of initiatives related to 'data use'.

IT issues have been reported from virtually all RHIS components or domains, including digitisation, fragmentation, interoperability, timeliness, completeness and inefficiencies in the different data management processes. The reports on the impact of COVID-19 on the RHIS seemed to confirm these findings. These findings seem consistent with the economic analyses suggesting that the RHIS contribution to quality of care outcomes is marginal. Despite the high costs and the very high value of some of the costs associated to human resources contributions to the functioning of the RHIS, even in the most optimistic scenarios, RHIS do not seem to 'make a difference'. However, the differences between countries are also very large, suggesting that the potential of RHIS to improve quality of care could be massive.

[a] See findings and discussion in the work package 1 report.

In all countries, HIS investments reflected less than 1% of the potential amenable deaths due to poor quality care (which accounts for non-utilisation as well as poor quality care once individuals access care). However, the role of RHIS in health care delivery policies and strategies is critical, their dimensions are as large as the health system dimensions, across all tiers and programmes, and the diversion of time spent by human resources on the RHIS can be unreasonably extensive, yet RHIS funding is marginal at its best.

Limitations

The main limitation of WP2 methodology arises from the fact that the amount and quality of data to populate the case studies was limited. We have relied on expert opinion, which has allowed us to build the case studies at the expense of some biases. However, we have reported most of the findings with ranges, which allows to consider more pessimistic or optimistic scenarios. We have also reported on the type of source used in each section of the questionnaire used to collect data from countries.

In terms of outcomes we have decided to use quality of care indicators that are composite and include many different aspects including access to services. This allows to build the case studies using standard outcomes already developed although it does not solve the issue of attribution of RHIS to the observed outcomes. The nature of the RHIS, which encompasses the whole health system, makes it virtually impossible to identify clear cut attributions of costs; this can happen in integrated health systems, where different functions, including those in the RHIS, are shared between programmes; as well as in decentralised systems, where tracking funds and expenditure is rather challenging.

In our analyses, we did not distinguish between different data management processes; i.e. data collection, storage, transmission, cleaning, analyses, interpretation and reporting. Certainly, the costs in each of these may largely differ and their analyses could provide further insights on the strong and weak points in the RHIS funding.

ANNEXES

Annex 1. XLSForm items to collect data in the countries

(A) DOCUMENT SOURCES

A·1 Is there any document, produced reasonably recently, describing the high-level national health policy or strategy in the country?

Please:

1) Obtain the document(s) and rename them starting with {Country}_1HPolicy_... (if there are more than one document, add a numbering at the end, like 1, 2...

2) Make sure you upload the documents to this folder:

Please, make sure that you provide a hard copy to the supervisor of the questionnaire.

A·2 Please, provide a proper citation for this document and/or copy and paste the web address.

A·3 Please, explain how is it possible that the country has no national policy or strategy document or a similar document.

A·4 Is there any document, produced reasonably recently, related to the Health Information System in the country (e.g. strategy, guidelines, Standard Operations Procedures, training materials…)?

Please:

1) Obtain the document(s) and rename them starting with {Country}_1HPolicy_... (if there are more than one document, add a numbering at the end, like 1, 2...

2) Make sure you upload the documents to this folder:

Please, make sure that you provide a hard copy(ies) to the supervisor of the questionnaire.

A·5 Please, provide a proper citation for this document and/or copy and paste the web address.

A·6 Please, explain how is it possible that the country has no such document.

A·7 Is there any document, produced reasonably recently, related to an assessment or evaluation of the Health Information System in the country?

Please:

1) Obtain the document(s) and rename them starting with {Country}_1HPolicy_... (if there are more than one document, add a numbering at the end, like 1, 2...

2) Make sure you upload the documents to this folder:

Please, make sure that you provide a hard copy(ies) to the supervisor of the questionnaire.

A·8 Please, provide a proper citation for this document and/or copy and paste the web address.

A·9 Please, explain how is it possible that the country has no such document.

A·10 Is there a Monitoring and Evaluation plan in the country?

