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Strengthening national health research systems in Africa: lessons and insights from across the continent

Deliverable D – Final report on the project “Building the case for investment in health sciences research in Africa”

Contents

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List of acronyms and abbreviations

AAS – African Academy of Science

Africa CDC – Africa Centres for Disease Control and Prevention

AUDA-NEPAD – African Union Development Agency

BHP – Botswana Harvard AIDS Institute Partnership

BUP – Botswana-UPenn Partnership

CAC – Codex Alimentarius Commission

CEREB – West African Regional Biobank

CSRS – Centre Suisse de Recherche Scientifique

DFID – United Kingdom's Department for International Development

EAC – East African Communities

ECOWAS – Economic Community of West African States

EDCTP – European and Developing Countries Clinical Trials Partnership

HIC – High-Income Country

HIV/AIDS – Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome

HSR – Health Sciences Research

GDP – Gross Domestic Product

GERD – Gross Expenditure on Research and Development

IPCI – Institut Pasteur de Côte d'Ivoire

ISPED – The School of Public Health at the University of Bordeaux

KEMRI – Kenya Medical Research Institute

LMIC – Low- and Lower-Middle-Income Country

LSE – London School of Economics and Political Science

MHESR – Ministry of Higher Education and Scientific Research

MoE – Ministry of Education

NCHE – National Commission on Higher Education

NHRS – National Health Research System

NGO – Non-Governmental Organisation

NPHIL – National Public Health Institute of Liberia

OECD – Office for Economic Cooperation and Development

Principal Investigator – PI

R&D – Research and Development

U.K. – United Kingdom

USAID – United States Agency for International Development

WHO – World Health Organization

STI – Science, Technology, and Innovation

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Glossary

Capacity / capacity building: the development and strengthening of human, institutional, and financial resources to strengthen a health research system. Involves public, private, and non-profit sectors at multiple levels of society – individual, institutional, and societal.

Elements: features of an NHRS that serve a relational function to connect the pillars and processes of a system and support successful efforts to strengthen the overall health research system. Examples include: the regulatory environment, political will, research leadership, and research culture that are critical to achieve capacity building.

Enabling environment: the elements of the system that support HSR activities, but which may not be measured themselves when assessing metrics of activities. Includes such things as policy frameworks, regulatory systems, political commitment, institutional rules and arrangements, and human resources, such as for research management, which enable the growth and development of national health research systems.

Health Sciences Research (HSR): refers to the basic, clinical, applied, and social science on human health and well-being and the determinants, prevention, detection, treatment, and management of disease.

Indicators: measurable items to track HSR performance used to assess the aggregate status of HSR achievements at the national level. Examples of HSR performance indicators include the number of clinical trials conducted; number of publications; number of researchers; or research and development expenditure as a percentage of GDP.

Metrics: related to *Indicators*, above. A set of indicators that when looked at together provide comparable information about HSR performance and/or capacity in different national health research systems.

National Health Research System (NHRS): the people, institutions, and activities whose primary purpose is to generate high-quality knowledge that can be used to promote, restore, and/or maintain the health status of populations.(1)

Pillars: the core functions of a national health research system, which are fundamental to the development and strengthening of national health research systems and enable countries to produce and use scientific knowledge to attain health and development goals. Four essential pillars of an NHRS are: governance; financing; creating and sustaining resources; and producing and using research.

Processes: dynamic and ongoing methods, practices, and activities of an NHRS that are integral to the system's development, organisation, and adaptation. This includes partnerships and collaboration, advocacy, alignment and prioritisation, and innovation processes.

Systems approach / perspective: interconnected elements, processes, and relationships within a system. The systems approach takes into account how decisions, processes, and actors are both influenced by and have an impact on the wider system(s).

Systems indicators: measurable items within the key pillars of national health research systems, which have been proposed to track progress towards the development of national health research systems. Examples of system indicators for NHRS pillars include such things as the number of research institutions in a country, ethics review boards, a national health research policy or law, knowledge translation platforms, or health research governing mechanisms that are in place to facilitate research.

Executive Summary

Since the publication of the Commission on Health Research and Development (1990), national, regional, and international efforts have been made to improve health research capacity in Africa. However, these investments have been uncoordinated, intermittent, and in many instances have not led to sustainable national health research systems. While there is considerable progress in the production of health sciences research by Africa-based authors over the past ten years, African states are grappling with challenges of ensuring enabling environments, investment mechanisms, knowledge translation processes, and regulatory systems for health science research.

Improving health sciences research in Africa requires a broad and diverse knowledge base, that is informed by experiences across the continent. Initiatives and interventions that focus on strengthening individual researchers' or cohorts' training and skills development, or research capacity at an organisational level, comprise the bulk of current efforts to build, develop, and strengthen research capacity in health sciences. Changes in policy and practice that comprehensively consider the entirety of a national health research system are needed to tackle these challenges.

A first step in measuring the performance of health sciences research in African countries across the continent is to assess standard indicators for research outputs, innovation, and financing. Metrics used include the number of clinical trials conducted, number of publications produced, number of researchers, or financial investment as a percent of gross domestic product. These indicators can be limited by data availability, and such quantified evaluations of health sciences research at an aggregate level do not necessarily capture the nuances of the institutional dynamics and the role of local contexts (e.g. political, economic, social, cultural, epistemic) that are critical for developing a national health research system. Indeed, a country with a small, but locally financed and organised, system of research serving local needs might perform 'worse' on many metrics compared to a country which has several high-cost projects run by international organisations with limited local integration or ownership.

In this report, we apply a whole-systems perspective to building capacity for health sciences research. The lessons drawn from our in-depth case studies show that elements such as research leadership, political will, and research culture must be considered as part of a holistic and home-grown investment strategy in health sciences research capacity. A whole systems approach recognises the need for integration of health with other sectors such as education, as well as the dynamic processes, such as advocacy, collaboration, and innovation, that can make research systems more robust. Ultimately, this work produces insights on how countries can build a foundation of long-term support for research systems that are rooted in local expertise, committed to local ownership, and responsive to the knowledge and data needs of their communities, practitioners, and decision-makers.

Countries share common challenges related to human resources and research personnel, institutional capacity, lack of prioritisation of health research, absence of clear coordination mechanisms, and inadequate domestic public funding for health research. However, the policy and regulatory frameworks and institutional arrangements for governing health research systems vary greatly across African contexts. While operating differently within each national setting, several elements and processes influence the development of national health research systems. For example, long-term advocacy efforts by local champions, and the use of data from in-country research to identify priorities appears critical to the process of institutionalising health research governance. Additionally, external partnership and international collaboration are essential inputs for African research institutions, but their ability to contribute to capacity development depends on whether these investments are aligned with local health needs, provide training and opportunity for local researcher leadership development, and equitably involve local leadership in decision-making. Events, such as health crises, have served as windows of opportunity to modify the

health sciences research landscape through rapid investments used to strengthen local infrastructure and capacity in some settings in the past. Yet, the ability to seize on these opportunities is contingent on a range of supporting elements in place such as well-connected and politically astute local research leaders who are dedicated to building independent research capacity, and professionally respected in national and international networks.

A key insight identified is that the multi-sectoral nature of national health research systems should not be neglected when planning and investing in health research capacity. National health research systems in Africa intersect with multiple government policy sectors – including higher education; health; development; and science, technology, and innovation. Yet this project's findings point to a siloisation of many decision-makers in health sciences research. In some cases, there is a lack of clarity about lines of authority, which can create either overlapping areas, duplication, or vacuums of responsibility within health sciences research decision-making in government and in the governance of the national health research system. Decision-makers acknowledge the value of opportunities to meet, collaborate, and create channels of communication to improve coordination within countries and to exchange and learn from their counterparts with regional networks between countries. Furthermore, while funding is obviously important, findings show that a narrow focus on investing in health research staff, infrastructure, or projects is not sufficient to build national capacity, due to the ways that health research is integrated with, and relies on, these other sectors and processes.

A key challenge for the governance of national health research systems is to ensure research undertaken and capacities developed are aligned to those priorities defined by African leaders. International collaborators from outside and from within the continent are vital, but leadership by African experts and decision-makers to negotiate and design partnerships are necessary to guarantee such alignment. Processes of aligning national priorities can be hampered by the influence of foreign partners seeking to impose their own preferences on the national agenda. Donor-recipient dynamics that espouse donor privilege can significantly reduce the space and opportunity for African decision-makers to challenge the priorities that are not in line with their needs and goals.

While alignment of research priorities works to ensure that health research serves local needs, it also may be an important step to convincing local leaders of the utility of domestic investment into health research systems. However, findings point to a further need for ongoing advocacy by research leaders and networks with strong ties to government and political elites to achieve this goal. Building relationships and improving communication between researchers and policy-makers can assist in establishing supportive foundations for successful, long-term advocacy and help create trust, which is vital for these ongoing conversations between national stakeholders.

This report concludes with recommendations on how to strengthen national health research systems in Africa, aimed at African stakeholders in government, those working in research or academia, and international donors and research funders. The recommendations fall under three broad areas:

- Support national ownership and governance of health sciences research through equitable partnership agreements that promote leadership of African experts and benefit the national health research system.
- Invest in research infrastructure (institutions, ethics committees, technical platforms, laboratories, data management systems) to create a conducive regulatory environment to coordinate research activities.
- Cultivate a national culture of research, which promotes research leaders as advocates and advisors of national policies, and create pathways to attract, train, and retain skilled researchers.

Chapter 1. Introduction

It is well established that the majority of health sciences research (HSR) takes place in high-income countries (HICs).(2–4) Despite a number of high profile reports highlighting the '10/90 divide' – whereby only 10% of global health research is dedicated conditions affecting 90% of the world's population - and the need for capacity development for HSR in low- and lower-middle-income countries (LMICs), development of a fertile HSR landscape in many LMICs is still lagging.(3,5) As of 2018, less than 1% of scientific articles published worldwide each year include at least one author based at an African institution, according to analysis by Elsevier (6). Yet, as highlighted by the World Health Organization's (WHO) 2013 World Health Report, an ultimate goal is that "all nations should be producers and users of research as well as consumers".(4) Africa remains a region of the world particularly under-represented in HSR. Achieving the WHO's goal will therefore require strategic steps for local governments in African countries to become producers, users, and consumers of research. These steps will need to build the capacity and the environments in which HSR can sustainably grow.

We define HSR to refer to basic, clinical, and applied science on human health and well-being and the determinants, prevention, detection, treatment, and management of disease.(7,8) Although, it is well recognised that the definition for this, and related capacity building activity is complex.(9) Outside of simply allocating financial resources to research projects, there are a wealth of other important actions and measures that governments may have control over that affect how the private sector or international research funding bodies view a country's attractiveness to invest in HSR. Policy frameworks, political commitment, regulatory systems, institutional rules and arrangements, and human resources all combine to create the enabling environments in which HSR may be established and grow, or otherwise stagnate and dissipate.

Arguments for investing in HSR in Africa

The 1990 Commission on Health Research and Development stated that strengthening research capacity in LMICS is "one of the most powerful, cost-effective and sustainable means of advancing health and development."(2) First, improved HSR broadly can potentially contribute to improvements in health, social welfare, and poverty reduction. (1,10,11) Increasing and improving HSR capacity within countries can serve to improve health services and health outcomes for the population. Africa is home to nearly one-sixth of the world's population and is estimated to account for about a quarter of the global burden of disease.(12,13) Locally relevant health research provides valuable evidence to address health concerns within a country. The focus of research defined in HICs means that the actual disease concerns of African settings are neglected and under-analysed. The WHO notes that while there has been research investment into some diseases such as Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS), tuberculosis, and malaria, many other diseases of poverty affecting African nations have not seen significant research attention, with funding largely directed from the global north.(14) So whilst there have been developments in the HSR landscape over the last three decades, many LMICs still lack sufficient capacity to build an evidence base relevant to the specific health issues faced locally, with which to inform policy and improve population health. (15–17) However, public health issues and health systems improvements require locally contextualised solutions that national health research can help to inform.

Secondly, there are arguments to be made outside the health focus alone for strengthening HSR. Indeed, health sciences can be an important contribution to the development of so-called 'knowledge economies.' International agencies such as the Office for Economic Cooperation and Development (OECD) and the World Bank emphasize the importance of developing knowledge economies as key pathways to social and economic development more broadly. In terms of the macro developmental potential of HSR, significant discussion of African development has focused on economic growth in many parts of the continent.(18,19) For example, the OECD argues that knowledge economies can support governments to diversify from primary commodity production (e.g. oil, gold, and other minerals) towards professionally-oriented services with greater potential for macroeconomic growth.(20) Given the move away from reliance on commodities, African economies are often seen as needing new sources of sustainable income.(18) Growing interest is focusing on the health science industry and the potential it might hold for both economic development and improving outcomes in the African health sector.(21)

Significant investment in HSR in Africa remains low, with only one African state (Malawi) meeting the African Union goal of increasing the Gross Expenditure on R&D (GERD) to 1% of GDP. While (albeit limited) data demonstrate the existence of a problem in terms of insufficient levels of investment in HSR in Africa, we know little about potential solutions to improve the situation.

Development of an agenda for investing in HSR in Africa

Investing in strengthening health science research capacities in LMICs has been a key consideration of global agencies for the past thirty years.(21–23) The Commission on Health Research for Development, argued that local capacity and systems for research were essential to reduce inequities in health and advancing knowledge for development in LMICs. (2) The Council on Health Research Development, the Global Forum for Health Research, WHO, and the World Bank convened international conferences and workshops to develop a framework for national health research systems in LMICs and share case-based experiences. These global efforts were reproduced through national commitments and regional policy development and efforts in Africa as well, the Algiers Declaration (24) and the Bamako Call to Action on Research for Health (25), the African Union Development Agency's *Health Research and Innovation Strategy for Africa (2018-2030)*(26) and the WHO's Regional Office for Africa *Research for Health Strategy for the African Region (2016-2025).*(27) In the past five years, a number of international organizations, including the African Union (28), WHO (27), and World Bank (29), have called for political and economic investment in HSR in Africa. However, despite the establishment of this coherent agenda at national, regional, and global levels, there is little known about the actual uptake and implementation of these efforts within African countries, and anecdotally it appears that a systemic health research policy implementation gap exists in most states.

It has been argued that reliance on donor funding has also meant little for the sustainability of national health research systems when these collaborations end.(30,31) Moreover, these international arrangements have resulted in research agendas set by HICs and donors, meaning that they either reflect the need of the funding location (32,33), a focus on spotlight issues or vertical interventions (34) or so-called parachute research(35–38), which may do little to support improving health outcomes in the host location. Local research

development is vital to addressing health concerns since country researchers have the best understanding of the national agenda and cultural context which increased the likelihood of evidence uptake by policy-makers.(15,39) Improving investment and capacity for research in health sciences in Africa would thus help to redress this balance to allow more direct and sustainable attention to local health priorities and needs.

Implementing action to strengthen HSR capacity in Africa

Within this overarching agenda, international health research funding bodies have emphasized strengthening health research capacity (e.g. skills, resources, or infrastructure) in Africa through strategic programmes, consortia, and interventions. Evaluation frameworks developed for these interventions typically categorize health research capacity strengthening actions that target individual, institutional, or national levels (40–43) with outputs and outcomes of capacity building associated with improvements at each level of research capacity.(3,9,40,44–46) Although international agencies and national actors are pursuing an agenda for developing health research capacity in LMICs, definitions are scarce. A scoping review on the science of health research capacity strengthening in LMICs revealed a lack of clarity on the meaning and dimensions of research capacity development.(47) Specifically, Dean et al.'s analysis of 172 publications found that only 19% of them presented an operational definition of capacity, and 36% of those definitions explicitly referred to all the levels of research capacity (e.g. individual, institutional, national).(47)

The empirical literature on strengthening health research capacity in LMICs reports mainly on outcomes for capacity at the individual level – such as training for skills.(22,48) Whilst a comprehensive approach to strengthen health research capacity through integrated, horizontal actions that address multiple levels of capacity together has been suggested as a promising strategy for system coherency, interventions to improve health research capacity tend to be carried out for each level of capacity in an isolated, vertical manner.(48,49) Factors such as financing and sustainability, resources, stewardship and leadership, mentorship, partnerships, and research production and utilisation are generally found to influence health research capacity strengthening efforts targeting specific levels of capacity and have been rarely used for cross-cutting or longitudinal analysis about what shapes capacity within a national system.(48) Given how existing studies have focused on capacity gains in key areas (e.g. individual research skills, research governance) at different levels, but not necessarily on national trends over time, the evidence base around what interventions and strategies may be effective to build health research capacity in LMICs remains limited.(48,50) However, a meta-narrative review of qualitative literature on health research capacity development in LMICs by Franzen et al. found that the importance of a systems approach was one of the particularly key ideas in this literature.(15)

We observe two tensions in the literature on health research capacity development in LMICs. First, the focus on individual and organisational levels of health research capacity has neglected to advance knowledge about a more holistic and integrated approach to strengthening health research systems at a national level. Second, the top-down efforts and health research capacity development interventions of international organisations, funders, or consortia may obscure the priorities, needs and processes for bottom-up development of national health research system building that arises from efforts of local leaders in their context. Because of the disparity in HSR investment between Africa and HICs, African health concerns have been widely ignored in global research to date. This is exacerbated by the

fact that African states are dependent on external agendas, funding, and drivers of research as ongoing artifacts of colonialism and its legacy for HSR and knowledge production systems for international health in Africa.

Project aims, objectives, and methodology

The objectives of the project are to identify what enables HSR to develop and potentially thrive in African countries at different levels of capacity – exploring key areas such as the policy environment, funding mobilisation, and the regulatory and coordinating systems for HSR conducted in the public and private sectors. To meet these objectives, the project undertook three phases of analysis:

Phase 1. Map indicators to assess and compare HSR performance and achievement across Africa;

Phase 2. Review in-depth HSR experiences in nine African countries from the perspective of those who fund, undertake, or regulate health science research; and

Phase 3. Facilitate learning between key government officials from the nine cases with a mandate to steer HSR in their country through sharing ideas, challenges, and potential solutions to improve HSR in their settings.

The research provides an in-depth analysis of the state and the development of national health research systems, exploring them with methodological approaches corresponding to each of the three phases:

Phase 1. Quantitative analysis based on publicly available metrics of HSR investment and expenditure and available indicators of health research capacity and performance in all African states;

We systematically mapped the status of HSR across the continent through the development of a framework of publicly available proxy indicators. Building on an initial framework developed by Simpkin and Mossialos, these indicators represent capacity, input and output activity, and investment to date to better understand country performance in HSR.(51) This produced a comprehensive mapping of the current HSR landscape in Africa from which the project drew to select the cases for the subsequent phases.

Phase 2. Qualitative analysis of nine in-depth case studies involving multiple stakeholders (Botswana, Côte d'Ivoire, Ethiopia, Kenya, Liberia, Madagascar, Tunisia, Uganda and Zambia);

From the framework, we purposefully chose nine case studies of national health research systems in African states against three criteria: level of HSR activity and relative performance (high, medium, low), language (French and English-speaking countries), and geographical sub-regions of the African continent (Northern, Eastern, Southern, and Western Africa). We then interviewed 189 key informants from these nine cases: 18% were funders, 53% researchers, and 29% decision-makers. We first thematically coded interview data specifically looking for best practices and challenges, the investment and incentive mechanisms, and the barriers and facilitators for improving and increasing HSR. We then produced individual case narratives that described the history of the development of the national health research system (NHRS) in each country and efforts to strengthen it in order to understand from a systems perspective what supportive elements and processes were influential in the development of each NHRS. Finally, through a comparative analysis of all

the cases, we examined these elements and processes in detail to better understand the dynamic connections between the core pillars of national health research systems as a key determinant of countries' trajectories in strengthening their systems overall.

Phase 3. Decision-maker engagement to facilitate knowledge-sharing and strategic planning among key officials responsible for health research governance.

In the final phase of work, we facilitated peer-to-peer workshops for a target set of national policy-makers from the nine case study countries. The goal was to facilitate a process by which individuals who hold national mandate and responsibility over HSR systems could reflect on the goals and strategies of HSR development and work together as peers to identify best practices to overcome challenges faced. By structuring these as peer-to-peer workshopping, a goal was to overcome top-down external information provision and facilitate a process that might lead to greater local ownership and contextual strategies to improve HSR for a small set of individuals working within government agencies.