Please:

1) Obtain the document(s) and rename them starting with {Country}_1HPolicy_... (if there are more than one document, add a numbering at the end, like 1, 2...

2) Make sure you upload the documents to this folder:

Please, make sure that you provide a hard copy(ies) to the supervisor of the questionnaire.

A·11 Please, provide a proper citation for this document and/or copy and paste the web address.

A·12 Please, explain how is it possible that the country has no such document.

A·13 Is there a document describing the Data Quality Reviews or alike in the country?

Please:

1) Obtain the document(s) and rename them starting with {Country}_1HPolicy_... (if there are more than one document, add a numbering at the end, like 1, 2...

2) Make sure you upload the documents to this folder:

Please, make sure that you provide a hard copy(ies) to the supervisor of the questionnaire.

A·14 Please, provide a proper citation for this document and/or copy and paste the web address.

A·15 Please, explain how is it possible that the country has no such document.

A·16 Is there any document, produced reasonably recently, based on or reporting data from the routine HIS (e.g. Annual Health Statistics) in the country? (consider obtaining an Excel or csv file, if available)

Please:

1) Obtain the document(s) and rename them starting with {Country}_1HPolicy_... (if there are more than one document, add a numbering at the end, like 1, 2...

2) Make sure you upload the documents to this folder:

Please, make sure that you provide a hard copy(ies) to the supervisor of the questionnaire.

A·17 Please, provide a proper citation for this document and/or copy and paste the web address.

A·18 Please, explain how is it possible that the country has no such document.

A·19 Upload a picture (if available) that depicts the overall structure of the health system in your country

A·20 Upload a picture (if available) that depicts the overall structure of the HIS in your country
A·21 Upload a picture (if available) that depicts the flow of data in the health system in your country
A·22 You can write here any comment or notes that you think are important and were not contemplated in this section.

(B) HEALTH SYSTEM

B·1 How many levels of reporting exist in the country?
B·2 Please, give a name to level #{Level_ii}:
B·3 How many entities of the type {LevelName} exist in the whole country?
B·4 _Please, indicate the source of evidence you have used to complete the information in this sub-section_.
B·5 Please provide a citation of the source document (or provide a short reference to the document if already cited).
B·6 You can write here any comment or notes that you think are important and were not contemplated in this section.

(C) HEALTH FACILITIES

C·1 How many types of health facilities exist in the country?
C·2 Please, provide a brief name to the health facility type #{HFTypes_ii}:
C·3 What is the typical health system level this type of health facilities operate?
C·4 How many of those health facilities are in the whole country in the governmental sector?
C·5 How many of those health facilities are in the whole country in the private sector?
C·6 _Please, indicate the source of evidence you have used to complete the information in this sub-section_.
C·7 Please provide a citation of the source document (or provide a short reference to the document if already cited).
C·8 You can write here any comment or notes that you think are important and were not contemplated in this section.

(D) STAFF

D·1 Now we would like to ask you about the amount of staff in the health facilities in your country. This information may not be readily available to you and you may have to provide some estimates. You can select whether to report them as total absolute numbers for the country (e.g. total number of staff providing health care in hospitals) or as averages per health facility (e.g. average number of staff providing health care in a typical hospital), which of course can vary a lot.

Health facility type
Clinical staff
Nurses staff
Health auxiliary
Data clerk
TOTAL

For governmental health facility of types, please report the total number across the country.
For governmental health facility of types, please report the average for a typical health facility.
For private health facility of types, please report the total number across the country.
For private health facility of types, please report the average for a typical health facility.

D·8 _Please, indicate the source of evidence you have used to complete the information in this sub-section_.
D·9 Please provide a citation of the source document (or provide a short reference to the document if already cited).
D·10 You can write here any comment or notes that you think are important and were not contemplated in this section.