Two workshops (in Nairobi and Addis Ababa) brought together senior government officials from the health, higher education, and Science, Technology and Innovation (STI) sectors. In the first workshop, participants shared experiences and successes, discussed common challenges, and identified practical lessons for strengthening HSR. In the first workshops, participants discussed what constitutes an HSR system and what is needed for its development across African settings, including barriers faced and possible ways to overcome them. This led to officials for each country, in consultation with peers, devising their own plans for incremental changes they could potentially make over the course of a 6 to12-month period to improve HSR development in their national context. In the second workshop, participants gave updates on their action plans and feedback on their efforts with the purpose of sharing ideas, challenges, and potential solutions with relevance to other countries and contexts. These sessions were important venues for local leadership in HSR and for developing relationships and networks for HSR decision-makers in the region.

Further detail on the research methods for data collection and analysis can be found in **Appendix 1**.

Conceptual approach

A systems approach to understanding NHRS development

While the most visible indicators of HSR performance may consist of research studies, scientific publications, clinical trials and patents, HSR arises out of the functioning of broader systems that are not directly captured by individual indicators alone. Pang et al. define a NHRS as "the people, institutions, and activities whose primary purpose is to generate high-quality knowledge that can be used to promote, restore, and/or maintain the health status of populations."(1) They add: "It can include the mechanisms adopted to encourage the utilization of research." They elaborate four essential pillars of an NHRS: stewardship/governance; financing; creating and sustaining resources; and producing and using research. These pillars have been used to guide much of the thinking about what constitutes an NHRS and what to look for when assessing the functions of NHRS.(52–54)

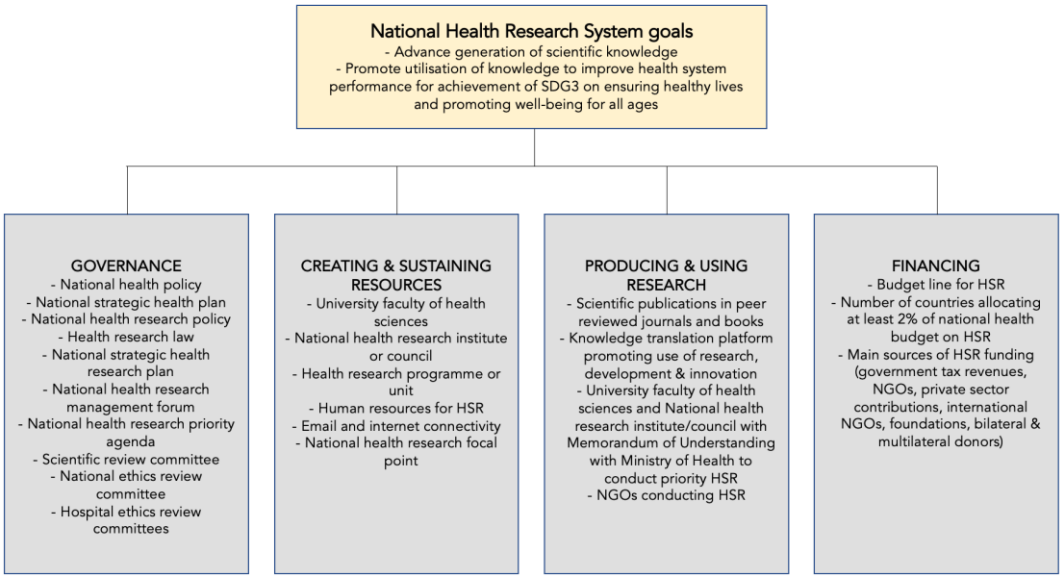


Figure 1. Reproduction of NHRS Pillars, adapted from Kirigia, et al. 2015 (55)

These pillars have also been used within international efforts to assess aspects of health research across countries (see **Figure 1**). In the African region, for example, based on Pang et al.'s work, the WHO Africa Regional Office developed a set of NHRS indicators, the 'African Barometer,' for routine monitoring of development of the pillars: health research policies and governance; human and institutional resources for health research; health research knowledge production, translation, and use; and health research financing. (56–60) But this descriptive analysis does not on its own answer the questions that decision-makers, funders, and researchers have about how to organise and support the development of NHRS in African countries in a holistic and sustainable way.(61,62)

According to Franzen et al., a systems approach to health research capacity strengthening emerged from the "perceived failings of capacity development targeted at only one level," and promotes more sustainability and local ownership of health research capacity by acting on the individual, institutional, and macro levels alongside each other.(15) From a systems thinking perspective, an NHRS should be more than the sum of a set of components – such as those measured in the African Barometer.(60,63,64) To understand systems more holistically requires complimenting measurement efforts with qualitative case-study based investigations that can advance knowledge of the ways that health research systems are set up, strengthened, or sustained at the national level.(65) However, despite the recognition of the systems approach in narratives on strengthening health research capacity and "the accepted importance of research systems development" in the literature on health research capacity development in LMICs, little is known about the emergence and formulation of national health research systems and the empirical examples of success in developing these systems.(15)

We have identified only a few empirical examples of studies drawing lessons about strengthening health research systems in LMICs that explicitly consider systems issues related to how NHRS develop and what factors contributing or hinder to their evolution.(32,50,55,66,67) D'Souza and Sadana (2006) conducted a review of health

research systems in 28 (primarily) LMICs, finding that the impediments facing these systems were similar, although the systems' structures and context varied across countries.(65) The main challenges identified facing NHRS in LMICs were the lack of coordination between health research institutions; inadequate participation of stakeholders in research, policy, and implementation processes, lack of demand for research; and lack of accessibility of findings, while their main constraints were inadequate financial, human and institutional capacity, and lack of data. This list synthesised by D'Souza and Sadana presents a broad overview of challenges and constraints for NHRS generally, but in doing so we miss more granular detail about specific HSR activities that are going on at the country level and how NHRS experience and manage these challenges differently across contexts. Developing a NHRS is a long-term and iterative undertaking. While case studies have identified obstacles and challenges to health research system development, few have explored how these are overcome in practice. Also lacking in the literature are examples of the supportive elements and ongoing processes carried out together for health research systems change, or explorations of NHRS that are showing positive signs of strength and sustainability.(53,54) Thus further case studies and comparative analysis of successful approaches to health research system strengthening could provide particularly useful information to guide policy and practice of decision-makers, researchers, and partners in LMICs.(65) Indeed, Rusakaniko et al. conclude their analysis of the most recent data on system indicators of NHRS in 47 member states of the WHO African Region with a yet unanswered question of "what works elsewhere to help national health research systems grow?"(60)

Insights from government stakeholders on a systems perspective for NHRS

In addition to the ideas arising from the literature on the importance of a whole system approach to understanding HSR strengthening, we also were able to empirically derive conceptual insights based on our engagement with local stakeholders working to improve HSR. As noted above, the third phase of research engaged with decision-makers and bureaucratic officials with mandates to support the development and governance of HSR in their countries. Their unique perspectives from within key institutions responsible for formulating and implementing policy changes provided us with additional insights into the conceptualisations of the NHRS system in national settings, as well as priorities and challenges faced in developing such systems. Discussions with this group corroborated the findings in the literature about the need for knowledge about how to build strong NHRS, going beyond recognition of the core pillars of the systems. Their insights helped to elucidate why investigating the establishment of the pillars of NHRS alone is inadequate to capture the wider system issues which influence their development and the connections between them.

For example, decision-makers emphasised that a NHRS which fosters an enabling environment for HSR comprises several interactive features that support the HSR activities in one way or another, but which may not be counted themselves when assessing metrics of HSR performance or NHRS pillars. They particularly referred to having an appropriate health research policy framework in place – either or both a regulatory and a legal framework. However, the policy framework alone does not capture the supportive elements and ongoing processes over time required for HSR regulation to function within a NHRS. They underscored the importance of elements such as political will – in terms of commitment from higher level politicians to health research – as being influential in shaping regulation through the way this commitment is translated into government support for the financing and governance of NHRS. They also stressed the importance of continuous processes, such as

advocacy, collaboration and stakeholder engagement, as necessary ways of working within NHRS to enable the core pillars to function and to promote a shared awareness of the importance of HSR and its value to society.

Ongoing processes of alignment and prioritisation are conducive to review and redefine the strategic direction for HRS within a NHRS, but they are also integral to connecting its impact on the overlapping systems (e.g. health, education, innovation) and its contribution to overarching national health and development goals and objectives. Thus, the critical reflections which emerged from the third phase of work with key decision-makers from the health, higher education/research, and STI sectors underlined a number of issues which contributed to defining a conceptual approach that incorporates both how African stakeholders conceptualise NHRS development, as well as the state of knowledge in the scientific literature. It is from this vantage point that we investigate NHRS in nine African countries with a focus on understanding the interconnectedness and interactions between the various parts of a national health research system that are needed to support its functioning and achieve its goals. Ultimately, whilst there has been acknowledgment of the need for a systems approach to the study of NHRS, much of the available knowledge remains focused on the core pillars in place in a given setting without significant exploration of the supportive elements and processes that connect and enable them as part of a whole NHRS.(60,65)

Using a systems approach to study NHRS development

Combining the insights from the literature and from African decision-makers, we define a systems approach to study NHRS development as one that looks at the connections between the pillars of NHRS, the elements that support them, and the ongoing processes that enable the strengthening of the system as a whole.(68–72) A systems approach recognises that the presence of the four pillars is necessary but insufficient on its own to capture the essence of a NHRS and comprehensively understand its development. The systems approach therefore takes into account the interdependence of people, institutions, and arrangements within the NHRS and seeks to identify interrelationships between the pillars, the elements that support them, and the ongoing processes which influence and reinforce a NHRS. This perspective considers NHRS as dynamic social systems, which are continuously emerging, adapting, organising, and learning through interaction of actors and ideas within NHRS and in wider overlapping systems (e.g. health system, higher education system, science and innovation system). This conceptualisation focuses attention on elements, such as research leadership or regulatory structures, that support the integration of the main pillars of a NHRS; and also ongoing processes, such as collaboration or advocacy, that are required for NHRS to function and develop over time. We propose that a systems perspective defined in this way is helpful to identify lessons from experiences across the continent about how and why NHRS have developed differently in various settings.

As discussed above, most scholarship and research on NHRS focuses on the pillars (see **Figure 1**), which are the core functions of a NHRS. Although our report begins by presenting results related to the metrics of HSR performance and the NHRS pillars, the more novel contribution (and core findings) of our research is in connecting them to the supporting elements and ongoing processes that help explain how to develop, strengthen, and sustain NHRS. Although these elements and processes are not captured and counted in the metrics

of HSR performance or NHRS pillars, we argue that they are equally important for NHRS to function and develop over time. A whole systems approach to analyse NHRS thus combines knowledge about how the necessary pillars, supporting elements, and ongoing processes work together in various combinations to support, connect, and facilitate the development of NHRS in context.

Outline of Results Sections

The findings presented in this report are based on comparative empirical analysis from the project, focused on understanding what actors in African states are doing to build strong NHRS and the challenges they face in doing so. **Figure 2** displays the frequency of prominent themes in the data visually in a word cloud, while the detailed results herein are organised thematically, under three main chapters.

Figure 2. Key Themes in the Data from Key Informant Interviews

Chapter 2, **Mapping the metrics of NHRS**, presents findings on the available indicators of HSR performance and achievement at the national level across all 54 sovereign states, drawing on the work done in the first phase of the project. The chapter also critically discusses the interpretation of these standardised metrics and provides examples of alternative and complementary perspectives on HSR performance linked to local understandings of capacity.

Chapter 3, **Strengthening NHRS in Africa**, presents findings in two main subsections. The findings draw on the in-depth analysis of a dataset of 189 key informant interviews conducted in nine African countries across the major sub-regions of the continent.

First, section 3.1 – **Pillars of NHRS and the state of the HSR environment**, presents results on the four core pillars of NHRS in the countries studied. This section presents local perspectives on the key components already established in the literature: domestic funding for HSR, institutional and human capacity for HSR, HSR use and uptake,

and governance of HSR. These four pillars were often discussed as part of the shared challenges faced by multiple African states regardless of the stage of development of their NHRS. However, while the core challenges to developing and strengthening NHRS appear similar across cases, the solutions and responses to these challenges manifest in context-specific ways, outlined in our results.

Secondly, section 3.2 – **Elements and processes of NHRS** looks at themes under the supporting elements and ongoing processes that connect the four pillars and enable the strengthening of NHRS as a whole. These involve various combinations of actors, structures and processes that support NHRS functioning as well as its ability to learn, self-organise, change, improve, and adapt as a system.

Supporting elements (such as regulatory environments, political will, research leadership, research culture,) serve a relational role to link up different parts of the system. Ongoing processes (such as collaboration, advocacy, alignment and prioritisation, and innovation) serve as practices and methods used by actors in the NHRS to support the functioning and the improvement of the NHRS. The themes are discussed individually, but they are nonetheless interrelated in terms of how they work together in NHRS.

A guide to getting the most from Chapter 3

A systems approach highlights the interconnectedness of the people, institutions, and activities in NHRS through elements and processes that support the functional pillars to finance, govern, produce and use knowledge, and create and sustain resources for HSR.

Chapter 3 presents findings under the NHRS pillars (Section 3.1) and the NHRS elements and processes (Section 3.2). While the results sections present themes separately, they are also seen throughout the chapter due to their interdependence. As a visual tool to guide the reader, we have underlined the central elements and processes that appear in thematic sub-sections other than their own. We do this to signpost the interconnectivity between these within NHRS and emphasise the systems approach to analysing NHRS development.

NHRS are strengthened through these dynamic processes over time, and the relationships between the supportive elements and processes operate uniquely in different contexts. To further illustrate how these are interwoven, we have curated ten vignettes from the cases (**Boxes 1-10**) positioned throughout Chapter 3 to spotlight how these elements, processes, and pillars interact and strengthen NHRS in practice in various national settings.

Chapter 4, **Enabling NHRS change through peer exchange and learning**, shares results and reflections from the third phase of our work using structured engagement with decision-makers. We examine how peer-to-peer learning workshops could stimulate or support incremental changes by individual decision-makers in their contexts, and how stakeholders perceived the benefits and impact of this branch of the project work.

Through this ensemble of results, we aim to present a more holistic picture of NHRS in Africa beyond the architectural pillars of NHRS and indicators of performance and capacity. We hope to highlight the nuanced supportive elements and ongoing processes that influence NHRS trajectories, whilst recognising that there is no universal, prescriptive approach for strengthening these systems that can be reproduced in different contexts. From this, we underline a range of options based on analyses of these experiences, recognising the variety of ways that actors can manage complexities in developing NHRS capacity.

Chapter 2. Mapping the metrics of NHRS

Indicators of HSR performance

The first phase of this project undertook a review and mapping of existing indicators (and proxy indicators) for HSR by searching for metrics and data to identify stronger or weaker performance across the continent. This work serves to construct an indicator framework for assessing HSR performance at the level of NHRS based on existing data sources. The framework incorporates and expands on indicators from previous studies (see **Appendix 1** on methods), and consists of the following items (available in gross figures or per capita ratios):

1. Bibliometric data to capture academic publications in health sciences with an author from the country;
2. Clinical trials conducted in country;
3. Patent applications;
4. Research Personnel
5. Gross Expenditure on Research and Development (GERD), and Gross Expenditure on Medical and Health Sciences;
6. Research regulatory bodies;
7. Health research funding received from major donors.

To our knowledge, this is one of the first studies to systematically outline the contributions and achievements of African countries to HSR across a wide range of indicators. A set of results tables and figures are provided in **Appendix 2**.

Appendix 2 – Table 1 presents the bibliometric data collected from the Scopus database and SciVal, analysing total number of outputs published with a first author and total number of outputs published with at least one author based at an institution in one of the 54 countries, classified in one of the health or medical categories available in those databases. Collaboration figures are from SciVal and reflect outputs published in 2013-2017. All other data cover outputs published in 2008-2017. The total number of outputs published in this period ranged from 25 in Sao Tome and Principe to 63,171 in South Africa. If one excludes Seychelles (due to its very small population), on a per-capita basis, Tunisia had the highest output of 1800 publications per thousand population, while South Sudan had only 0.007 publications per thousand people. The absolute number of citations for published outputs ranged from 335 in Sao Tome and Principe to 243,026 in Kenya (note: no citation or first-author publication data were retrievable for South Africa or Egypt). First authored publications by researchers based in each country were a relatively small share of total publications, while in more than three-fourths of the countries (43/54) over 70% of publications included international authors.

Appendix 2 – Table 2 shows the data on clinical trial infrastructures and intellectual property rights. The number of clinical trials indexed in the WHO's International Clinical Trials Registry Platform in 2018 ranged from 0 in Cape Verde to 4,341 in South Africa. The number of patent applications by residents (2016, or last available year) ranged from 1 in Botswana, Djibouti, and Tanzania to 2,783 in South Africa.

Appendix 2 – Tables 3 and **4** gives information on R&D personnel and spending, respectively. We collected data (where available) on the number of Research and

Development staff, researchers, medical and health sciences researchers, and researchers with a PhD per million inhabitants. Based on data from 2016, or the nearest available year, the number of researchers per million inhabitants ranged from 7 in the Democratic Republic of Congo to 1965 in Tunisia; the proportion of researchers with doctoral or equivalent degrees ranged from 10% in Malawi to 72% in Cape Verde. The gross expenditure on R&D as a share of GDP ranged from 0.01% in Madagascar to 0.8% in South Africa. The proportion of gross expenditure on R&D that went to the medical and health sciences ranged from 0% in Lesotho to 30% in Swaziland.

Appendix 2 – Table 5 presents data on regulatory capacities reflected in both policies and institutional structures. Overall, there are few organisations, legislations, regulations, and guidelines covering human subjects standards in African countries. About half the countries had a national public health institute (27/54) and national ethics committee (25/54). The number of institutional review boards ranged from 0 in several countries to 30 in South Africa.

Appendix 2 – Table 6 shows the amount of HSR funding awarded to researchers in each country (2008-2017) from ten of the largest public and philanthropic funders of health research globally: 1) U.S. National Institutes of Health, (2) European Commission, (3) U.K. Medical Research Council, (4) French National Institute of Health and Medical Research, (5) U.S. Department of Defence (including the Congressionally Directed Medical Research Program), (6) Wellcome Trust, (7) Canadian Institutes of Health Research, (8) Australian National Health and Medical Research Council, (9) Howard Hughes Medical Institute, and (10) German Research Foundation.

Recognising the fact that many indicators of research capacity or outputs are highly linked to finances, **Appendix 2 – Figures 1** through **10**—and the corresponding tables under each figure – present associations between various metrics and national GDP (gross and per capita). Unsurprisingly, there tend to be strong positive association between GDP and the HSR indicators.

Table 1 below here in Chapter 2 combines our main indicators into a single table. It colour codes countries based on their per-capita score on each indicator and divides them into top, middle, and bottom terciles to illustrate relative performance on key indicators. These metrics should always be presented per-capita, to avoid biasing analysis of performance to larger countries. An indicator in the top third is coded green, middle third coded orange, and bottom third as red. Our data indicate some countries scoring highly across a range of indicators we have reviewed. For example, Botswana, Tunisia and Zambia all score well on multiple indicators. Similarly, there are states that are struggling on multiple indicators – such as Democratic Republic of Congo, South Sudan and Liberia. Whilst there are structural and historical factors that may account for relative achievement, such as income level or recent conflicts, there is clearly a range of outcomes for countries at similar levels of income as well. Thus, while obviously important, GDP per capita is not the key determinant of a flourishing HSR landscape. There are multiple and competing factors contributing to how a HSR environment is facilitated and/or what barriers are in place for the development of such a system.

For most states, quantifiable metrics present a mixed picture – showing high relative performance in some indicators, but lower in others (and in many cases lacking data). For example, Libya is a relatively high achiever for publications, first author publications and number of research institutions, but has relatively few clinical trials conducted within the

country. Conversely, Burundi has low numbers of publications, first author publications, number of clinical trials and GERD as a % of GDP but performs relatively well in number of research institutions. It is interesting to also note that it is not simply donor funding put into health sciences research that leads to greater output. States which have had major donor investment in health sciences research (per capita), including Uganda and The Gambia, have not necessarily emerged at the top on several other indicators.

Table 1. Indicators Framework for all 54 Sovereign African States

The table below presents key data used to identify case studies for Phase 2 of this research project. Country indicators are colour coded depending on whether they fall in the top third (green), middle third (yellow), or bottom third (red) of all included countries for that indicator. This provided a simple way to identify countries that appeared to be doing well (mostly/all green), doing poorly (mostly/all red) or somewhere in the middle (mixed).

Country	GDP (million, current US$, 2016)*	Population (thousand, 2016)**	GDP per capita (current US$, 2016)	# of publications per 1 million inhabitants	# of first author publications per 1 million inhabitants	# of trials per 1 million inhabitants	# of universities per 1 million inhabitants	GERD as a % of GDP	GERD per capita (in current PPP$)	Total R&D personnel per million inhabitants (full-time equivalent [FTE])	Researchers per million inhabitants (FTE)	Researchers (FTE) – ISCED 8 %
Algeria	159,049	40,606	3,917	198.07	159.41	4.06	0.76	0.06604	7.2459	220	168.0163	16.2167
Angola	95,335	28,813	3,309	15.48	4.16	0.56	0.59			84	47.48423	20.08696
Benin	8,583	10,872	789	223.23	107.25	4.97	0.37					
Botswana	15,581	2,250	6,924	784.80	335.96	41.33	3.56	0.53728	86.56169	570	179.46852	29.37026
Burkina Faso	11,693	18,646	627	166.47	71.65	9.98	0.11	0.22183	3.69759	131	47.57672	41.85226
Burundi	3,007	10,524	286	23.09	6.37	1.81	0.86	0.12126	0.93551			
Cameroon	32,218	23,439	1,375	254.83	143.18	4.82	0.55					
Cape Verde	1,617	540	2,998	229.82	35.21	0.00	12.97	0.07264	4.35263	73	49.20611	72
Central African Republic	1,756	4,595	382	72.48	29.82	2.83	0.22					
Chad	9,601	14,453	664	14.05	3.81	0.83	0.07	0.31584	6.29966	76	58.32884	29.7242
Comoros	617	796	775	76.67	16.34	3.77	1.26					
Democratic Republic of the Congo	35,382	78,736	449	19.50	7.73	1.10	0.20	0.01677	0.13431	19	7.22867	11.94626
Djibouti	1,727	942	1,833	64.73	31.84	4.24	1.06					
Egypt	332,791	95,689	3,478	634.28	N/A	38.78	0.49	0.70876	79.03017	1209	680.30277	55.86286
Equatorial Guinea	10,685	1,221	8,747	93.33	9.82	4.91	0.82					
Eritrea	2,608	4,475	583	34.42	12.07	1.34	0.22					

Ethiopia	72,374	102,403	707	96.93	64.74	1.84	0.30	0.60474	8.29691	121	44.96602	16.65635
Gabon	14,214	1,980	7,179	607.64	225.28	31.82	1.01	0.57924	83.1039			
Gambia	965	2,039	473	576.40	178.07	58.38	1.47	0.13309	2.02923	603	33.55545	55.6314
Ghana	42,690	28,207	1,513	248.34	130.50	8.44	0.92	0.37655	11.28715	123	38.37288	34.39294
Guinea	8,200	12,396	662	124.80	33.72	2.50	0.32					
Guinea-Bissau	1,165	1,816	642	183.40	61.13	34.15	N/A					
Ivory Coast	36,373	23,696	1,535	110.65	66.38	3.04	0.30				69.20697	
Kenya	70,529	48,462	1,455	294.79	125.27	13.19	1.03	0.78578	19.06104	1029	225.0294	6.072
Lesotho	2,291	2,204	1,040	84.40	29.04	9.98	0.45	0.04804	1.38796	33	22.83131	28.0597
Liberia	2,101	4,614	455	55.92	9.75	5.42	0.22					
Libya	34,699	6,293	5,514	240.42	116.79	3.02	1.91					
Madagascar	10,001	24,895	402	80.30	27.32	1.08	0.24	0.01498	0.226	113	24.7042	46.99187
Malawi	5,433	18,092	300	190.25	66.55	17.52	1.16			113	48.26897	9.88531
Mali	14,035	17,995	780	93.97	27.51	9.45	0.06	0.31461	6.44217	73	30.79076	61.79232
Mauritania	4,739	4,301	1,102	52.78	19.30	2.33	0.23					
Mauritius	12,168	1,263	9,631	583.31	319.75	26.91	1.58	0.17773	31.00158	500	181.82964	27.58227
Morocco	103,606	35,277	2,937	341.61	269.70	5.41	0.79	0.71454	45.77682	1149	1068.96019	16.23857
Mozambique	11,015	28,829	382	60.04	18.80	3.36	0.55	0.33751	4.02668	83	41.47952	13.9878
Namibia	10,948	2,480	4,415	413.76	135.90	2.82	1.61	0.33996	34.44063	236	143.31554	21.76018
Niger	7,528	20,673	364	38.89	13.45	1.64	0.05			44	7.41641	
Nigeria	404,653	185,990	2,176	166.80	139.00	1.84	0.65	0.21896	9.38995	77	38.7694	34.11257
Republic of the Congo	7,834	5,126	1,528	179.68	68.48	10.14	0.20			67	31.54328	
Rwanda	8,376	11,918	703	127.46	45.14	8.14	0.92				12.34785	37.66234
Sao Tome and Principe	343	200	1,715	125.06	20.01	10.00	N/A					
Senegal	14,684	15,412	953	237.94	114.13	6.68	0.65	0.75183	18.4002	623	549.32251	38.68145
Seychelles	1,427	95	15,075	3580.48	602.03	31.69	21.12	0.2214	63.26424	2028	146.48878	15.38462
Sierra Leone	3,737	7,396	505	71.66	13.79	5.27	0.41					
Somalia	6,217	14,318	434	5.10	1.68	0.98	1.12					

South Africa	295,456	56,015	5,275	1127.74	N/A	77.50	0.45	0.79848	105.3203	743	473.12028	35.21929
South Sudan	9,015	12,231	737	0.00	0.00	0.16	0.25					
Sudan	95,584	39,579	2,415	93.31	49.67	1.79	0.96	0.29844	9.09993			
Swaziland	3,721	1,343	2,770	403.54	148.16	16.38	0.74	0.27013	22.36062	309	119.14495	24.98067
Tanzania	47,340	55,572	852	138.85	56.99	7.79	0.40	0.52924	12.31825	39	18.33753	32.78053
Togo	4,400	7,606	578	121.48	73.89	2.10	0.13	0.27166	3.76403	42	31.76941	68.88061
Tunisia	42,063	11,403	3,689	1800.54	1502.90	37.36	1.67	0.59989	69.69501	2069	1964.96647	35.06687
Uganda	24,079	41,488	580	198.85	84.27	15.69	0.46	0.17043	2.93947	42	26.46695	30.51177
Zambia	21,064	16,591	1,270	166.23	51.89	15.79	0.48	0.27819	7.7016	163	40.97071	
Zimbabwe	16,620	16,150	1,029	186.06	81.73	11.76	0.93			118	88.72377	13.45285
	* Except Djibouti (2015), Eritrea (2011), Libya (2011), and South Sudan (2015) **Source**: World Bank	** Except Eritrea (2011) **Source**: World Bank			**Note:** put two N/A (South Africa and Egypt) as highest category		Note: put two N/A as lowest category	Split 10/11/10	Split 10/11/10		Split 11/12/11	Split 10/11/10

Interpreting metrics: African perspectives on HSR performance versus capacity

Metrics such as those analysed above can potentially be used to construct a scorecard by which to compare or rank countries. Indeed, by classifying countries into high, middle, and low achievements, this begins to do just such a comparison. However, there are challenges to comparatively using the data in such a way, and our research and engagements with stakeholders have led to resistance to using a limited range of indicators to come up with a single score for countries.

Several critiques of these metrics were raised by the technical government staff who took part in the second and third phases of research (primarily working within Ministries of Health or Education) and questioned whether standardised global metrics for assessing HSR performance were the most relevant for the African context. Stakeholders raised issues about the intended audience for these metrics and their potential use, highlighting that the structures that shape the selection and significance of some indicators over others should not be neglected when trying to understand how and why we map HSR performance in African countries. Their concerns about the use of these metrics for constructing a single indicator of capacity that might be used to score or judge countries noted possible built-in biases around decisions of which data matters and which variables would be included. The lack of comprehensive data across the continent – with data missing in many indicators – makes it difficult to find this information and thus difficult to comparatively understand any differences in achievement. Indeed, to construct a single indicator based on available data inherently biases the resultant indicator towards those items where more robust data exists – either because it is easier to collect, or because an agency has already decided to invest in data collection. Thus, it is important to reflect on the potential implications of reproducing a global hierarchy of indicators that may influence HSR and funding policies, strategic decisions, and evaluation of HSR in a manner that is not adapted for African contexts.

Furthermore, it was argued that some variables are more correlated than others, such as international collaborations and authorship in publications. For example, publications per thousand habitants does not describe the ownership of the production of HSR knowledge, the international collaboration involved, where the intellectual leadership of the project was based, the source of funding, the relevance of the research to local priorities and knowledge user needs, or the contribution of the research to strengthening local capacity. Similarly, counts of clinical trials do not indicate which phases of the trials are conducted locally, the extent of oversight or review undertaken through local bodies, the institutions and scientists responsible for running the trials, the role of private industry, and whether the trials contribute to building sustainable infrastructure and technology transfers locally.

The critical reflection on the use of indicators, particularly informed by local stakeholders, highlights that HSR performance indicators should not be confounded with, or considered a proxy of, HSR capacity itself in many regards. Our third phase of work, however, allowed us to undertake a series of brainstorming exercises and collective discussions to specifically consider the question of what HSR capacity means from the perspective of senior bureaucrats working in health, education, and science sectors. These discussions lead to a list of 4 key aspects of HSR capacity and multiple action areas where the stakeholders looked to achieve improvement. These are summarised below. While these brainstorming exercises in the third phase of work were carried out for the purpose of

developing individual action plans (see Chapter 4), the ideas which emerged are useful to situate within our conceptual framework from a systems perspective.

Decision-makers' conceptualisation of HSR capacity and their ideas about strategies to improve it.

Key aspects of HSR capacity
Financing
Human Resources
Enabling environment
Utilisation and uptake

Action areas to achieve improvements in HSR
Generating funds (government, donor, private)
Build/retain human resources
Coordinate and align activities (higher education, donor agendas, local needs)
Implementation of policies or plans
Generate innovation
Integration of HSR within the health system
Improve cross-border collaborations
Improve governance within research system
Involve the community
Networking – both internal and external to a country
Increase commitment and/or political will
Improve research quality
Lead by example

The key aspects of HSR capacity elaborated by local decision-makers reflect many of the pillars of NHRS on which there is broad agreement. Financing, human resources, and research utilisation and uptake are well recognised as the basis of a functioning NHRS, as per the classic frameworks of NHRS and incorporated in the African Barometer to monitor NHRS in the WHO African Region.(1,52,53,57,60) However, the enabling environment reveals a sense of connection; it is a matter of bridging those pillars with the elements and processes of the NHRS that support and sustain HSR activities, but which may not be explicitly considered or measured themselves as part of HSR performance or capacity. The enabling environment includes other pillars, such as policy frameworks, but it relies on the strong interaction of research leadership and political commitment within regulatory environments and various institutions which enable the growth and development of national health research systems. The actions they consider for improving the situation of their respective NHRS also refer to many of the supportive elements and processes of NHRS addressed in Chapter 3 of this report, such as innovation, collaboration, and advocacy.

These insights from the third phase working with and listening to decision-makers again emphasise the interconnected nature of NHRS from the perspective of those mandated to develop it, thus highlighting the importance of a systems perspective whereby pillars, connected by supporting elements and ongoing processes within a given context are equally instrumental to an understanding of NHRS. Looking at these metrics of HSR performance in isolation may well provide a general idea of how different countries in Africa are comparatively situated to one another and to countries around the world, but they tell us little about the history and context of NHRS in those countries. The stories behind these metrics are equally vital to learning lessons for HSR capacity development.

Chapter 3. Strengthening national health research systems in Africa

In this section of the report, we turn to the empirical findings from second phase into the broader factors supporting or challenging the development of health sciences research from a whole-systems perspective. This section begins by laying out the conceptual framework which emerged from our empirical findings based on the nine in-depth case studies carried out in the second phase of the project. The findings draw on the analysis of a rich corpus of qualitative data collected from interviews with 189 key informants who are researchers, decision-makers, and funders in Botswana, Cote d'Ivoire, Ethiopia, Kenya,

Liberia, Madagascar, Tunisia, Uganda, and Zambia. The key informants we interviewed (see **Table 2**) came from a stakeholder groups including local government (ministries of health, education, and science; legislatures; regulatory agencies; and national public health institutes); research institutions (public, private, non-governmental, and academic); donors (government agencies; non-governmental organisations – NGOs); global organisations (UN agencies, international organisations, NGOs); and private (for profit) industry (see **Appendix 1** for further details on methods).

Table 2. Number of Stakeholders Interviewed by Country and Role

	Donors	Decision-Makers	Researchers	Case Total
Botswana	0	1	17	18
Côte d'Ivoire	5	5	9	19
Ethiopia	0	8	9	17
Kenya	4	4	17	25
Liberia	4	13	8	25
Madagascar	12	11	14	37
Tunisia	2	2	7	11
Uganda	3	6	7	16
Zambia	4	5	12	21
Total	**34**	**55**	**100**	**189**

Figure 3 provides a visual guide to the key themes which are presented in this chapter under the conceptual headings of the pillars (section 3.1) and elements and processes (section 3.2) of an NHRS, with the aim of representing their relationships to each other within the system. The foundation of the system is the four pillars of an NHRS, which are essential to its functions (rectangles). The pillars are interconnected through elements and ongoing processes that are required to support the development and implementation of those functions and strengthen the NHRS as a whole. The supporting elements of NHRS are research culture, research leadership, political will, and regulatory environment. As a dynamic system, these elements interact in a NHRS with a number of ongoing processes to create an enabling environment for HSR in supporting its pillar functions, and to create relationships within the system between actors. These cover an array of continuous social, political, scientific, and economic process that underpin the HSR activities and functions of the NHRS and provide the basis for its subsistence, including partnership and collaboration, advocacy, alignment and prioritisation, and innovation. In addition to forging connections within the NHRS, these supporting elements and ongoing processes are also a means to strengthen a NHRS' relationships with other overlapping or adjacent systems such as the health system; higher education system; science, technology, and innovation system; and development system.

Finally, national ownership lies at the centre of the NHRS because it is the core principle on which any NHRS should be operating. When the supporting elements and processes come together with this principle as their main focus, they can not only strengthen the pillars of the system, but also embed the NHRS in local needs, resources, expertise, and power to develop and carry out its functions in appropriate ways that serve, benefit and are accountable to the local population.

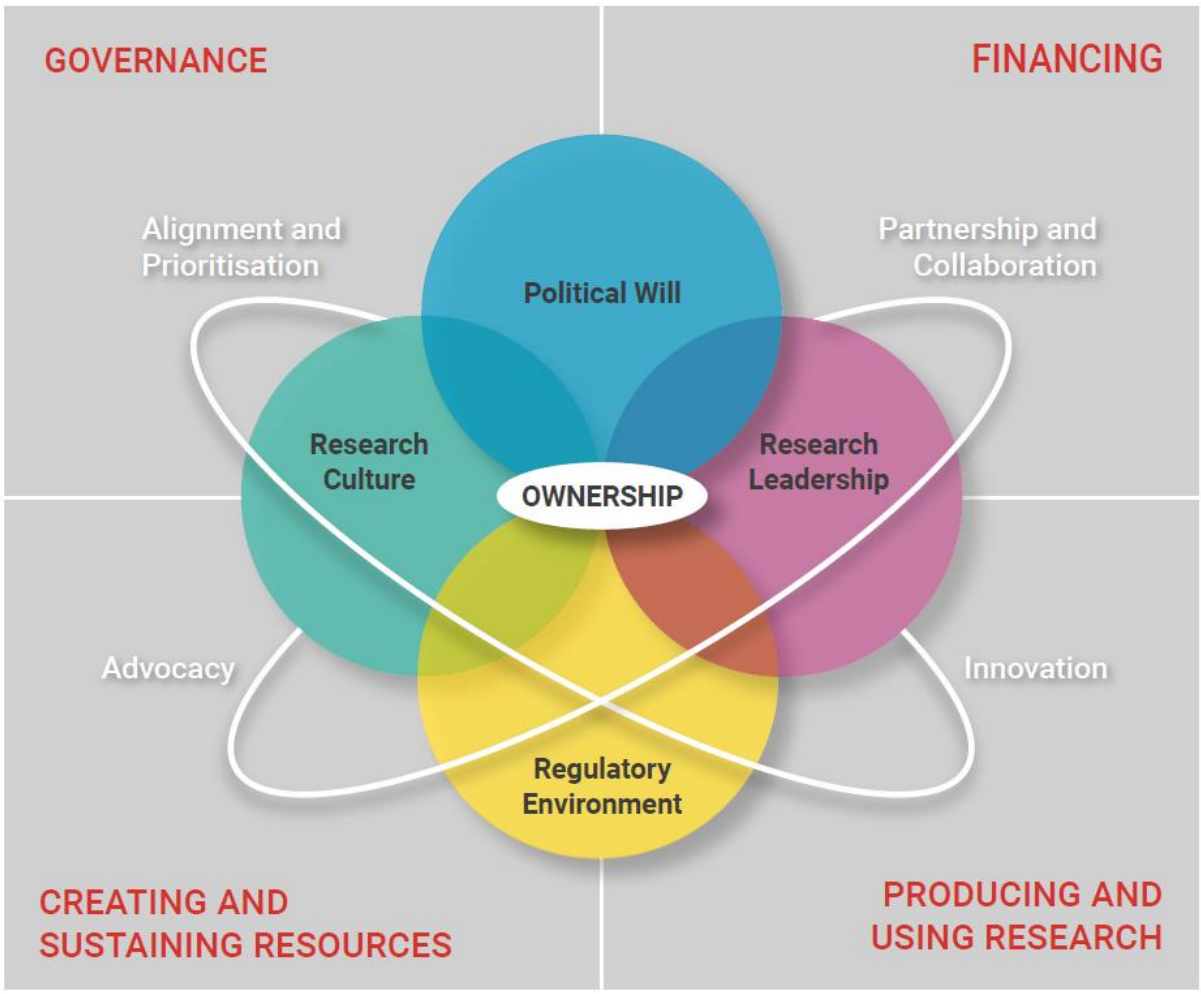


Figure 3. Conceptual Framework of a National Health Research System

Section 3.1 of this chapter presents findings on the pillars of NHRS, and Section 3.2 presents findings on the supportive elements and ongoing processes. While the themes under each of the categories of pillars, elements, and processes of NHRS are presented and discussed individually in Chapter 3, they are integrally linked and interconnected in terms of how they operate within NHRS. For this reason, we underline these eight central elements and processes that appear in sections other than their own to illustrate the ways that these are interwoven in practice. For example, in the section focused on alignment and prioritisation processes, political will and research leadership (among others) are often integrally linked in efforts to put HSR on national agendas; in discussions of innovation, the regulatory environment and advocacy are commonly referenced and thus underlined for emphasis. Similarly, to demonstrate how ownership undercuts and is central to our findings, it is underlined throughout Sections 3.1 and 3.2. The findings presented below are further illustrated through brief vignettes to highlight examples from the data (see **Boxes 1-10**). These boxes, which are presented throughout Section 3.2, provide concrete examples from case countries to demonstrate how the elements, processes, and pillars of NHRS uniquely interact in practice in different contexts.

3.1. Pillars of NHRS and the state of the HSR environment

This section presents findings on the foundational pillars of an NHRS (see **Figure 1**) in the nine cases. Recognising that these are discussed widely in the literature, this section only briefly discusses these before we elaborate more on the findings in Section 3.2, which provides deeper analysis of systems features typically absent in the broader literature.(56–60) However, as the key informants across all stakeholder categories discussed the challenges in establishing and functioning the key pillars in their NHRS, we felt it important to discuss them first. The descriptive data collected from a literature review and the interviews provides an overview of the state of the NHRS pillars across the nine countries (see **Table 3**).[1] Together with detailed comparative analysis of material from the qualitative interviews, this section shares African perspectives on these four key areas: domestic funding for HSR, human and institutional capacity for HSR, use and uptake of HSR, and governance of HSR. While the results within section 3.1 will not be surprising to those familiar with and working in ministries, universities, ethics committees, and other HSR regulatory agencies in these contexts, they underline the challenges faced by those who conduct, govern, and fund HSR in African countries to set up and attain the fundamental pillars of NHRS.

[1] The information presented in Table 3 was collected from literature review and interviews with key informants in the nine cases. Any gaps or blank cells in this table means that the data was not found in the document review, nor did it come up in the interviews. Only policies that have been officially adopted and institutions that have been formally established are included in the table. Therefore, legislation, policies, or institutions pending, in progress, and under development are excluded from the table.