(E.1) RHIS ORGANISATION

E·1 Briefly describe the legal framework that supports RHIS in the country.
E·2 Briefly describe the legal framework for data protection issues in your country.
E·3 Briefly describe the historical hallmarks (with dates, at least years) of the RHIS in the country, for the last 5 to 10 years.
E·4 Briefly describe the level of integration (or lack of integration) of the RHIS in relation to (i) different levels (e.g. more peripheral versus more central levels of the health system); and/or (ii) different programmes or health care activities (e.g. vaccination, antenatal care=).
E·5 Briefly describe how the RHIS is coordinated and planned.

E·6 Briefly describe the main roles and responsibilities of key staff in relation to the RHIS, across the different reporting levels.
E·7 Briefly describe how the RHIS is aligned with international standards of information and data management.
E·8 Briefly describe whether and how the COVID-19 pandemic has modified any policy, managerial or technical aspect of the RHIS in your country.
E·9 You can write here any comment or notes that you think are important and were not contemplated in this section.

(E.2) RHIS PROCESSES

E·10 Briefly describe the different sub-systems of the RHIS (e.g. in the public or private sectors, systems mainly used by government or used by donors or NGOs, etc.).
E·11 Briefly explain what are the technical guidelines used to operate the RHIS.
E·12 Briefly explain what are the technical standards for the RHIS (i.e. standards that describe how the system _should work_ in order to produce good quality data).
E·13 Briefly describe any technical support mechanisms for RHIS (e.g. donors or NGOs supporting data quality meetings or cloud storage…).
E·14 Briefly describe whether there is a RHIS indicators dictionary; if so, indicate how many indicators are there.
E·15 Briefly describe the flow of data and information from the periphery of the health system to the national level.
E·16 Briefly describe any programme, project or initiative in the country that you think may influence the costs and performance of the RHIS.
E·17 _Please, indicate the source of evidence you have used to complete the information in this sub-section_.
E·18 Please provide a citation of the source document (or provide a short reference to the document if already cited).
E·19 You can write here any comment or notes that you think are important and were not contemplated in this section.

(F) DATA TOOLS AND PROCESSES

Please address the following issues considering a single health facility of each type, as an average. We are aware that the responses may vary by geographical area or other variables; here we ask for what is 'typical' or more common in a health facility of each type.
F·1 Are there patients or family folders used?
F·2 How many register books?
F·3 How many computers?
F·4 How many software programmes for data management?
F·5 How many digital 'Clinical Decision Support System' are in place and routinely used?
F·6 How many 'official' mobile phones used?
F·7 How many 'private' mobile phones used for work?
F·8 How many mobile apps used for data management?
Please provide brief explanations on the following issues, by health system level. Consider both paper and digital sub-systems.
F·1 How / who / when are data collected?
F·9 How / who / when are data stored?
F·10 How / who / when are data transmitted?
F·11 How / who / when are data quality monitored or assessed?
F·1 How / who / when are data analysed?
F·12 How / who / when are data disseminated?
F·13 How / who / when are data used?
F·14 _Please, indicate the source of evidence you have used to complete the information in this sub-section_.
F·15 Please provide a citation of the source document (or provide a short reference to the document if already cited).
F·16 You can write here any comment or notes that you think are important and were not contemplated in this section.

(G.1) FUNDING SOURCES

G·1 Is there a budget line dedicated to RHIS in the national budget?
G·2 What is the amount?

G·3 Currency
G·4 Is there any other stakeholder / partner / initiative / project with a component supporting the RHIS in the country (including government!)?
G·5 Name of the institution / project / initiative.
G·6 Name abbreviation
G·7 Total annual funding or spent dedicated to RHIS in {StakAbr}.
G·8 Currency
G·9 Areas of support in {StakAbr}
G·10 _Please, indicate the source of evidence you have used to complete the information in this sub-section_.
G·11 Please provide a citation of the source document (or provide a short reference to the document if already cited).
G·12 You can write here any comment or notes that you think are important and were not contemplated in this section.