Table 3. Overview of NHRS Pillars Across Cases

	Pillar 1: STRENGTHENING GOVERNANCE OF HEALTH SCIENCES RESEARCH						Pillar 2: CREATING & SUSTAINING RESOURCES FOR HEALTH SCIENCES RESEARCH			Pillar 3: PRODUCING & USING HEALTH SCIENCES RESEARCH		Pillar 4: FINANCING HEALTH SCIENCES RESEARCH
Case of NHRS	**Legal framework for health research**	**Health research regulation (institutional structures)**	**Science, technology, innovation and development policies and priorities relevant for health research domain**	**Health research policies and priorities**	**National ethics committees/ IRBs for health research**	**Research / health research governance, norms and guidelines**	**Main health research institutions, universities, collaborations, and national research centres***	**Centres of excellence (for HSR)**	**National Laboratories**	**Knowledge translation platforms**	**Health research coordination (institutions and mechanisms)**	**Domestic health research funds (national funding schemes and government co-funded schemes)**
Botswana		Ministry of Health and Wellness (Health Research Unit in the Department of Health Research, Policy and Development) Ministry of Tertiary Education, Research, Science, and Technology Ministry of Infrastructure, Science, and Technology (Department of Research, Science and Technology)	Vision 2036 – Achieving Prosperity for All Vision 2016 – 10th National Development plan (2009-2016) National Policy on Research, Science, Technology, and Innovation (2012) National Research, Science, and Technology Plan (2005) National Science and Technology Policy (1998)		Health Research and Development Committee (HRDC) IRB, University of Botswana IRB in some hospitals	National research guidelines for all sectors	University of Botswana Botswana International University of Science and Technology The Botswana Harvard AIDS Institute (1996) Botswana-Upenn Partnership (BUP) Botswana Vaccine Institute	Infectious diseases University of Botswana – WHO Collaborating Centre for Nursing and Midwifery Development			MoH responsible for coordination of HSR – government has mandated some of this to the University of Botswana	
Côte d'Ivoire		Ministry of Higher Education and Scientific Research (1971) Ministry of Health and Public Hygiene (Directorate of Training and Medical Research est. 1999)	Development plan for Higher Education and Scientific (2016-2025) National Development Plan (2016-2020) National Policy on Scientific Research and Technological Development (2014)	National Strategic Plan for Health Research (2018) National Health Research Policy (2013) 9 national research programmes (1 of which focuses on health)	National Ethics and Research Committee (CNER) National Ethics Committee for Life Sciences and Health Ethics review committee of CSRS	Programme Commissions (1976, reform in 1982)	National Institute of Public Health (INSP) (1970) Research Centre on Infectious Diseases and Associated Pathogens (CERMIPA) (2019) PAC-CI – Côte d'Ivoire research site of French National Agency for Research on AIDS and Hepatitis (ANRS) Centre Suisse de Recherche Scientifique (CSRS) Institut National d'Hygiène Publique (INHP) Laboratoire National de Santé Publique (LNSP) (1956)	Institut Pasteur de Côte d'Ivoire (IPCI) (1972)	West African Reference Biobank for ECOWAS IPCI High Safety Laboratory (P4) with international containment infrastructure to conduct viral pathogen research		Both the MHESR and MOH are responsible for coordination of health research – no single structure or collaborative mechanism to coordinate this.	The Strategic Support for Scientific Research Project (PASRES) National Fund for the Support of Research and Innovation (FONARI)

Ethiopia	Ethiopian Constitution (Articles 29- 1 and 2, 51- 3, and 91-3)	Ministry of Science and Higher Education (2018) Ethiopian Public Health Institute (1995) Ministry of Health	Ethiopian National Science and Technology policy Health Sector Transformation Plan	National Health Science and Technology Policy (1993)	Ethiopian Public Health Institute Research Ethics Committee Regional ethics	National ethical guidelines for research (1995)	Ethiopian Health and Nutrition Research Institute (EHNRI) (1996) Ethiopian Science and Technology Agency (ESTA) (1975) Armauer Hansen's Research Institute (AHRI) (1970) Addis Ababa University, Addis Ababa University Medical Faculty (1962) Jimma University Gondar University, Dept. of Public Health (1997) Institute of Pathobiology (1966) Gondar Public Health College and Training Center (1952) Imperial Medical Research Institute (1942)	Addis Ababa University – WHO Collaborating Centre for Mental Health research and capacity-building			Ethiopian Public Health Institute	
Kenya	Health Act (2017) Science, Technology and Innovation Act (2013) Constitution of Kenya (2010) – academic freedom and freedom of scientific research (Article 33) Science and Technology Act (1977,1979)	Ministry of Health (Research and Innovation Division) Ministry of Education (Directorate of Research Management and Development) National Council for Science and Technology (NACOSTI) Commission for University Education	Vision 2030 National Research and Development Agenda (2013-2018)	Research for Health Policy Framework (2019) National Research for Health Priorities (2019-2023) National Health Policy (2014-2030)	KEMRI Scientific Ethics Review Unit (SERU) IRB, AMREF IRB, Kenyatta National Hospital IRB in some universities	National Bioethics Committee (with 27 accredited Institutional Ethics Review Committees for human and animal research) KEMRI Scientific Ethics Review Unit AMREF Ethics Review Committee Kenyatta National Hospital Research Committee multiple university IRB Pharmacy and Poisons Board (mandated for regulation of clinical trials)	University of Nairobi, College of Health Sciences Trypanosomiasis Research Centre (KARI-TRC) (merged Kenya Trypanosomiasis Research Institute and Kenya Agricultural Research Institute in 2003) Kenya Institute for Public Policy Research and Analysis (KIPPRA) Alupe Leprosy & Other Skin Diseases Research Centre	Kenya Medical Research Institute (KEMRI) (1979) Academic Model Providing Access to Healthcare (AMPATH) Institute of Tropical and Infectious Diseases (UNITID), The Centre for HIV and AIDS Prevention and Research (CHIVPR) East African Kidney Institute (EAKI)			National Health Research Committee (2019) NACOSTI (coordination falls within mandate of the Health and Biological Sciences Specialist Committee)	National Research Fund (est. 2015) (Kenya National Innovation Agency – KENIA)

Liberia	Act to create National Public Health Institute of Liberia (2016) Act to establish the Medicines Regulatory Authority (2010)	Ministry of Health (Health Monitoring, Evaluation and Research Unit – research included in 2011) National Public Health Institute of Liberia (2017) Medicines Regulatory Authority (2012)	Pro-Poor Agenda for Prosperity and Development (2018-2023)	National Research for Health Policy and Strategy (2018-2023) National Health Research Priorities (2011, 2017) National Public Health and Medical Research Agenda (2017-2021)	National Research Ethics Board IRB, University of Liberia-PIRE Africa Centre	Guidelines for the governance of research for health in Liberia	Liberian Institute for Biomedical Research (1970) in 2017 it merged with NPHIL as Department of Public health and medical research University of Liberia, A.M. Dogliotti College of Health and Life Sciences Cuttington University	Liberia Centre for Outcomes Research in Mental Health (2008)	National Reference Lab at National Public Health Institute of Liberia			
Madagascar		Ministry of Public Health Ministry of Higher Education and Scientific Research (Directorate of Scientific Research)	National Research Plan	Strategic plan for the development of Health Research in Madagascar 2018-2022 (2017) National Policy for Health Research (2016)	Biomedical Research Ethics Committee		National Institute for Public Health I (2020) National Institute of Public and Community Health (INSPC) (2002) Institut Pasteur de Madagascar (IPM) (1927/1998) National Centre for the Application of Pharmaceutical Research (CNARP) (1976) National Centre for Environmental Research (CNRE) National Institute of Nuclear Science and Technology (INSTN) (1976) National Office of Nutrition (ONN) University of Antananarivo (1960) Antsiranana, Fianarantsoa, Mahajanga, Toamasina and Toliara (1975) Madagascar Scientific Research Institute (1947)	Institut Pasteur de Madagascar (IPM)	National Institute for Public Health Research - National Reference Laboratory (2020) Centre d'Infectiologie Charles Merieux Institut Pasteur de Madagascar (IPM)			

Tunisia	Law on the orientation of scientific research and technological development (1996)	Ministry of Public Health (Directorate of Medical Research) Ministry of Higher Education and Scientific Research (1978) (Directorates of Scientific Research) National Agency for the Promotion of Scientific Research High Council for Scientific Research and Technology National Committee for Evaluation of Research Activities	National Policy on Scientific Research and Technological Development (2013)	National strategic plan for health research (2018) National Health Research Policy document (2015) 1/6 national research priorities on health	Biomedical Ethics Committee, Institut Pasteur de Tunisie National Medical Ethics Committee National Committee for the Protection of Personal Data Various IRBs in hospitals and other institutions		Institut Pasteur de la Tunisie (IPT) Institute of Occupational Health and Safety Salah Azaïz Institute National Institute of Neurology National Institute of Nutrition and Food Technology 13 universities, 6 of which offer medical or paramedical studies and 37 doctoral schools, 19% of which are involved in health research There are also 40 research centres, 329 research laboratories (11% involved in health research) and 301 research units (22% in health) in universities and research centres	Directorate for Drugs and Pharmacy, Ministry of Public Health WHO Collaborating Centre for Training on Medical Product Registration and Regulation International Training and Research Center in Reproductive Health–and Population - WHO Collaborating Centre for Training and Research in Reproductive Health		National Agency for the Promotion of Scientific Research (ANPR)	Ministry of Higher Education and Scientific Research is line ministry for research - but nothing specific to health research State Secretariat for Research (1991-2020)	Fund for Scientific Research and Technology Control (FORESMAT) (1984)
Uganda	Uganda National Health Research Organisation Act (2011) Uganda National Council for Science and Technology Act (1990) National Research Council (replaced by UNCST)	Uganda National Health Research Organisation (UNHRO) Uganda National Council for Science and Technology (UNCST) Ministry of Health Ministry of Science, Technology and Innovation (2016)	National Science, Technology and Innovation Plan (2012-2018) National Science, Technology and Innovation Policy (2009)	Health Research Policy (2012/2020)	23 IRBs that are accredited by the UNCST		Natural Chemotherapeutics Research Laboratory Uganda Industrial Research Institute Makerere University Walter Reed Project (MUWRP) Makerere University Mbarara University of Science and Technology Clarke International University Gulu University Kampala International University Nkozi University	Uganda Virus Research Institute Infectious Diseases Institute (IDI)			Uganda National Health Research Organisation (UNHRO)	Government Research and Innovation Fund (est. 2019)
Zambia	National Health Research Act (2013) Science and Technology Act (1997)	Ministry of Health - National Health Research Authority (2017) - National Health Research Advisory Committee (1997) Ministry of Science, Technology and Vocational Training – National Science and Technology Council	National Development Plan (2017-2021) National Policy on Science, Technology, and Innovation (2009) National Policy on Science and Technology (1996, 2006)	National health strategic Plan (2011-2015) National health research policy (2010) National health research strategic plan (2008) National health strategic Plan (2006-2011)	National Health Research Ethics Board (2017) ERES-Converge IRB, University of Zambia	National guidelines for research in traditional medicine	Macha Malaria Research Institute (1998) Tropical Diseases Research Centre (1974) University of Zambia	Centre for Infectious Disease Research		Zambia Forum for Health Research (ZAMFOHR)	National Health Research Authority (2017)	Health Research Fund (est. 2019) Strategic Research Fund (est. 2007)
**does not include NGOs that do research, and does not distinguish between research-intensive universities and universities with health research graduate or post-graduate training grammes*												

i. Financing HSR

Key Messages: Among those studied, no country met the 1% GDP investment on research and development goal laid out by the African Union, leaving NHRS underfunded. The funding that is available can be subjected to burdensome administrative and political restraints and complex delivery mechanisms that make it difficult for researchers to access funds to operate.

- In the absence of domestic funding, HSR priorities and programmes are largely defined and dictated by external sources and partners. Through local government involvement, decision-makers can shape external contributions to benefit local needs and health research issues.
- Insufficient domestic financial investment can be explained by limited political priority for HSR by decision-makers who do not seriously consider HSR as an activity of high national importance. Additionally, in a limited fiscal space, NHRS must compete with other economic pressures and immediate priorities such as funding health services.

The lack of domestic funding for HSR is one of the top challenges that faces countries in establishing a strong foundation for NHRS. It is difficult to quantify this challenge since national health research budgets are not clearly delineated in any single place. Instead, funding can be found within multiple budget lines in Ministries of Health (for operational research, research unit staff, contracts with donors for regular survey data or assessments for health information systems or national programmes linked to global health initiatives) or the Ministry of Higher Education, or other related ministries with mandates for education, science, or research (e.g. for salaries and equipment).

The target set out by the Executive Council of the African Union in 2007 for African states to spend 1% of GDP on research and development has not been met by any of the governments in the cases of NHRS that we studied. We found a range of investment as Gross Expenditure on Research and Development (GERD) extended from 0.04% in Madagascar, to 0.20% in Uganda, 0.40% in Côte d'Ivoire, and 0.66% in Tunisia according to the most recent data available. The *Bamako Call to Action on Research for Health* in 2008, to which several African Ministers of Health pledged, sets out alternative targets that are specific to health research public expenditure.(25) These are found in WHO's *Research for Health: A strategy for the African Region 2016-2025* which proposes that African states invest at least 2% of the national health budget in health research, at least 5% of development assistance funds earmarked for the health sector in health research, and to tracking health research spending from all sources.(27) We did not find information reporting on these WHO/AFRO targets in the data we collected on financing health research from a review of the literature or from key informants in case countries. Interviews with decision-makers in government agencies and researchers in public and private institutions revealed that the documentation and tracking of health research spending as well as health research projects, partnerships, and results was absent in the governance and management of most national health research systems. Without tracking HSR funding and investments, data on the absolute amount of money being spent on HSR in countries is missing as well as on the relative amounts being spent on research activities, research training and capacity

development, operational or administrative support, strengthening local institutions, or infrastructure improvements.

Participants in all cases and across all stakeholder groups described the limited domestic funding to finance health research activities as inadequate for fulfilling the functions of their NHRS. The precise amounts that are budgeted, allocated, and spent are poorly documented. The clear message from a large majority of researchers and decision-makers interviewed is that HSR in most of the countries we studied would not happen without funds from foreign collaborators an' donors.

> *There's not a budget for research, unless donors provide funding, there's no way you can do research.* Decision-maker, Government - ministry (Liberia)

Funding from donors and foreign research partners are vital financial contributions to advancing HSR in African countries. However, many researchers communicated that this can also lead to skewed priorities, power, and possession of research processes away from local contexts.

> *Zambia produces a lot of research but most of it is externally funded. One of the biggest challenges we have is to get research funded from domestic resources. Research could be designed to fit our needs if there were more domestic resources. Our organisation only does research that is relevant to Zambia. But that means you need to look for donors who are willing to fund that research. You may have questions that you'd like answered but it's not something that the external donors are necessarily interested in, so it means you can't do that.* Researcher, NGO (Zambia)

Ongoing processes involving international partnerships and collaborations play an important role in connecting multiple NHRS pillars such as creating and sustaining resources (particularly research institutions), producing and using research (e.g. scientific publications), and financing as they continuously regenerate and renew external resources for HSR production in many NHRS. But governments, research institutions, and individual researchers face substantial challenges in negotiations with donors for funding for their HSR priorities, even when they are clearly established. The dynamic processes of alignment and prioritisation are thus crucial to connect and feed into the financing pillar while simultaneously supporting local ownership of the HSR activities and agenda.

> *For us to be vibrant, is to be your own. To not look at the hands of other partners, just have your own health priority, your health problem, and follow these. You need to execute based on priorities that are not getting influenced by partners.* Decision-maker, Government - autonomous (Ethiopia)

While decision-makers we interviewed from public institutions and government ministries acknowledged that government spending in the health sector (as a proportion of the total government budget or as a percentage of GDP) was increasing towards targets of the Abuja Declaration, similar trends were not seen and reported in health research (exact figures were not always available). Political rhetoric and stated commitments to funding HSR abound, but the action and follow through on these is scarce. For example, the Ethiopian National Science and Technology Policy committed to providing 1.5% of the GDP to science and technology development. But the government has not been able to meet it, despite government financing of the health sector, including the budget of the Ethiopian Public Health Institution, steadily increasing in recent years. Some participants highlighted that it is important to look not only at government funding in absolute terms within ministries or public

institutions as part of the NHRS financing pillar, but *how* the cumulative funds are spent to strengthen the NHRS and its impact on the broader environment for HSR.

> *When you're funding health sciences research or health systems … one should not look at the money that flows directly in the institutions of a particular sector, but at [all of the] institutions [including public, private and NGOs] that are handling a particular problem or a particular challenge.* Decision-maker, Government (Uganda)

We found that domestic government investment in HSR is insufficient on its own to support an NHRS to carry out its HSR agenda. Even countries with firm government financial commitments rely on external sources of funding, and most depend largely on external donor and partner support. For example, in Uganda, the government's Research and Innovation Fund is supporting research institutions and universities to have their own research and innovation budgets, receiving 30 Billion Uganda shillings (equivalent to US$ 8,100,000) for the first time in the financial year 2019/20. The government has committed the funds for the first three financial years to ensure continuity. These domestic contributions are critical complements to external sources, thereby strengthening the financing pillar of NHRS; yet they must be supported by processes of stakeholder engagement, advocacy, and prioritisation to increase ownership of budgeting decisions and allocation of resources for HSR and the development of a NHRS.

Although governments may comparatively invest little directly into HSR when compared to the investments of external sources and partners, government actors and institutions can play important leadership roles in shepherding these external sources and as stewards of how these funds are used in country: highlighting the key needs, negotiating the terms of investment to benefit local actors and institutions, and offering an enabling environment to facilitate these investments. The involvement of government in international partnership and collaboration processes, underpinned through political will to improve HSR, is thus a necessary element to translate external funds into useful contributions. These collaborative processes support the pillar on creating and sustaining HSR resources (infrastructure, institutions, human resources) to improve local capacity and helps to foster more sustainable long-term collaboration with foreign partners.

But the lack of sustainable sources of funding is compounded by a lack of access to funds for participation in scientific conferences, for paying open access publication fees, or for supporting dissemination and translation of research results. Instead, this becomes an individual financial burden for university researchers to bear.

> *I had to pay more than $1000 [to be] published in BMC Malaria Journal. [If we don't, there will] be a lack of visibility for the work we do. But [even] as senior researchers, we don't have enough money since there is no real funding for research. We struggle to manage to do this kind of research. For those of us who are passionate about research, we ask ourselves… because we have students, we have small research projects, and so on. Many of our colleagues no longer want to venture into this field because, health research is expensive; and the money comes from your own pocket.* Researcher, Public research institution (Côte d'Ivoire)

We found that domestic government funding for HSR was generally channelled through small awards and scholarships (in Côte d'Ivoire, Kenya, Tunisia), operating funds for public research institutions (in Ethiopia, Kenya, Liberia, Tunisia, Uganda), regulatory institutions (in Kenya, Tunisia, Uganda, Zambia) and salaries for researchers in public universities (in Côte d'Ivoire, Madagascar, Uganda). One challenge which presented across case settings is the governance of government-managed funding schemes. For example, on

the macro scale, the small grants offered by the National Council of Science and Technology in Kenya are distributed to multiple ministries, and there has been no mechanism put into place to track what goes to HSR and its subsequent impact. On a micro level, in Côte d'Ivoire, one participant observed that the conditions for eligibility and evaluation of applications are not transparent and associated political constraints can distort the review and decision processes, favouring those with political connections over research rigour, excellence, or impact.

> *The administrative environment can be an obstacle, especially the administrative environment of finance because the procedures are cumbersome and sometimes lack transparency. As a result, it is difficult to obtain adequate funding or to know what to do to obtain funding.* Decision-Maker, Government (Côte d'Ivoire)

These limited resources are nonetheless valuable for local researchers since few universities have their own research budgets.

> *The major barrier here is really research funding locally and nationally; it has been a challenge to access research funds. The University also doesn't have enough ... The budget is limited, 50,000 to 250,000 Pula [$4,600 - $23,100 USD]. It's small if you really want to do impactful research.* Researcher, Academia (Botswana)

But authorities are concerned with donor dependence and recourse to donor funding posing potential threats to the sustainability of HSR in their countries.

> *…because most of our researchers, including myself, believe in donor-driven fundraising, but that won't be sustainable. As you know, donors can give you the money, but you can't sustain. The sustainable solution is to influence the government to [provide a] larger part of the funds.* Decision-maker, Government (Uganda)

We identified two possible explanations for this insufficient domestic financial investment in the data gathered from case studies. First is that there is a lack of political will present (as a supportive element of the NHRS financing pillar), with decision-makers not seriously considering HSR as a national priority on its own or within national health, education, or development agendas. Second is an economic and fiscal capacity issue. The NHRS competes with economic pressures and restricted fiscal space that are either related to the health sector (medicines, staff, facilities, disease burden) or other sectors (mostly infrastructure – roads, water, etc. – or human capital investments for education).

> *I am not optimistic that we can get policy-makers to invest a lot more in health [research]. There are way too many [other] priority areas for the government now to channel [funds] for building research capacities. People like to see tangible things. The government likes people to see the building of new roads*. Decision-maker, Government (Liberia)

Particularly following a severe socio-political crisis period (such as have been experienced in Côte d'Ivoire, Liberia, Madagascar, Uganda), immediate national priorities tend to coalesce around a country's large-scale reconstruction projects, such as education (especially primary and secondary) or health (provision of health care services). Yet there is evidence from the case studies of Botswana, Côte d'Ivoire, Liberia, and Uganda that health crises can also serve as windows of opportunity to stimulate development of NHRS and mobilise international partnership and collaboration processes to invest in its key pillars.

> *Leadership within the government is obviously very important -- that they have the knowledge and interest to ask different questions and to seek support from their partners to dig into these questions.* Donor (Liberia)

The challenges with negotiating these trade-offs are not only felt within the government, but also with the bilateral partners who bring their own interests and priorities to development plans. Political will and research leadership in countries for NHRS development are critical elements to support these partnership processes even from a funder perspective, highlighting the kinds of calculations that are made when HSR investments like this are being negotiated with donors.

ii. Creating and sustaining resources for HSR

Key Messages: Health research capacity combines human capacity (of individuals) and institutional capacity (of structures).

Creating and sustaining HSR resources was a second major challenge noted by the study's informants across all cases. This includes human capacity (for HSR, HSR management, and knowledge translation) as well as institutional capacity (public and private research institutions, university-based research, laboratories, and other equipment and research infrastructure).

- Human capacity, characterised by national human resource availability and skill, is largely concentrated in key hubs. Additionally, there is a mismatch between labour market needs for HSR and human resources in specialist areas. Some countries are not able to absorb excess capacity of highly trained workers in their institutions, while others do not have enough human capacity to support institutions.
- Regardless of individual labour capacity to conduct, manage, or translate research, HSR requires strong, well-resourced, research institutions to be successful. For example, in limited funded environments, HSR institutions have limited ability to provide competitive funding and invest in professional development for staff. For many institutions, international collaboration is a useful mechanism to overcome local capacity challenges.

Human capacity

The human resources needs for NHRS include researchers, research-related professionals, and educators. Many informants relayed concerns about unequal distribution across institutions and particularly between capital and non-capital-based institutions. Often HSR is largely concentrated in urban areas.

> *Antananarivo is the intellectual centre of the country, so it is often difficult to find experienced scientists who have some experience working in the regions. This presents problems for us to access local populations because it is always better to work with researchers from the region we are working in.* Donor, Global organisation (Madagascar)

As the "health research capacity strengthening" agenda has emerged and grown internationally as well as regionally in Africa (as discussed in Chapter 1), there appear to be concerns about seeing the capacity building process as an end in itself, and not within a larger, long-term strategy of NHRS strengthening. This "rush" as one informant described, to build up numbers or a critical mass within this NHRS pillar, may risk neglecting suitable attention to high quality human capacity and high calibre institutions, unless there is a strong element of research leadership to support a long-term vision and appropriate strategies that connect with other processes to enable a training to tenure pipeline.

I realised from quite a while back that people might not be doing research because of the capacity. I mean, there are many calls out there, but unless you can write a winning proposal, it's very difficult to do research. And people get discouraged. They write one, two, three proposals, they don't get funding, so they give up. Researcher, Academia (Kenya)

These challenges directly link with the conditions and environments in the overlapping higher education system to support, train, equip, and retain health sciences researchers – especially researchers with PhDs. As many informants expressed, "capacity building" activities cannot be separate from the research itself.

There has to be some development in terms of capacity so that you start weaning off and transferring more responsibilities to those people that are actually doing the research on the ground. It helps because sometimes they have the local knowledge and understand the local situation. Researcher, Private research institution (Zambia)

Liberian senior researchers criticised the archaic approaches of the capacity building models that are still espoused by many donors, who think that bringing people together to attend one-off workshops for a few days to follow a generic power point presentation will build sustainable HSR capacity. Rather, they emphasise that capacity building for HSR needs to be directly and fully integrated with local research processes, projects and research leadership. Successful examples of these integrated approaches to capacity strengthening in Liberia include supporting medical doctors to write abstracts to submit as papers or conference presentations to present their research, creating opportunities for competitive seed funding to work on a research project that helps to develop skills for grant writing, and building senior/junior mentorship schemes into grants and projects of all sizes to promote supportive learning and guidance relationships. Capacity strengthening thus appears most appropriate when it is approached as a learning process to promote scientific advancement through skill development for scientific writing, a peer-reviewed process, and with avenues to engage directly in the national research platform. In this way, HSR capacity building interacts with local professionals and decision-makers and contributes to developing an HSR research culture, which can support the development of an interest in HSR through the applied practice of using scientific tools and norms.

For example, in Tunisia and Kenya, institutions face the challenge of being able to absorb all the highly trained health researchers into their universities or other health research professional job markets. Conversely, in Liberia there is a shortage of health researchers and faculty members as the MPH and PhD in public health were only recently established. In Madagascar, the number of researchers and professors has been slow to increase since the early 2000s despite a significant increase in the number of students. One explanation is the staff hiring freezes at public universities (1986-2006) following the IMF structural adjustment plans. The government contracted retired researchers, but this initiative did no' solve the country's shortage of researchers. As a result, there are few opportunities or incentives for the next generation of researchers to become faculty, and the shortages force faculty to invest most of their time in teaching activities. Many researchers we spoke to face challenges of competing demands on their time, which reduces their opportunities for research.

The work here makes it a challenge to do research, because the teaching load is heavy. Researcher, Academia (Botswana)

This tension between teaching commitments, limited research funds, and lack of incentives for research in academic departments means that research is not prioritised and

that there are few opportunities for students to gain research experience through their involvement in professors' research projects.

> *We need to value and promote the students as researchers, because we often have a problem when they complete their programme of studies. Since we can't take into account their needs, they're going to leave. I think that we, the technical and financial partners, can pool our strengths to make a better environment for these researchers and to keep them there.* Donor, Philanthropic foundation (Madagascar)

Nevertheless, the ensemble of human capacity for HSR in African countries is a major asset as an input towards strengthening the NHRS pillar on HSR resources. This is one reason why our research suggests that an integrated systems perspective on NHRS is necessary. Many informants underlined the institutional challenges related to attracting, maintaining, and retaining health science researchers; however, solutions to these problems must be considered across the NHRS, and connect to supportive HSR regulatory environments — not simply handled within individual institution's policies. Academic research career tracks are neither incentivised nor secure, especially in countries without strong local research institutions and research culture.

> *I don't think it [the human resource gap] is due to the in-availability of researchers in the country, but it is directly related to the motivation and retention mechanisms that we are using.* Decision-maker, Government - regulatory agency (Ethiopia)

When there is low investment in HSR generally, wages for researchers are in turn too low to retain them. Low salaries often mean that faculty members need to work overtime in other institutions to supplement their income. Many researchers we interviewed reported a lack of institutional rules and structure to incentivise and reward scientific publication, grants applications, et cetera. However, the problem of retention is also a challenge in countries with overall high performance and HSR output.

> *We are beginning to export our senior researchers to other places, [which] is good thing, but ... also a risk because I think the way we pay scientists remains unacceptable. So, scientists fend for themselves, have to scavenge for research and keep themselves going. But there is no structured way to keep them.* Decision-maker, Government - ministry (Uganda)

The way that research promotion and reward is structured in institutions is one part of this challenge, but indeed the overall enabling environment for HSR and quality of the research institutions also matters significantly in terms of how to retain local health science researchers. Interventions have been implemented in Côte d'Ivoire to incentivise HSR, such as increasing payments to researchers (who are not part of the faculty) through research allowances from 100 to 120% and harmonising evaluation and career progression with that of faculty members. The allowance aims to reduce the individual financial burden on researchers, covering the costs of publication of scientific articles, attendance to conferences, and other research activities. As another example, medical doctors in the public sector can pursue a full-time research career advancing from a research associate to research director, which is the equivalent of a university professor.

The challenge of insufficient human resources for research also cascades into barriers for mentoring, which is a critical ongoing process to strengthen a NHRS and support productive, competent, and independent researchers. Many researchers interviewed cited mentorship as key to facilitating inter-generational support and development of the HSR community, as well as a strong research culture, at the macro-level, and important for individual health research careers (whether academic or otherwise) at the micro-level. For

example, in the case of Liberia, senior researchers expressed a genuine concern and interest for building the next generation(s) of Liberian researchers with a view toward improving local ownership of the NHRS. Within a systems perspective, processes of mentorship were also seen as building and learning local research traditions (not only supporting individual research careers) as part of a growing shared research culture.

> *Mentorship is key. I think, if you have a well-defined mentorship programme, then you can build capacity. Your own researchers need to be paired with mentors, and then they can pass on.* Researcher, Government (Liberia)

Institutional capacity

Institutional capacity is the second important area of local health research capacity within the NHRS pillar on creating and sustaining local HSR resources. Capacity to produce research and generate longer-term funding is not simply a function of the skills of individual researchers, as strong local research institutions and an enabling regulatory environment are necessary to effectively carry out research. As seen in **Table 3** under the pillar of creating and sustaining resources for HSR, there is a mix across the cases of NHRS of local and foreign-based research institutions, including institutions set up by international collaborations to produce HSR. This descriptive list provides an illustrative picture of the current HSR institutional assets on which local capacity can be strengthened. The experiences relayed by researchers in the cases of Côte d'Ivoire, Kenya, and Uganda underline the significance of having strong research institutions as a key pillar for an NHRS; the institutions serve as both a necessary physical structure for local researchers to develop and take root, and as an ideational structure to foster research culture and develop research leaders. One donor from Uganda emphasised however that the capacity of strong, independent institutions to mobilise resources through grants and other funding mechanisms in order conduct high quality research depends on dedicated teams to forecast and plan, so that research ideas are converted into timely and feasible proposals.

Strong local research institutions are also essential for increasing the capacity of a critical mass of local researchers in various HSR specialist fields. The institutional landscape in Kenya was described as particularly successful in this activity given its research institutions and centres of excellence, as well as the strong research-intensive University of Nairobi, which anchors its NHRS resource pillar.

> *University of Nairobi has always stood out because their mandate is teaching and research. I think most other universities score in teaching but not in research. But the University of Nairobi I think scores well in both.* Researcher, Public research institution (Kenya)

The growth in research institutions in Kenya contributed to an increase in the number of highly trained health researchers through innovative graduate programs to build capacity for young researchers. Institutions like the Kenya Medical Research Institute (KEMRI) incorporate research capacity building with mobility programmes for masters and PhD students to go abroad. The KEMRI Graduate School trains postgraduate students in health research through opportunities presented by the well-established medical research facilities and global research expertise available at KEMRI.

> *Mainly it has been through the effort of specific research institutions that nurture capacity for research internally. KEMRI has an internship program that takes in fresh undergraduate graduates to undergo an internship for some time. It used to be six*

months, but I think it's one year. Then the successful ones, if they're still interested, they get scholarships for masters. They can proceed until Ph.D. level as well as postdoc. They offer very good training, structured training within their own institution. I'm actually a beneficiary of that to some extent. Researcher, Academia (Kenya)

However, some researchers in Kenya also cited the quality of training, especially for locally trained researchers, as a concern for the NHRS, given the challenges in supervision and lack of funding for graduate research activities.

In Côte d'Ivoire, several strong research institutions have benefited from international collaboration (see **Box 2**) which has supported the development of state-of-the-art technology and infrastructure for local researchers to use. The successes achieved in building up significant local institutional capacity that also promotes local ownership of infrastructure, technology and know-how to conduct and manage HSR are key accomplishments of the NHRS in Côte d'Ivoire. The combination of highly skilled researchers with up-to-date technology and equipment not only strengthens the resources pillar of the NHRS, but also enhances processes of international partnership.

I would say that we have the resources that we need here in Côte d'Ivoire. [For example,] the American partners themselves said that for the clinical trials they did on lymphatic filariasis in Côte d'Ivoire, they don't need to come regularly because the people are well trained. Researcher, Private research institution (Côte d'Ivoire)

In several of the cases, the presence of research institutions as strong anchors of the NHRS also seemed to correlate with the presence of Centres of Excellence (e.g. in Côte d'Ivoire, Kenya, Tunisia, Uganda, and Zambia). Centres of Excellence can be described as organisations, teams, or networks that are leaders in their fields of expertise, developing high standards and best practice for research and training focused on a particular area or theme of HSR. The development of Centres of Excellence can have numerous benefits for other supporting elements and processes in the system such as research leadership and innovation.

However, structural barriers to access advanced scientific technologies, equipment, and supplies remain a significant challenge within the resources pillar of the NHRS. International collaboration processes are one of the most common solutions to overcoming this challenge, but technology transfer is not always prioritised as an objective of HSR research partnerships. This challenge is also exacerbated by contextual issues such as electrical infrastructure and reliability, internet access, and affordability which require creative solutions to support the use of these technologies (e.g. solar panels). The barriers to access of technology to increase institutional capacities for HSR research also have a negative impact on local ownership of HSR. However, even when infrastructure is available and with local researchers skilled in its use, political will can influence decisions that exclude or undermine the use of local infrastructure to support the NHRS (as multiple researchers from Madagascar have pointed to the mistrust of local researchers by government officials).

Food poisoning from marine animal consumption is common in Madagascar, and the last case was in the far north of Madagascar. But as soon as we took the samples of the animal that was consumed by the population, the State took the decision to send the sample abroad for analysis, whereas we proposed that we could do the toxicological analysis, the microbiological analysis, and the physio-chemical analysis of these samples, but we could not convince the decision-makers, so we preferred to send it abroad for analysis. So it's not in the direction of improving health research in Madagascar because we don't consider health research in Madagascar very much,

we don't consider the infrastructures involved in health research in Madagascar very much. Researcher, Public research institution (Madagascar)

Since 2019, new national reference laboratories have been built and launched in Liberia and Madagascar through international partnership processes, as well as the West African Biobank for the Economic Community of West African States (ECOWAS) and the level 4 high safety laboratory in Côte d'Ivoire. The funding sources for these are not always limited to foreign health agencies and HSR related funders, but also include investments from the defence sector.

So, one of the things we decided that in this region, there will be a central disease control laboratory. Besides that, each country will have its own Centre for Disease Control. So, now, as we talk, most of these specimens are not taken out of the region. In fact, specimens are hardly taken out of Liberia because we have improved laboratory system now. Decision-maker, Government (Liberia)

iii. Producing and using HSR

Key Messages: Beyond the production of HSR, decision-makers and researchers struggle to disseminate research results. National health research systems frequently lack knowledge translation platforms to encourage research outputs to be used among stakeholders.

- Individual researchers, acting as champions of HSR, play an integral role in elevating HSR outputs and advocating for its use in public policy-making.
- The use of HSR is limited by availability of data. Researchers can consider expanding and formalising data sharing networks to connect stakeholders with research.
- There are gaps in investment in knowledge translation by national governments and research institutions. In areas of limited domestic investment, funders may be persuaded to build this investment into grants and long-term support.

According to our interview data with researchers and decision-makers, producing and using research is one of the weaker pillars of many NHRS, particularly as it relates to the use and uptake of HSR results. Processes for disseminating and promoting research results and mechanisms for knowledge exchange (such as knowledge translation platforms) are absent or very limited. This contributes to an overall poor use of HSR findings for improving national health policies, practices, or programmes. As seen in **Table 3**, there is a stark lack of knowledge translation platforms, with the exception of Zambia's Forum for Health Research and Tunisia's National Agency for the Promotion of Scientific Research (which mainly focuses on innovation, see **Box 10**). In Zambia, research leadership has been a critical element to connect this pillar with that of governance through advocacy processes to integrate HSR into health policies, and support alignment between health and HSR priorities. For example, the National Health Strategic Plan (2011-2015) includes five strategies for health research (such as coordination, capacity building, monitoring). Two of these five strategies are related to knowledge use: "enhance the use of research findings for policy and decision-making through improved dissemination of research findings to all stakeholders" and "strengthen strategic partnerships to improve and rationalise resource availability and use." The Zambian Forum for Health Research, an

annual conference that involves researchers and leadership from across the country, has thus served as an effective means to disseminate findings not only among the scientific community, but also to decision-makers (see **Box 5**).

> *You can see it in the support we receive when we have symposia conferences for dissemination. We have very good representation by government at various levels. The ministers, the Permanent Secretary and directors of departments. And when we write research proposals, we discuss with government for supporting and encouraging utilisation. And we do get very strong letters of support for the work we do. So, the environment is fairly conducive to advancing research.* Researcher, NGO (Zambia)

With strong advocacy processes focused on all of the NHRS pillars (see **Box 5**), Zambia has shown promising lessons for integrating knowledge use throughout its regulatory environment, supported by an in-depth policy and legal framework. This has included using various strategies for stakeholder engagement across the spectrum from decision-makers to communities. For example, the National Health Strategic Plan lays out a strategy to establish linkages between neighbourhood health committees and community research advisory boards. Further, knowledge translation is also explicitly mandated as a responsibility of the National Health Research Authority.

However, in most of the cases of NHRS, participants reported very low use of research in decision-making. For example, in the case of Kenya's NHRS, researchers pointed to the contrast between the low research utilisation for policy and programmatic decision-making as compared to the high levels of national HSR production. Kenyan researchers cited that in addition to the absence of a formal national knowledge translation platform, there are weak and uncoordinated knowledge transfer systems within and between institutions. Nevertheless, many researchers stated that they are working to enhance research use by engaging with decision-makers early, including decision-makers as project co-investigators and collaborators, and disseminating their research in the media.

Indeed, most of the activities we found supporting HSR research use and uptake are ad-hoc. However, there are some good examples drawn from national programmes which could provide useful lessons for scaling up and better integrating the NHRS pillar on producing and using HSR. The National Malaria Programme in Madagascar is a good example of coordinated research use at a national level. Regular partner and stakeholder meetings are held to share information and disseminate the latest research, but most importantly the programme has a comprehensive annual review system. In this, there is a collective assessment and discussion ahead of determining the programme's annual workplan, which incorporates new results and learning from the previous year into the upcoming year's objectives and activities. The good leadership of this programme was cited by researchers and donors as one of the keys to its success overall, but particularly in the area of research utilisation.

As a pillar of NHRS, research use often also relies on advocacy processes for support. For example, the National Institute of Nuclear Science and Technology in Madagascar carried out several studies on the level of lead in the atmosphere which found that the level was very high, especially in Antananarivo, due to the use of leaded petroleum. Supported by ongoing advocacy to the community and the government for the use of unleaded petroleum, the government decided to adopt researchers' recommendations. Similarly, the same institute also successfully advocated for the

government to establish a regulation for the management of nuclear waste by companies and hospitals. This was done through demonstrating the results of their research, which found that radioactivity levels were higher in the country. These examples are also notable as they show the multisectoral and interdisciplinary nature of HSR production and use for improving health outcomes.

International collaboration processes have also been shown to support the research production and use pillar of NHRS. For example, in the 1990s in Tunisia, there were important changes made to health policies based on findings from a UNICEF-funded study on the causes of maternal mortality, which led to a decrease in maternal mortality rates across the country. Moreover, this study in partnership with an international organisation enabled local capacity building of young Tunisian researchers who were involved in the research team and trained in research methods. This had additional regional impacts, with these young researchers later sent to other African countries to support local teams' utilisation and implementation of the same research. Similar to our findings about health crises as catalysts for international collaborations that can build up the NHRS creating and sustaining resource pillar (see **Boxes 1, 3,** and **9**), these events are also opportunities to strengthen the pillar on research use. For example, in Liberia the Incident Management System was a multi-stakeholder platform established during the Ebola outbreak to review the latest research and surveillance from which to adapt local responses. This mechanism has been institutionalised as a regular weekly meeting hosted by the National Public Health Institute of Liberia which brings together local and international partners to disseminate research findings and reflect on their potential to influence policy and programme changes in the health system.