(G.2) HUMAN RESOURCES

What is the approximate typical monthly net salary of a physician in your country? You can indicate a reasonable range here:
G·13 Lower average
G·14 Higher average
G·15 Currency
What is the approximate typical net monthly salary of a nurse in your country? You can indicate a reasonable range here:
G·16 Lower average
G·17 Higher average
G·18 Currency
What is the approximate typical net monthly salary of a data clerk in your country? You can indicate a reasonable range here:
G·19 Lower average
G·20 Higher average
G·21 Currency
Tell us, how much time (in person-hours -e.g. 2 people 15 hours/month = 30 hours) a typical professional would spend on data management over a one month period:
G·22 For a physician or doctor - Minimum
G·23 For a physician or doctor - Maximum
G·24 For a nurse / health auxiliary / data clerk - Minimum
G·25 For a nurse / health auxiliary / data clerk - Maximum
Tell us, how much time (in person-hours -e.g. 2 people 15 hours/month = 30 hours) a typical data clerk would spend on data management over a one month period ONLY in management levels (NOT health care facilities):
G·26 - Minimum
G·27 - Maximum
G·28 _Please, indicate the source of evidence you have used to complete the information in this sub-section_.
G·29 Please provide a citation of the source document (or provide a short reference to the document if already cited).
G·30 You can write here any comment or notes that you think are important and were not contemplated in this section.

(G.3) OTHER COSTS

G·31 What is your estimate of the costs of investments in infrastructures related to the RHIS?
G·32 Currency
G·33 How many years is this investment supposed to last?
G·34 What is your estimate of the costs of investments in equipment used for the RHIS?
G·35 Currency
G·36 How many years is this investment supposed to last?
G·37 What is your estimate of the annual running costs of the RHIS activities, across the whole country?
G·38 Currency
G·1 What is your estimate of the annual running costs of HIS software (e.g. maintenance, licences…), across the whole country?

G·39 Currency
G·40 Are these HIS software costs already included in the estimate of annual running costs above in G·37 ?
G·41 _Please, indicate the source of evidence you have used to complete the information in this sub-section_.
G·42 Please provide a citation of the source document (or provide a short reference to the document if already cited).
G·43 You can write here any comment or notes that you think are important and were not contemplated in this section.

(H.1) DATA OUTPUTS

H·1 What is the status in the country of data on population estimates (e.g. demographic data)?
H·2 What is the status in the country of Civil Registration and Vital Statistics (CRVS)?
H·3 What is the status in the country of a Master Health Facility List?
H·4 What is the status in the country of a formal Human Resources management system?
H·5 What is the status in the country of a formal Logistics Management Information System?
H·6 What is the status in the country of data on disease surveillance?
H·7 What is the status in the country of a indicators list or dictionary?
H·8 What is the status in the country of International Classification of Diseases (ICD) use?
H·9 What is the status in the country of dashboards or other RHIS analytical outputs?
H·10 What is the status in the country of data dissemination products?
H·11 _Please, indicate the source of evidence you have used to complete the information in this sub-section_.
H·12 Please provide a citation of the source document (or provide a short reference to the document if already cited).
H·13 You can write here any comment or notes that you think are important and were not contemplated in this section.

(H.2) DATA USE

Inspect a legal document (e.g. a law or regulation issued by government) related to the health sector and identify whether data from the RHIS is mentioned there.
H·14 Please provide a citation of the source document (or provide a short reference to the document if already cited).
H·15 Please, qualify the use of RHI data in this document.
Inspect a policy / strategic document related to the health sector and identify whether data from the RHIS is mentioned there.
H·16 Please provide a citation of the source document (or provide a short reference to the document if already cited).
H·17 Please, qualify the use of RHI data in this document.
Inspect a document used to request funding in relation to health sector and identify whether data from the RHIS is mentioned there.
H·18 Please provide a citation of the source document (or provide a short reference to the document if already cited).
H·19 Please, qualify the use of RHI data in this document.
Inspect planning, monitoring evaluation reports in the health sector and identify whether data from the RHIS is mentioned there.
H·20 Please provide a citation of the source document (or provide a short reference to the document if already cited).
H·21 Please, qualify the use of RHI data in this document.
Inspect minutes or reports of meetings in relation to health sector and identify whether data from the RHIS is mentioned there.
H·22 Please provide a citation of the source document (or provide a short reference to the document if already cited).
H·23 Please, qualify the use of RHI data in this document.
Inspect mass media (e.g. TV, radio, press, internet local news sites) and identify whether data from the RHIS is mentioned there.
H·24 Please provide a citation of the source document (or provide a short reference to the document if already cited).
H·25 Please, qualify the use of RHI data in this document.
H·26 You can write here any comment or notes that you think are important and were not contemplated in this section.

(I) HEALTH OUTCOMES

Please, complete the following data for the most recent complete year ONLY using the RHIS available in the country. Some information may be available in public websites, but please use ONLY the data found in the country.

I·1 Number of deaths due to any cause
I·2 Year for this data
I·3 Is there any evidence of time trend?
I·4 Number of deaths in infants less than 1 year
I·5 Year for this data
I·6 Is there any evidence of time trend?
I·7 Number of new tuberculosis cases
I·8 Year for this data
I·9 Is there any evidence of time trend?
I·10 Total number of HIV positive cases
I·11 Year for this data
I·12 Is there any evidence of time trend?
I·13 Number of cases with cardiovascular disease
I·14 Year for this data
I·15 Is there any evidence of time trend?
I·16 Percentage of infants of 1 year of age fully immunised
I·17 Year for this data
I·18 Is there any evidence of time trend?
I·19 Percentage of pregnant women with at least one antenatal care consultation
I·20 Year for this data
I·21 Is there any evidence of time trend?
I·22 _Please, indicate the source of evidence you have used to complete the information in this sub-section_.
I·23 Please provide a citation of the source document (or provide a short reference to the document if already cited).
I·24 You can write here any comment or notes that you think are important and were not contemplated in this section.

Annex 2. Details related to the economic analyses

Alkire et al [15] have estimated deaths amenable to high-quality health care and then modelled the macroeconomic impact of those deaths. The value-of-lost-output approach estimated the effect of amenable mortality on GDP in the period 2015–30, while the value-of-lost-economic-welfare model estimated total economic welfare losses in 2015. The models use different meanings of economic loss and different periods of time. The counterfactual in both models is the absence of amenable mortality.

The value-of-lost-output approach used the WHO calibration-based simulation model, which projects the GDP losses resulting from disease-specific mortality on a country's effective labor force and physical capital. This scenario was compared with a counterfactual scenario, which assumes an absence of amenable mortality and adjusted the labor supply accordingly. The counterfactual labor-supply estimates were then used to calculate forgone GDP due to disease by subtracting the status quo GDP from the counterfactual GDP. The increased economic output under the counterfactual scenario also results in an increase in capital stock.

The value-of-lost-welfare model was based on the concept of the value of a statistical life, which attempts to capture market and additional non-market losses such as forgone leisure time or the value placed on good health in and of itself. Because the value-of-lost-welfare approach includes non-market welfare losses and all years of life lost (taking a long-run view), the value of lost welfare is a broader measure than the value of lost output. This study assessed the value of lost welfare due to amenable mortality during 2015.

Formal VSL studies have not been conducted in most low- and middle-income countries; however, economists have proposed a method for estimating the VSL in country's which lack empirical studies. Using the ratio of gross national income per capita (GNI per capita) as a conversion factor, one can transfer VSL estimates from a country in which empirical studies have been performed to countries in which studies are lacking or absent. A critical factor for converting VSL estimates is the "income elasticity of VSL" (IE-VSL), which dictates how VSL changes in proportion to the relative income of two countries. Increasing the IE-VSL results in decreased VSL estimates when transferring to low- and middle-income countries. Although IE-VSL's of 0.5-1.0 have traditionally been used when transferring estimates from high-income countries to LMICs, some have argued that an IE-VSL of up to 1.5 may be more appropriate for low-income countries. This study uses an IE-VSL value of 1.0 for all countries as the base case. VSL's were used to place an economic value on YLLs estimated in the study.

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