Both researchers and decision-makers alike in most cases underlined two main challenges for the research use pillar. First, there is limited access to data and research findings for HSR studies that have been conducted in countries. Many research use activities rely on informal information sharing through networks or institutional seminars.

> *It's not always [easy], unless you hear about it from somebody, "These people or this organisation has done research like this, can you contact them?" That's how you get the information. Maybe we should have a platform where we can share this kind of research. Besides the dissemination and sharing the report, it's not always available for other people to use and it's unfortunate.* Researcher, NGO (Madagascar)

Secondly, there are limited skills and systems in place for knowledge translation among researchers and decision-makers in the NHRS. Researchers and decision-makers are not trained in or familiar with knowledge translation and the use of research results for decision-making. They expressed a need for knowledge translation to be considered as a capacity to develop within the NHRS pillar on resources, with hope for this skill to be included in HSR education and training. Likewise, partners and funders acknowledge that building institutional capacity of Ministries of Health for research use and uptake is an equally important objective to strengthen this pillar of NHRS. Only through cementing this as a core function of the system will local HSR have an impact on policy ideas and planning at the national level.

> *A lot of it comes down to individuals. Some of its systems, but individuals play an important role. The National Public Health Institute of Liberia has put into place some of the systems and has the right individuals to use research, to promote it. But the systems and the basic organisation at the Ministry of Health is not strong enough right now to do so.* Donor (Liberia)

iv. Governance of HSR

Key Messages: Policies and frameworks governing HSR combined with a strong regulatory environment and political will amplify NHRS output. However, many countries still lack a unified national vision for their HSR sector.

- Governing HSR requires significant coordination across multiple sectors including health and education. Without robust coordination mechanisms and institutional mandates, NHRS can be inefficient and unproductive.

The governance pillar of NHRS is generally understood to cover the policy and legal frameworks and institutional structures that govern and manage HSR – including ethical governance. Information on this pillar in **Table 3** indicates that there is an abundance of national health research policies, strategies, and frameworks in place. Among our cases, Botswana was the only country that does not have a national health research policy or strategy. But while this type of systems indicator for the governance pillar may indicate a strong HSR governance context within the NHRS, the existence of these policies and plans is insufficient on its own to inform us of how governance of the NHRS is carried out.

Indeed, these policies and frameworks are a critical foundation, but they must be connected to a strong regulatory environment and have sufficient political will to support them. **Table 3** shows that legal frameworks specific to health research are largely missing from the governance pillar in many countries. As discussed in the findings in the following section, 3.2, a regulatory environment can benefit from legislated institutions, with dedicated mandates and funding for HSR. Multiple researchers and ethicists across cases highlighted the need to legislate for ethics review and national ethics boards to secure the legal and judicial protections in governing research involving human subjects, and specialty areas such as genetic research. For example, Tunisia and Zambia both have inscribed ethics as part of their legal framework for HSR, mandating specific health and medical research ethics institutions with oversight. Without this high-level authority to oversee and uphold the law, it is difficult to ensure alignment processes for the ethics of HSR between the variety of public and private institutional review boards in countries.

Coordination is one of the most important aspects that researchers, decision-makers, and funders discussed as often overlooked in the development, organisation, and functioning of NHRS; it is a persistent weakness in the NHRS governance pillar across our nine case studies. Theoretically, according to the structure of the pillars outlined in **Table 3**, the coordination of health research falls under the pillar of producing and using research. However, there is rarely a specific organisation mandated to coordinate HSR within the system. Limited examples can be drawn from the Uganda National Health Research Organisation and the Kenyan National Research Committee, founded in 2019. In many cases however, the responsibility of coordination is delegated to regulatory institutions – often without additional funding or staff to support this role. Coordination between HSR institutions often translates to alignment of priorities across institutions and government agencies, streamlining research processes and creating a more efficient and effective NHRS. Thus, the absence of coordinating mechanisms between departmental counterparts in ministries (health, education, science) was noted by many stakeholders, even in cases

with otherwise strong regulatory environments. This suggests that coordination should be recognised as both a crucial ongoing process within the framework of a dynamic NHRS as well as a critical function of a core pillar (governance). Although evidently an essential process, we found a lack of empirical lessons on successful coordination mechanisms in the qualitative data we collected. Despite this omission, the establishment of coordinating agencies should not be neglected as a critical step in strengthening the governance pillar of NHRS which simultaneously supports many other system elements and processes discussed in the following sections.

3.2. Elements and processes of NHRS

While the above discussion presents deeper insights into barriers and facilitators of key pillars such as funding and human resource development, our qualitative interview data from our 9 case study countries also identified a number of critical elements and processes that serve a relational function within a NHRS, and were thus integral to successfully strengthening the pillars of the system as a whole. As dynamic systems, these elements and processes work continuously to support the activities of actors in their efforts to strengthen the NHRS.

In section 3.2, we present findings on the main processes that were found to be crucial for building the pillars of a system and helping them work together, creating an enabling environment for HSR production and to meet national health and development objectives. Specifically, this section explores findings about processes such as partnership and collaboration, advocacy, alignment and prioritisation, and innovation. Each of these processes is critical to the functioning of NHRS in Africa and influential to the ways that systems emerge, organise, and adapt. Key elements such as research culture and regulatory arrangements provide support to the actors engaged in these processes and to those working in institutions who are mandated to carry out the functions of the core NHRS pillars. Research leadership and political will are also vital elements to mobilise, sustain, and inform these processes which were found to cut across the entire system. As per the previous section 3.1, these terms are underlined throughout the findings of this section as a visual cue and reminder of the interrelationships between them and within a NHRS. Indeed, our findings aim to show that these elements and processes are part of the composition of these systems—not add-ons, but integrated.

We do not find these characteristics arranged and interacting in the same manner within each system, as their relative influence is context specific (related to timing, history, and events within the NHRS). Importantly, we do not wish to rank these elements or processes against each other, but rather show why each matter within a range of experiences of building and strengthening NHRS in Africa.

i. International partnership and collaboration

Key Messages: With limited domestic funding, international partnerships and collaborations are key for HSR investment in African countries. HSR partnerships, including those with capacity strengthening objectives, can be supported through a variety of arrangements with stakeholders, such as universities, research networks, foreign governments and bilateral agencies, regional organisations, and peer-to-peer scientific collaborations.

- Successful partnerships can contribute to local HSR infrastructure through technology transfer and other investments. To maximise the impact of collaboration on local capacity, partners should support activities, such as laboratory testing, to be conducted by local scientists in-country, rather than exported out.
- Health crises, such as HIV/AIDS or Ebola (and potentially COVID-19), create windows of opportunity for HSR investment due to the increased political attention, the acute need to train HSR personnel, and the urgency for local infrastructure to develop to carry out HSR activities.
- While international cooperation is useful, regional and national partnerships may contribute more to strengthening the research culture and local ownership of HSR, especially as these partnerships tend to align better with local needs and build local research leadership.

Key informants across all stakeholder groups reported that international partnerships have been, and remain, one of the most used mechanisms to invest in and increase HSR production in Africa and to improve human and institutional capacity for HSR. The economic context and lack of domestic government investment in health research necessitates external financial resources to support NHRS in African countries, as discussed in Section 3.1. Beyond the financial contributions of international partnerships, it is important to also examine the objectives and governance of partnerships through which these funds are transferred; this is vital to understand whether and how collaboration benefits other NHRS pillars and whether and how it interacts with the other elements and processes within the system as a whole.

Our analyses found that sustaining partnerships over long periods of time reaps the most system-wide and integrated benefits for strengthening an NHRS, particularly when they involve both African government partners and research institutions; multi-sectoral partnership tends to support coordinated approaches with negotiated collaboration frameworks rather than ad-hoc initiatives. This is not only because of the reliable flow of financial resources but also because long-term partnerships provide more continuous opportunities for engagement, relationship-building and trust between research and funding partners, as well as in the communities in which research is being carried out. These activities also build social capital for a shared NHRS vision. Collaborative arrangements such as these can help expedite action and remove bottlenecks when there is very high-level support from all the governments involved, as was seen in the Partnership for Research on Ebola virus in Liberia (PREVAIL). Thus, these types of arrangements appear less vulnerable to unexpected political or administrative change from partners because they are institutionalised at higher levels. Accounts from researchers, decision-makers, and funders of the important consequences and outcomes of long-term arrangements

underscore how they can simultaneously advance multiple pillars of a NHRS. This is facilitated through the training of researchers, establishment of joint research projects, and access to a broader pool of financial resources while strengthening elements such as research culture by supporting processes of networking and the growth of scientific networks. Foreign collaborations have also been the source of funding to develop national research institutes and centres of excellence, such as the Tropical Diseases Research Centre and the Macha Malaria Research Institute in Zambia. The work of centres of excellence leads to improvements in research infrastructure and research outputs and raises the profile and value of HSR in the country, which in turn attracts further external research funding and increases teams' capacity for high calibre research.

> *[M]ost of the capacity building in the past has not been coordinated nationally. What has supported capacity building in research has been researchers themselves and these research institutions which are probably 90-95% funded from abroad. [T]hey have had to train their own people to have a pool of researchers and research assistants to do the work. That really has helped a lot.* Decision-maker, Government - regulatory body (Zambia)

In some countries, health crises (e.g. HIV/AIDS and Ebola) have served as events that create windows of opportunity for international collaborations in NHRS that often accelerate investments in HSR and health research capacity, and if seized and negotiated well, can lead to improvements in key NHRS pillars (e.g. institutions, infrastructure, human resources). These investments may also include broader public health infrastructure additions to provide baseline material and data for HSR. For example, the West African Ebola crisis spurred rapid investment from donors to improve surveillance systems in Côte d'Ivoire and Liberia, and supported the creation of the National Public Health Institute of Liberia.

> *Any investment that we are seeing today has been an investment after Ebola. Between the civil war and Ebola, there was literally no investment in health science research.* Researcher, Government - autonomous (Liberia)

Examples from Botswana (**Box 1**), Côte d'Ivoire (**Box 2**), and Uganda (**Box 9**) illustrate how the HIV/AIDS crisis led to international collaborations that integrate sustainable HSR capacity improvements into the NHRS.

Box 1. Botswana - Increasing HSR production through international partnerships sparked by HIV/AIDS

The HIV/AIDS crisis created an opportunity to increase awareness and commitment to public health at the national decision-making level in Botswana, which has subsequently benefitted from international collaboration over the past three decades. This includes international partners and funding from abroad, which led to rapid growth in HSR production and in particular, the Botswana Harvard AIDS Institute Partnership and the Botswana-UPenn Partnership.

The Botswana Harvard AIDS Institute Partnership (BHP) was established in 1996 to help combat HIV/AIDS in one of the places hardest hit by the epidemic. For example, at that time about 37% of pregnant women in Botswana were infected with HIV. The BHP is a collaborative research and training initiative between Botswana's Ministry of Health and Wellness and the Harvard T.H. Chan School of Public Health AIDS Initiative. The scope of their research includes clinical and basic science, epidemiology, socio-behavioural science, and community-based biomedical research.

The Botswana-UPenn Partnership (BUP) is a partnership established between the University of Pennsylvania, the Botswana Ministry of Health and Wellness, and the University of Botswana using a broad, interdisciplinary approach to address the health sciences research and capacity needs for HIV/AIDS, with training opportunities for healthcare personnel in Botswana, postgraduates at the University of Botswana and University of Pennsylvania, and developing joint research programs linked to welfare for the population of Botswana. Capacity building is a central long-term mission of the partnership for trainees from both universities.

These two international partnerships have been the foundation for a significant amount of HSR produced in the country.

> *Botswana-Harvard have done quite a lot of research. They are publishing, and a lot of it has led the way in defining policy. In Botswana, if you look strictly at research, I think they're one of leading organisations. Botswana-UPenn does more on the educational side and capacity building. They've been helping with training of the medical school, so their publications are more on the clinical care and operational research side, whereas Harvard is looking more at pushing the envelope.* Researcher, Private research institution (Botswana)

Although there is acknowledgment that external partnerships have contributed to advancing knowledge locally, general concerns focus on the distribution of benefits between external and local partners – which has implications for local ownership of the NHRS. For example, there has been an increase in postgraduate HSR opportunities in tertiary education. However, weak institutional capacity means research specimens must be taken out of the country for analysis.

> *People have concerns over [whether] specimens can be taken out and we're like, "Well, is there capacity here to do it at the level you want it done for research?" Those discussions. Up to now, I don't think it's been a huge issue. I think that's something potentially on the horizon that could be a threat.* Researcher, Private research institution (Botswana)

While the foreign investment in HSR has benefitted human capacity, in terms of increasing offers for local training and research opportunities, the institutional capacity of local research institutions has not similarly benefitted from these partnerships. Thus, international collaboration processes in Botswana seem to have better served to create and sustain local resources (a pillar of NHRS) at the individual rather than the institutional level.

Box 2. Côte d'Ivoire – Creating new HSR institutions and opportunities for HSR training through international cooperation

The arrival of the HIV epidemic was a window of opportunity that allowed international research collaboration to give a real boost to HSR in Côte d'Ivoire. Bilateral cooperation (from France and Switzerland) in scientific research also strengthened research capacity (human, institutional, and financial), working concomitantly with government's efforts, thanks to strong political will, to institutionalise scientific research through institutions such as the *Institut Pasteur de Côte d'Ivoire* (IPCI) and the *Centre Suisse de Recherche Scientifique* (CSRS). These bilateral agreements were catalytic for building well-equipped and robust research institutions and training human resources for HSR in the country.

> *There is a very favourable, advantageous environment in Côte d'Ivoire, such that the scientific collaborations, particularly Franco-Ivorian ones, have made it possible to establish long-lasting partnerships that are now even expanding to be regional in scope.* Donor, Bilateral partner (Côte d'Ivoire)

Local researchers have been able to leverage health crises and related cooperation opportunities to improve the NHRS. They helped constitute a pool of well-trained and skilled researchers in Côte d'Ivoire through scholarships to send local researchers to France or Switzerland for training and capacity building.

> *The very strong links with the School of Public Health (ISPED) at the University of Bordeaux were part of this dynamic 'fermentation' of research here. ISPED has been a partner here since the beginning of 1996. And ISPED has been training people in PhD, Master's and inter-university diplomas since the beginning. There is a continuous exchange of people between ISPED and here. There are at least 20 PhDs that have been done here.* Researcher, Public research institution (Côte d'Ivoire)

The "Programme Pac-ci" is an example of the growth of international collaboration for HSR in the wake of the HIV epidemic. The research site of the French research agency against AIDS and Hepatitis (ANRS) was created in Côte d'Ivoire in 1995. Its objectives were to train health personnel and implement medical research on HIV/AIDS, the results of which should quickly be useful to people affected by the disease. The programme trained over 30 PhD and 100 Master's students in Côte d'Ivoire and maintains over 30 ongoing research projects on infectious disease. The investments in HIV research and research programmes in Côte d'Ivoire also influenced the appreciation of the importance of multidisciplinary research teams to strengthen HSR**.**

> *It must be said that the HIV epidemic has benefited health research…it changed the way we look at health research a little bit. And then we had the economists who calculated the cost of this disease, the financial cost, the human cost, the social cost and so on.* Researcher, Public research institution (Côte d'Ivoire)

However, there remains some frustration from stakeholders in country that a situation needs to reach a high-level of alert or severe crisis to elicit swift action from international partners to release funds for health research.

> *What is unfortunate is that dramatic situations are needed in order for partners to mobilise funds. AIDS, the Ebola epidemic, and ... now everybody wants to put funds into research on resistance to antibiotics*. Researcher, Public research institution (Côte d'Ivoire)

International partnerships that do not involve government actors from African states comprise the large majority of collaborative processes for HSR work, such as direct collaborations between researchers, institutions and/or funders, co-investigators on research grants, and capacity-building and training exchange programmes. This is a problem for coordination of HSR across the NHRS. When governments are not part of the collaboration,

opportunities for alignment and sustainability of partnerships can be missed. Research training collaborations and scholarships for Masters and PhD programmes overseas further expand and create feedback loops to the local NHRS system creating additional opportunities for international collaboration.

The important role of international collaborations in building structural and human resources for research is rarely contested in the data we collected. But according to informants across stakeholder groups, issues of ownership, alignment, and context-appropriateness of these collaboration processes should not be neglected in discussions about their impact on the development of the NHRS. The terms, rules, and governance arrangements for international collaborations influence whether the processes and its outputs serve the interests and priorities of the international collaborators and funders or those of the local actors (researchers, decision-makers, populations and communities) in the NHRS. As one decision-maker pointed out, this means that research which could have the most potential impact locally is frequently neglected if it is not related to donors' interests.

African researchers and institutions face trade-offs in situations where activities designed through collaborative processes are poorly aligned with local needs and priorities for HSR. For example, they bring in resources that are useful to support underlying needs and gaps in the research system, but may not be designed to produce results that will reach local audiences.

> *[C]ollaborations and partnerships with other institutions, particularly with Northern institutions, whose machineries are generally well oiled, help in overcoming some of the constraints. But that comes with a cost, in that you're working with the people from the northern institutions whose priorities may be slightly different from yours. For example, where to publish: they may be looking for their high impact factor journals, when actually the results from the research are less accessible by the people in the African continent. Therefore, potential users are unlikely to or find the results.* Researcher, Academia (Uganda)

Multiple stakeholders (especially researchers) recurringly stressed the importance of developing more locally based collaboration and partnership processes for strengthening NHRS. They expressed a need for greater collaboration on HSR especially between ministries and authorities of health and of higher education (among other sectors, such as environment, science and innovation). Yet there was also a desire for ongoing collaboration amongst local researchers to harmonise HSR efforts – such as through the creation of centres of excellence – and to strengthen local networks through boosting research culture. Researchers highlighted the importance of regional collaboration among universities in the region for networking, training, exchanges, and joint grants (frequently citing a number of countries with strong academic HSR collaboration networks that were not included in this study such as Ghana, Mali, Nigeria, and South Africa). Such regional collaboration processes were also seen as supportive to NHRS strengthening from a donor and partner perspective.

> *One of the facilitators has been one the openness of the Ugandans and the Ugandan academic community to really have these south-south, as well as north-south, collaborations that are really open. We are able to negotiate and do research together rather than alongside, but together.* Donor, Bilateral partner (Uganda)

The importance of more regional, sub-regional, cross-border, and south-south networks and collaborations (in addition to regional research consortia or multiple case/multi-site HSR studies) resounded across many interviews as an ongoing process to focus on that

could have a significant impact on multiple NHRS at the same time. For example, the authority and recognition of research leaders within their own NHRS, and within wider scientific communities in Africa and elsewhere, benefits from membership in regional networks and collaborations.

> *There's great collaboration going on within the One Health platform between National Public Health Institute of Liberia (NPHIL), the new veterinary lab, and organisations like Predict, WHO and others. There is great collaboration going on around disease surveillance, animal research, post Ebola research. NPHIL shares different articles, they present on new findings in their weekly meetings on Friday, and that is really positive. In the area of community health, there's also a lot of good research going on, a lot of collaboration, a lot of interest in learning and changing and adapting the programme.* Donor (Liberia)

In Liberia, we found that the connections and relationships cultivated in regional networks and cross-border collaborations were a part of the social and intellectual capital that supported research leadership as they became both key contacts for collaborators interested in HSR in Liberia as well as the trusted group of collaborators to the Ministry of Health. This positioning enabled research leaders to negotiate and participate in the shared governance and scientific leadership of the collaboration with the US government and National Institutes of Health on Ebola. **Box 3** provides an example of how researchers and decision-makers in Liberia and West Africa used the Ebola outbreak as an opportunity to form regional networks and explore what can be done together and learned from one another.

Box 3. Liberia – The emergence of regional HSR collaboration from the West African Ebola outbreak

The West Africa Research Consortium was founded by members from Liberia, Sierra Leone, and Guinea, and has since expanded to include Mali and Côte d'Ivoire. Coming together initially around Ebola, the network of researchers, community members, bioethicists, and other partners has recognised a desire and potential to expand to include other infectious diseases. In a short period of time, the network has created a platform for sharing knowledge and experiences, for developing joint research projects, and for mobilising interest and advocating for support of decision-makers.

> *We've organised scientific research conferences, with 100+ attendees including partners from all walks of the research community in the region coming together. Though small, it is really something that has been serving as advocacy because we engaged our government in a platform, and our communities are involved, that means there is something post Ebola to address together – such as transfer agreements for samples, regional biobanks, future research capacity and potential. We tried to publish some of these things, so it's also helping the overall scientific environment.* Researcher, Government (Liberia)

Thus, it demonstrates a strong example for regional and cross-border collaboration as a process that facilitates many of the other key elements and processes for strengthening NHRS – networking, advocacy, and research culture. However, the main goal of these researchers is to use regional collaboration to promote national ownership of HSR and NHRS in their respective countries.

> *One of the challenges in terms of the consortium is for the scientists to advocate for national ownership and leadership. That's one of the main objectives - for the Ministry of Health and the National Public Health Institute to really take ownership on that, not to see it as a club of researchers. We would like to convince these member countries take research very seriously and this is a regional initiative for us to work on that together.* Researcher, Government (Liberia)

As one international funder/partner pointed out, the West Africa Research Consortium responds to many of the recommendations of the World Bank's *Money & Microbes* report which suggests leveraging and supporting regional networks is an effective way to strengthen clinical research capacity. However, the network suffers from a lack of funds to support its work, now and in the longer-term, as it has been unable to secure IDA funding from the World Bank or from ministries of health and finance in member countries.

ii. Regulatory environments

Key Messages: Successful NHRS have robust regulatory environments and government institutions dedicated to promoting, coordinating, and regulating HSR. These institutions need to be designed around the local needs and contexts of implementing countries for regulation that efficiently aligns with and strengthens HSR capacity.

- While an enabling regulatory environment for HSR benefits from formal legislation, successful systems are built slowly with support from individual research advocates and leaders.
- Many currently operating Science, Technology, and Innovation institutions have been unable to advance and represent the specific needs of health research without supportive connections between HSR regulatory institutions.
- Simple investments in research institutions are not enough to develop a strong HSR capacity. Real political will that translates expressions of intent into action – with sustained funding and institutional support - is required to implement and maintain effective policies.

The policy frameworks for governing and regulating HSR in African countries range from normative-institutional to legislative (see **Table 3**). Therefore, supportive regulatory environments for HSR involve several formal and informal governance mechanisms. For example, Zambia was the only country that has adopted a specific health research law among the cases of NHRS that we explored. The two main institutions created by the National Health Research Act were the National Health Research Authority and the National Health Research Ethics Board. Both radically transformed the regulatory environment by institutionalising coordination of health research in Zambia through the consolidation of HSR mandates within the health sector instead of the education sector – where the line of authority for regulation and coordination still lies in many countries as a consequence of science and technology policy and legislation.

> *The regulatory environment has improved tremendously in 20 years, from nothing to a very rigid system, to now a system that is trying to facilitate and encourage research.* Researcher, Private research institution (Zambia)

Box 5 in the next section explains how research leadership and advocacy supported Zambia's legislation and institution building for its HSR regulatory environment. However, although research leaders and Ministry of Health officials have focused on building up institutions and mechanisms for good governance (supported through legislation) as a key element of the regulatory environment, it has not had an equivalent impact on strengthening the pillar of domestic investment in HSR capacity.

The Tunisian case provides a good example of how the legislative framework to improve the regulatory environment also includes government commitment for public financing of research. Adopted by the Parliament in 1996, the law on the orientation of scientific research and technology structured the coordination, governance, and financing of scientific research in Tunisia at administrative and operational levels, which had positive impacts on health research production. According to researchers, the implementation of this law led to concrete improvements in the pillar of HSR production and increased the indicators of HSR performance of the country.

> *After 1996, we saw a national increase in the number of publications in health research. Currently between 30% and 40% of Tunisia's publications are in the health field. So Tunisia is a fighting force in terms of health research.* Researcher, Public research institution (Tunisia)

For many years, the public funding of scientific research in Tunisia was above 1% of GDP. A number of other governments have signalled intentions and aims for public financing

of HSR commensurate with their commitments within international agreements and declarations to improve levels of public expenditure on research and development (ranging from 1-3% of GDP) – such as in national science and technology policy documents (e.g. Ethiopia, Zambia) or legislation (e.g. Kenya's Science, Technology and Innovation Act). However, the commitments in these declarations remain largely unmet. Levels of domestic investment are mostly stable, with positive trends in some cases. The Tunisian government's political will to support their NHRS through public investment in scientific research funding (0.66% of GDP in 2017, the highest of any of the cases studied here) has been institutionalised by legislative action specific to scientific research and secured through ongoing processes of advocacy linked to innovation and private enterprise (see **Box 4** and **Box 10**).

Kenya's Health Act, while not specific for just research, prioritises adequate investment in HSR to promote technology and innovation in health care delivery, with implications for larger HSR regulatory structures in Kenya. Building on the political will and regulatory environment from institutions established through the previous Science, Technology and Innovation Act, the Health Act is a law that delineates the roles of the national and county governments in conducting HSR, establishes the national research-for-health committee responsible for the development of national HSR policy and priorities, and defines the key HSR stakeholders in the sector, including private and development partners. This transition from STI to a specific HSR regulatory framework was expressed by many informants to be strongly desired (if not already actualised) in most countries, and the realisation of the African Union's vision to improve investments and infrastructure for STI. However, they did not have the inclusive vision and appropriate institutional arrangements to tailor regulatory environments to the specificities of HSR coordination, regulation, ethics, and funding.

The legislation institutionalising mandates for STI within national councils appears to be significant (although not obligatory) in national trajectories to build up regulatory environments as an essential supportive element for governing HSR. For example, in Uganda, the establishment of the Uganda National Council for Science and Technology by an act of parliament was instrumental in streamlining the regulation of research in the country and reorganised a fragmented HSR system; stakeholders noted this subsequently increased confidence in the system for both local and foreign researchers and funders. Many informants refer to its creation as a turning point for HSR (among other areas of scientific research). The leadership and political will for HSR in Uganda have gained momentum in the years since. Aside from the president's support for national science and innovation programmes, and pushing for integration of STI in the educational system's curriculum, the Ministry of Science, Technology and Innovation was also recently created in 2016.

In Botswana, while institutional structures for HSR governance are in place within the Ministry of Health and the University of Botswana, the overall policy framework as part of the regulatory environment for HSR is weak. Botswana does not have a national health research policy, and the available normative guidance for HSR does not have official policy or legal status. Despite the investment and progress in developing multiple national STI policies for the country, none of these specifically address the needs of the NHRS to regulate HSR.

> *We've had a lot of donors coming in doing a lot of research, and there is no protection around intellectual property. The Ministry of Health thus thought it proper that [since] we are dealing with human research; we need to deal with the legislative*

environment that is specific to that area. Hence are drafting a bill that would guide any research now that has to deal with human beings, to protect participants and the intellectual property. Decision-maker, Government (Botswana)

Currently, in Botswana, decision-makers are developing a Health Research Bill in Parliament. If adopted, it would enable the strengthening of the NHRS' regulatory environment, including identifying health research priorities and establishing a national health research regulatory authority, with funds allocated from Parliament to facilitate and regulate HSR. This would present a radical change in the budgeting process for the financing pillar of the NHRS; decisions about expenditure on HSR are currently left to the discretion of individual ministries or sectors. The organisation would also have a mandate to seek external funds, whether from the private sector or donors. The impetus for this piece of legislation emerged from the consequences and conditions of external financing and international partnership for HSR in the country since the HIV/AIDS epidemic. The influx of funds and the resulting increase in capacity for HSR in Botswana have been operating in a legal vacuum, leaving local researchers and research institutions, as well as participants, ill protected in terms of the rights, responsibilities, and duties associated with conducting health research.

Similarly, in Ethiopia, the lack of a legal framework or formalised regulatory environment leaves much of the HSR in the country without an agreed direction, focus, or coordination towards a defined set of priorities.

Universities have started allocating resources for thematic research. How do they choose the best researchers and how do they accept proposals and provide grants for that thematic research? There are no clear criteria. So, resource limitation is one [challenge], but even if there are limited resources available, allocating those limited resources to the right kind of tasks, to the right kind of research, is one of the most important things. Decision-maker, NGO (Uganda)

As policies, a legal framework, and general guidance for HSR are absent, HSR does not appear to be a priority on Ethiopia's agenda. More fundamentally, the Ethiopian Constitution has explicit provisions favouring the conduct of research. Articles 91-3 and 51-3 indicate the country's will to enact and implement activities that promote science and technology. Article 29- 1 and 2 relate to the broad provisions of intellectual and academic freedom and the pursuit of knowledge. However, detailed laws and regulations regarding research conduct have not been enacted, and no law specifically defines the concept of HSR in Ethiopia. These laws are essential to support a regulatory environment with clear guidelines for research conduct and its governing institutions, thereby legally establishing research as a regulated activity.

In Côte d'Ivoire, there are numerous health research policies and action plans, but with a notable implementation gap. The political will and international collaboration processes that have been so influential in building the NHRS pillars for creating and sustaining resources (strong research institutions, increasing research capacity and infrastructure) and for financing HSR (stewarding external funding from donors) have not (yet) played a role in moving from HSR policy adoption to policy implementation. Additionally, the absence of laws setting guiding principles, objectives, and accountability structures limits a policy framework within the current regulatory environment of HSR. A draft law on the programming and orientation of scientific research was submitted to the National Assembly for adoption. This law is intended to set the legal framework in which the Ivorian NHRS will evolve, including provisions for creating a High Council for Scientific Research

and Technological Development and a National Fund for Scientific and Technological Research as well as the creation of new scientific public institutions. However, similar to the situation in Botswana, there is a lack of communication on the bill's status from parliamentarians to various ministries and other decision-makers, which complicates progress and hinders knowledge about the obstacles to moving it forward. Furthermore, the adoption of this law has been included as a specific aim of the 2016-2020 National Development Plan, which includes implementation of a number of key priorities related to the law (e.g. creating an agency to promote the use of research results, which would strengthen the NHRS pillar for the use of knowledge). Thus, there is a split between the rhetoric of political will and the observed lack of action taken to operationalise that will. This discrepancy may also have to do with a range of high-priority issues within African states, with deliberations from which the informants of this study are further removed.

Whilst the ongoing efforts in Botswana and Côte d'Ivoire to establish legal frameworks for creating a more formalised supportive regulatory environment for HSR have reached advanced stages, decision-makers and researchers elsewhere (e.g. Madagascar) expressed a desire to see the development of legislation that would create a legal status for the practice of HSR, and inscribe the institutions, rules, and arrangements for its regulation and governance into law. While there are examples of HSR governance and regulation routed in institutional and normative arrangements, legislation appears to be seen as a gold standard with the legal and judicial weight that it carries and as a means to embed and legitimise national ownership of the NHRS. One of the reasons that advocacy is essential to establishing a regulatory environment for NHRS is due to the lack of funding with a focus on strengthening HSR governance, as stated by a Ugandan decision-maker: *"Whereas people give money for research, very few people give money for regulatory development."*

iii. Advocacy

Key Messages: Researchers play a key role as advocates for NHRS in Africa. Success stories (e.g. from Tunisia and Zambia) demonstrate how advocacy can foster an awareness and appreciation of HSR among national governments.

The importance of the element of political will was a recurring theme in the data from all stakeholder categories in our case studies as well as in discussions during the workshops with decision-makers. Informants across the cases emphasised that politicians in finance ministries or other

- With concerted and sustained efforts, the influence of research leaders extends beyond Ministries of Health to reach decision-makers across a range of government stakeholders including education, science, and finance ministries.
- Advocacy networks can be formal e.g. an international conference of researchers that prepare recommendations for the national government, or informal, consisting primarily of individual relationships and personal networks between researchers and elites.
- Due to high turnover of individuals in government positions, researchers should seek to cement gains from informal advocacy in formal policies and legislation.

branches of government, such as legislatures, often have decision-making power over the financing pillar of NHRS, and thus indirectly over the prioritisation of HSR. Many researchers and decision-makers (within the health sector) found their role to involve lobbying for funds or convincing those with authority over budgets to allocate money to HSR.

We were intrigued to find in the case studies that senior researchers in African countries are actively engaged in ongoing advocacy processes for awareness-raising, agenda-setting, institution building, and policy formulation for the governance of HSR. Many see it as a necessity (even duty) for senior researchers to advocate for strengthening the financing pillar of NHRS to support HSR production and capacity, as well as for more formal regulatory environments of NHRS to support local expertise and national ownership of health research. The role of bureaucrats in advocacy processes involves working with parliamentarians; international development partners (i.e. aid donors); and routinely working both within and outside their ministries, including those of health, education, and finance. The importance of informal lobbying and influencing those outside the health sector was also noted, recognising that many determinants of health lay outside the health sector itself (e.g. social determinants of health). Long-term advocacy efforts of local research leadership have been able to facilitate the creation and institutionalisation of HSR governance arrangements in government and research institutions over time. Advocacy processes carried out by local researchers and decision-makers have been particularly influential in cases where NHRS regulatory environments were formalised through legislation, such as in the cases of Tunisia (**Box 4**) and Zambia (**Box 5**).

Box 4. Tunisia – Advocacy within government for domestic government funding for HSR

The Tunisian NHRS offers insights into how government funding for HSR has been secured through legislation to improve the element of the regulatory environment and institutionalised through advocacy processes. The Ministry of Higher Education and Scientific Research (MHESR) plays an important role in advocacy processes among government stakeholders (e.g. Ministry of Finance, Cabinet, and policy-makers) to maintain or increase the high-level of government investment outlined in the 1996 law on the orientation of scientific research**.** Before this legislation, the Fund for Scientific Research and Technology Control was established in 1984 with resources from a fuel tax. While the elements of political will and research culture work in sync to sustain these investments in the NHRS, senior officials at MHESR developed key arguments to support their ongoing advocacy processes and convince decision-makers in government to honour these commitments. Specifically, they highlight to the government:

1. the involvement of diverse stakeholders to define research priorities. Every 5 years, the MHESR organises a broad consultation to define national research priorities. These priorities go to the government for validation, which instructs the funding of activities. This stakeholder engagement promotes shared ownership of the national HSR programme by the various stakeholders, including those with authority over the funding pillar of the NHRS.

2. the transparent evaluation of research structures and allocation of funds. Research institutions are evaluated based on their performance, such as in publications, training, theses, number of ongoing projects, et cetera. The results of the evaluation are shared with the government and are made public on an online platform created by the MHESR that presents the activity reports and performance and impact indicators of the research institutions applying for funding.

3. the return on investment. This is a critical argument for convincing the government to continue investing in HSR. The ongoing innovation processes to transform research results into products and patents that can develop the local economy, with the potential to create jobs is a motivating factor for decision-makers to increase their funding for research.

The MHESR has combined these arguments in their ongoing advocacy to demonstrate the value of the government's investment in HSR. In essence, they draw on their capacity to communicate the message of the importance of interactions across multiple elements and processes within the NHRS to the government – structuring of the research landscape, stakeholder engagement, and the transparency of the financing mechanisms and decision-making – to demonstrate the effective use of government funding to improve the NHRS and serve the interests and needs of local stakeholders.

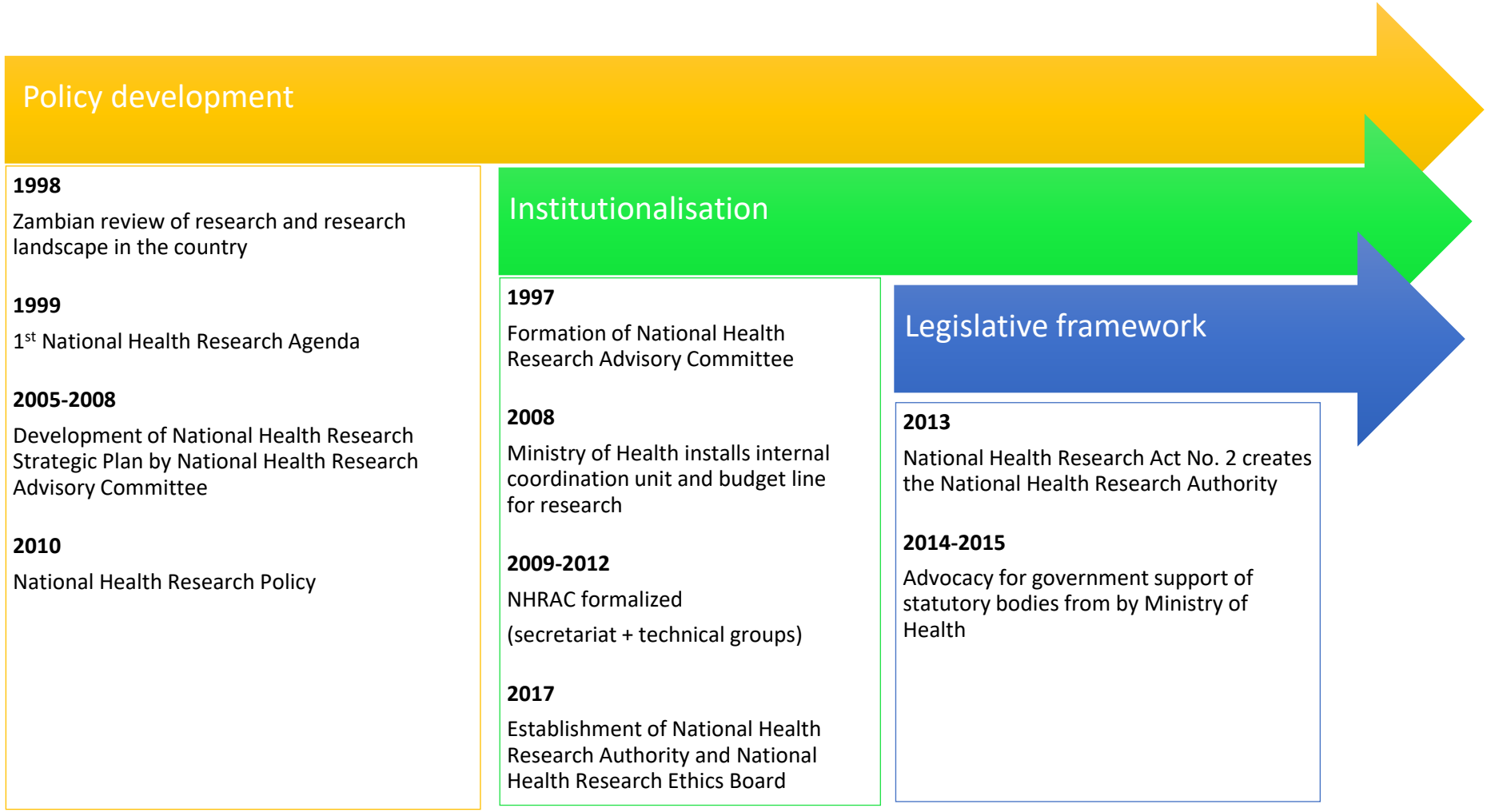


Figure 4. Advocacy for HSR Regulation and Coordination in Zambia

Box 5. Zambia - The 20 years of sustained advocacy for HSR regulation, coordination, and governance

The long-term advocacy processes over 20 years in Zambia, beginning with the National Health Research Advisory Committee in 1997, influenced legislation to strengthen the NHRS regulatory environment, establishing the National Health Research Authority and the National Health Research Ethics Board. Research leaders (individual champions advancing a strategic vision for a NHRS) had strong personal and professional networks, which gave them access to decision-makers and supported networking between key elites in research institutions, government, and international partnerships.

Research leadership was instrumental in the institutionalisation of the regulatory environment and aided using local data/evidence to support the advocacy processes for policy, legislative, and institutional frameworks (**Figure 4**). Sustaining these efforts over time and connecting them to the local realities of Zambian HSR needs through a local, data-driven strategic plan provided leaders with concrete arguments for the advocacy process.

During the first decade (1997-2007), researchers focused their advocacy efforts on the health sector, to build awareness, interest, and political will for HSR at the Ministry of Health. They worked with the National Health Research Advisory Committee to establish a national health research scientific conference. Essentially for dissemination and networking between HSR stakeholders, the conference also served to create value and demand for HSR. The government has adopted recommendations made at the conferences, such as the development of a National Health Research Strategic Plan. These conferences played roles in connecting many parts of the NHRS – disseminating research, creating opportunities for networking, engaging decision-makers, and developing a research culture. In 2008, concrete results of these advocacy processes were seen with a standing budget line for research and a dedicated directorate in the Ministry of Health to support provinces and research institutions.

> *Within the advocacy we were for the first time able to persuade government to have a budget line on the Ministry of Health budget specifically for research. That was not there before. And that happened in 2008 when we developed this strategic plan. We deliberately persuaded government to have a budget line, and that budget line has been consistent*. Decision-maker, Government - regulatory agency (Zambia)

Once HSR became a part of the Ministry of Health mandate, researchers expanded advocacy processes to a wider audience across government and to national lawmakers, leading to the adoption of the National Health Research Act No. 2 in 2013, followed by four subsequent years of intergovernmental advocacy for its implementation. The centralisation of communication and strategic positioning through the Ministry of Health provided a legitimate source for high-level inter-ministerial contacts to be made in the lead-up to the legislation's vote, and especially in the advocacy for financial (to Ministry of Finance) and legal (to Ministry of Justice) support for statutory bodies to operationalise the law and develop policy instruments. The advocacy processes for the health research bill benefited from having the right people, in the right places, at the right time – with the current and former Minister of Health at the time having interests in research and/or a history of international civil service in a global health organisation and both with influential ties to the President. They also drew on financial and technical support through international collaboration, such as with the Canadian Coalition for Global Health Research. This partnership supported local advocacy processes and built capacity of the National Health Research Advisory Committee to work together with the Ministry of Health to draft the Act and define the functions and structures of the National Health Research Authority.

The experiences from these two cases reveal key issues for how ongoing advocacy processes are used by researchers to influence and support the development of NHRS governance. Advocacy processes must be sustained over long periods of time to result in policy change and implementation. Effective elements of research leadership were seen to influence the level of awareness and appreciation for HSR in countries in multiple ways, in particular for laying out a vision for HSR and the structure of the NHRS pillars while developing a strategy to achieve that vision. Research leadership provides the critical perspectives that decision-makers need to support the alignment processes for the development of the NHRS in relation to national health needs and priorities and shapes NHRS pillars and processes through international social and epistemic capital built through high-calibre research, international scientific leadership recognition, and professional networks. Thus, research leadership brings the weight of knowledge, connections, and legitimacy to the ideas and proposals for developing NHRS – especially, but not only, in the processes of advocacy.

The element of political will is closely connected with advocacy processes because it is also related to the circulation of individuals between various positions of power in their own government, intergovernmental or multilateral institutions (such as WHO) – which is why the social capital of researchers and decision-makers involved in advocacy are so important for its success. Indeed, the local elite networks that span science and policy domains are mechanisms through which political will can be influenced and empowered to strengthen NHRS, in particular the governance pillar. Having senior decision-making positions in government occupied by people who understand the importance and value of HSR is also likely to stimulate and enhance political will. For example, a recent Minister of Health in Madagascar was a professor of public health and epidemiology, and researcher (when this position is frequently and traditionally occupied by a medical doctor). The Malagasy HSR community saw him as a strong ally for strengthening the environment for health research. Indeed, despite a very large portfolio, many of his first actions in office related to strengthening the NHRS. The actions included organising a national HSR scientific event, resuming processes for institutional reform to set up a National Council for Health Research, and restructuring the Ministry of Public Health to give a more important place to research, directly under the authority of the Minister, within the Service of Relations with University and Research Institutions. However, when the Minister was replaced, new relationships between the HSR leaders and decision-makers needed to be formed.

The rapid turnover of government officials is one challenge of maintaining political will, and perhaps why legislation is seen as the best means to embed a strong regulatory environment within the NHRS to protect rights, duties, and gains in the governance, regulation, and financing of HSR from unpredictable political changes. As such, the access of researchers or funders to political elites is insufficient on its own to foster political will as a supportive element of a NHRS. Decision-makers from multiple sectors underlined that a key challenge to increasing political will for NHRS is the pressure politicians face to deal with competing urgencies and other claims for attention and resources (i.e. water and sanitation, education, health care/systems and disease burden, infrastructure). Political will and research leadership are dynamic elements of NHRS. That is to say, they can and do fluctuate, with differing levels of political engagement and strategic leadership from heads of state/presidents, within or between ministries (e.g. health, education, finance), or district and local government authorities.

In Côte d'Ivoire, research leadership has been critical in efforts to leverage existing funds for the financing pillar of NHRS to address domestic HSR needs and increase ownership of HSR institutions as a foundation for local NHRS resources. In 2019, the Ivorian government announced the creation of the *Centre de Recherche des Maladies infectieuses et Pathologies associées,* an Ivorian institution in charge of infectious disease research that is partnered with a locally-based French research institution. This is a significant change in the dynamics and structure of infectious disease research in the country, with an Ivorian institute in the principal leadership role and a French institute in a supporting role. According to informants, the construction of the West African Regional Biobank (CEREB) is another example of the positive influence of the element of research leadership in connecting advocacy processes to the government and various organisations. The CEREB is the reference centre for the 15 ECOWAS countries to conserve high-risk microorganisms in high-security conditions for research purposes.

> *[Thanks to] the Director of the Pasteur Institute in Côte d'Ivoire, today it houses the first bio bank in West Africa, which now has the ECOWAS mandate for the collection and analysis of certain strains and samples. At the moment, Côte d'Ivoire has decided to focus on a p4 laboratory. So this is really the cream of the crop, and the tip of the iceberg. I can tell you that there is funding for this!* Donor (Côte d'Ivoire)

The political will which supported the negotiations and planning of both of these significant government achievements relied heavily on the research leadership of the Scientific Director of PAC-CI and the Director of the *Institut Pasteur* of Côte d'Ivoire. The creation of these institutions is seen as a vital step in the most recent stage of strengthening the NHRS in the country, reclaiming national authority and ownership of HSR and situating the power and leadership in local expertise – while working towards establishing it as a major pole for the region. From the perspective of foreign stakeholders, this constitutes part of the enabling environment that renders the Ivoirian NHRS attractive for international collaborations.

> *Côte d'Ivoire is very favourable for scientific collaborations … which have made it possible to establish long-standing partnerships that now have a regional scope, so focusing on Ivory Coast but within a policy of expansion, especially on infectious diseases and emerging and re-emerging diseases.* Donor, Bilateral partner (Côte d'Ivoire)

However, amidst the gains from political will and research leadership to build strong pillars of an NHRS through international collaboration with foreign governments, informants from Côte d'Ivoire warned that one should also not lose sight of the fact that this NHRS remains fragile. The system faces significant challenges across the core pillars, including in securing domestic funding for HSR, HSR governance and coordination, and human capacity for specialised research areas.

The case of the Tunisian NHRS provides a unique example of cultivating the element of research leadership from the diaspora. At independence, Tunisia invested in its higher education and scientific research through the progressive naturalisation of existing research institutes and creation of new institutions with the technical and financial support of multilateral organisations. The government had a deliberate strategy to invite researchers from the diaspora to organise and lead the research institutions that benefited the Tunisian NHRS. This allowed for scientific networks and international collaborations to strengthen the pillar of creating and sustaining human and institutional resources for HSR in Tunisia

through academic training, collaboration on research projects, mobility of young researchers, and co-supervision of theses with Western collaborators.

> *We were able to recruit renowned researchers who invested personally in the implementation of this quality research and I must also say that we appealed to the Tunisian diaspora abroad. Here the diaspora, it can play a very important role because we can import the expertise of Tunisian researchers in major research centres abroad to set up projects, to develop strategies, to orient research towards priority axes. With the help of the diaspora, these people really made it possible to take a step forward, to have the right people with whom we collaborate, to train young graduates who themselves have taken over at this centre.* Decision-maker, Government - ministry (Tunisia)

The diaspora contributed to structuring the new higher education institutions and doctoral research programmes post-independence. This in turn supported additional processes of international collaboration leading to the development of a critical mass of HSR capacity and rapidly strengthening the research culture and research leadership within the Tunisian NHRS. Informants from other cases, Liberia in particular, stressed the importance of involving the diaspora in strengthening the NHRS as key resources to build research leadership for local institutions in teaching and developing research as a core activity of the faculty. However, the Tunisian example is unique as an official government strategy for their involvement.

Research leadership and individual HSR champions in Uganda are seen to have been the bedrock for strengthening the NHRS – not only for their skills and capacity but for their networks and collaborations they built and carried forward after the civil war. Senior research leaders strategically used their networks to build the NHRS from the bottom-up with highly skilled and motivated individuals who have been instrumental in attracting and managing international collaborations. Their work and research leadership during times of extreme scarcity and insecurity were invaluable contributions to the future of the NHRS, as many of the NHRS pillars in place were a result of advocacy efforts several decades ago. These individual's contributions were fundamental to establish the reputation of Uganda as a regional hub of excellence for research training. They were also invested in developing the governance and resource pillars of the system – policies and institutions – which espoused confidence of stakeholders (including foreign collaborators) in the NHRS, even as they worked through political unrest where intellectuals were targets. Many in the current generation of scientists and researchers will have benefited from the mentorship and been under the leadership of one or several of these research leaders.

> *There's been a lot of mentorship. There are so many role models you can look at in every field and you get inspired or helped if you're a young researcher or if you're an external person wanting to look for collaborators. And I think this is probably one of the factors that we sometimes underestimate.* Researcher, University (Uganda)

Future generations of researchers in an NHRS depend upon strong research leadership to engage in mentoring processes, which are not always offered as part of the formal research training programmes due to capacity and resource constraints. Mentoring is an important process within the element of research leadership, and mentorship is needed over time from those with relevant experience to support those at different stages of their research careers.

Beyond the acumen of individual research leaders able to seize opportunities for advocacy, stakeholder engagement and working with local partners to collectively develop and communicate a shared strategic vision is essential in organising broad support behind a common advocacy message or goal. Advocacy for HSR needs to demonstrate the value of data, using success stories of how doing a piece of research can have impact. Advocacy processes are most effective when they are supported by local knowledge and data, thereby making the advocate's messages relevant to the local situation and needs (as shown in **Box 5** and **Box 6**).

Box 6. Madagascar – Using local data to participate in international organisations as advocacy for HSR needs in-country

The Codex Alimentarius Commission (CAC) is part of a joint FAO/WHO Food Standards Programme, which adopts evidence-based standards and codes on food safety and quality to protect consumers and ensure fair practices of food trade. Madagascar has been a member of the CAC since 2010 represented by a scientist from the National Centre for Research on the Environment. However, without key local data, even as a member state, the Madagascar representatives cannot take the floor to address the commission in plenary session.

Malagasy researchers started a training programme to learn about advocacy processes - how to approach decision-makers, develop arguments for advocacy, and communicate convincingly to secure funding for HSR and strengthen the NHRS in Madagascar. One of the strategies that they developed is to appeal to the economic ambition of Malagasy politicians for the country to become the "bread-basket of the Indian Ocean." Since the agricultural products of Madagascar must meet international norms in order to be exported successfully, research is needed to help meet those standards. There have been examples of containers of produce refused at port of entry overseas due to issues with pesticides, for example. The researchers are working to craft and use economic and health arguments to convince decision-makers to fund research on food safety for the Malagasy population, which would in-turn support HSR activities and provide them with local data, thus enabling them to participate in this intergovernmental decision-making body. Madagascar has urgent food security and safety issues which they consider dangerous for the population (i.e. storage practices for peanuts, food colouring and aspartame in drinks sold to children near schools, fake honey production increasing with deforestation, pesticides), but there are no funds available to do this research at the crossroads of nutrition, agriculture, and health.

The researchers thus try to use the economic goals of the government and aspirations for full participation in an international body to leverage the government's interest in financing HSR that would benefit trade as well as local population health.

Fulfilling ambitions for the national economy appear to be common underlying rationales that drive the element of political will for HSR, as shown in **Box 6** above. However, even when the political will is perceived to be strong by stakeholders, it is not sufficient on its own to strengthen NHRS. For example, in the case of the NHRS in Botswana there is a policy development and implementation gap between the goals of the government as expressed in successive national development plans (e.g. Vision 2036 and Vision 2016) for a knowledge-based economy and its realisation.

> *We have some institutions that are considered research based, which says that the country is ready for that. The head of state, the current president talks a lot about research and about resources, a knowledge-based society that needs people to be prepared at PhD level to conduct research. So, I believe we do have an enabling environment. The challenge is research funds.* Researcher (Botswana)

Yet, the observed lack of and slow policy implementation does not necessarily support our understanding of an enabling environment and political will for the NHRS in Botswana. The political will and support for research as a pillar for a knowledge-based economy has not yet translated into meeting the committed targets for substantial domestic government funding for research and development generally, or for HSR specifically. The government has not met the target of 1% of GDP for research and development, despite the strategic vision to transform Botswana into a knowledge-based economy through innovation processes and its history of STI policies. Some stakeholders from government agencies advocate that the financing pillar of NHRS should also be seen intertwined with health and the health budget, as a mutually reinforcing investment.

> *The government committed that it would put 1% of its GDP in funding research. It hasn't happened to date. We should not see funding health in isolation from research, it should be part of it. And that is where we're coming as an institution, creating these strategies, presenting them, and lobbying the government and saying, "Look. This is how you can solve the health problem, at the same time also funding research. Don't treat it in isolation, co-create things with research inclusivity.* Decision-maker (Botswana)

iv. Culture of research and valuing research

Key Messages: Establishing and nurturing a culture of research can significantly improve the environment for building capacity of HSR professionals.

- By engaging with public beneficiaries at each stage of HSR, researchers can design more impactful studies. Local stakeholders can help identify problems therefore, shaping research questions. Additionally, by following-up with local audiences on research outputs, researchers can create opportunities for dialogue that engender an appreciation of local HSR.
- Successful NHRS have instilled a culture of research through scientific conferences, mentorship, development of scientific associations, and political engagement.
- Additionally, health crises are important inflection points to generate researcher culture. The prominence of health issues at such a large scale generates increased general public attention and ultimately, increase the demand for and awareness of HSR.

A culture of research and the national recognition of the value of research were strong supporting elements of a well-developed NHRS. A culture of research was broadly defined as the methods, practices, and norms of scientific research activity within the scientific community. There was wide heterogeneity in research culture across the nine cases of NHRS we analysed. For example, the culture of scientific

writing (e.g. grants, publications, presentations) is less developed in some countries, such as Liberia and Madagascar, than others, such as Kenya, Uganda, Tunisia, and Zambia, where researchers and decision-makers noted a stronger, more established research culture.

> *When I came back to Liberia, I realised that there was an absence of research culture…. a lack of research written by Liberians, a lack of qualified researchers, and a lack of a research environment at the university.* Researcher, Government - autonomous (Liberia)

While this may be explained by the presence of a number of the NHRS pillars (for example the existence of research institutions and their capacity, availability of training, research in university curricula) it is one reason why taking the number of publications as an indicator of performance may miss crucial local HSR in places where research culture is nascent.

> *Few people publish papers in the health sector and even within the ministry, so there is limited capacity. There are volumes of research materials. The roles of Ministry of Health staff are to co-author or contribute to that research, but you see few papers that are authored by the staff of the Ministry because that culture of publication is not there. It has to be grown. It has to be guided by experienced researchers. We do not have that.* Decision-maker, Government - ministry (Liberia)

When a lack of research culture was discussed, researchers noted the absence of a well-connected research community to share these tools, habits, and traditions. More specifically, research culture was described by researchers as something which includes such themes as multi-disciplinary research collaboration and the integration of research as part of a university education or career pathways for professors, in addition to the core NHRS pillars, such as knowledge transfer and use.

Scientific conferences have been shown to be useful mechanisms to develop the element of research culture (**Box 5**). There are nascent examples of such conferences emerging in Madagascar and Liberia (**Box 3**) that are promising avenues to build national research culture from the ground up.

Box 7. Liberia - Developing research culture after the Ebola outbreak

Liberian research leaders transformed the interest, activities, and momentum around HSR capacity development generated by the West African Ebola crisis into an opportunity to build research culture within the NHRS.

Ebola provoked the inspiration of people to be inquisitive, to investigate the underlying factors. So it actually created an environment. Decision-maker, Government - ministry (Liberia)

As another decision-maker said, "*We have to encourage the culture of research*." After Ebola, Liberian researchers committed to doing this through a national HSR conference. The conference is named in honour of the first Director of the Liberian Institute for Biomedical Research and former President of the University of Liberia. The first Emmet Dennis National Scientific Conference, was held in 2018 and the 2nd one in 2019. The conferences were co-organised by Liberian institutions: Liberia Field Epidemiology Training Program, National Public Health Institute of Liberia, and University of Liberia with support from international partnerships. According to researchers, the most exciting result of the conference was the enthusiastic response and participation of students.

The most amazing part is that we had planned for 250 students, but we had 300 students from the medical school and from the universities who were there for three days doing oral presentations of their own research. That was the beginning of a very big transformation I want to see Liberia go through. The momentum is building. Imagine what's going to happen if down the line with funding. Researcher, Government - autonomous (Liberia)

This conference is an opportunity to raise awareness about HSR, focus on national priorities, provide a platform for networking between researchers and decision-makers, disseminate research results, build research skills (abstract writing, presentation, peer review), and engage with students to increase interest in scientific research. Each of these activities comes together to foster a vibrant and sustained local research culture, with long-term influence on the national environment for HSR.

The conference is creating that kind of awareness and is building excitement about undertaking research, working closely with the universities. The universities really should be supported to step up their game, leading and conducting research. Researcher, Private research institution (Liberia)

Informants identify an increasing interest in science and HSR, in particular among youth, as a spill-over effect from the Ebola crisis and the response to build local HSR capacity. One informant describes a snowball effect for the vision of the NHRS wherein as more research is conducted locally, and as capacity is built, "the more appealing it becomes to young and motivated researchers, or potential researchers."

We are now gradually building [a] research environment … people were illiterate to research but because of our social mobilisation, there was massive awareness. People are now more conscious of research. Researcher, Government - autonomous (Liberia)

The Ministry of Education wishes to change the curriculum policy for secondary education, by introducing a science track so that once students reach 10th grade, those interested in science can follow a science-focused curriculum.

We are trying to get a lot of young people interested in the sciences, which has not been the case in this country. We produce more economists, more accountants, and very few students of science. Getting a lot of young people into the sciences and getting them to develop and embrace that whole mindset of research -- I think that's the first stage. Decision-Maker, Government - legislature (Liberia)

Changes in the research culture have already been seen in a short time over less than a decade.

In 2012, I could count the number people who were conducting research or had interest in research on one hand with a few fingers. But today, I go to high schools to speak, and everyone wants to be a scientist. So there's a shift, a paradigm shift, and it all happened probably because of these kinds of activities. Researcher, Private research institution (Liberia)

Building up the element of research culture within academia is critical to support the NHRS pillars, but increased appreciation and value of local HSR research is also needed among decision-makers and society at large. For example, in Madagascar, researchers expressed that decision-makers lack confidence in local researchers. According to researchers, it is common for the government to prefer using international experts for HSR needs rather than national researchers.

> *Decision-makers and politicians tend to call on foreign experts rather than our own, yet there is no better choice than national experts, not only because they have the competence, but also because they are permanently on site. That's a big problem. If they would call on us, everybody would benefit, including the government, and they would have experts who speak Malagasy. Instead of paying astronomical sums to bring in experts for a few months, with the national experts they might not pay a tenth of that, and for us it would represent a lot. This is an example that could change the course of things.* Researcher, Public research institution (Madagascar)

The lack of a platform for exchanges between researchers and decision-makers and decision-maker's inaction to improve HSR in the country may also explain this situation. In part, this reflects the absence of political will and research leadership to improve and recognise local expertise. It also reproduces a lack of ownership of HSR by national researchers in the NHRS.

Finally, stakeholder engagement is also a key feature of a strong research culture. However, many researchers expressed that it is challenging to engage with communities and decision-makers because stakeholder engagement is not generally integrated into the researcher's toolbox of skills and competencies. Yet, engagement processes help to support research as a valued component of a knowledge-producing society, especially when researchers involve the public in their research projects and communicate results to a wide audience.

For example, the Tunisian state has worked to disseminate and strengthen their research culture and promote the value of research within society. The Jasmine Spring of 2011 that marked Tunisia's democratic transition was a catalyst for strengthening research culture within Tunisian society. The socio-political crisis led to the establishment of a citizen dialogue bringing workers' and employers' representatives together with the government to discuss subjects of common interest including health and HSR priorities. These social consultations were an opportunity for researchers to advocate for more investment in research and to increase citizen engagement. Since that time, researchers have implemented several projects aimed at strengthening communities' scientific education and their participation in research, such as the European Union H2020 funded project on "science stores" called *InSPIRES* (Science shops to promote Participatory Innovation, Research and Equity in Science). This project allows civil society organisations to submit a proposal expressing their needs and proposed solutions, which is evaluated by a scientific committee; the selected projects are funded and implemented with technical support from the committee.

> *My personal battle horse is to work on citizen engagement, to involve them as much as possible. The context lends itself very well to this with the new democracy, to be in dialogue with citizens, to listen to their needs, and moreover we have a very nice international project on this. We are working with the public and civil society organisations concerned about a problem that affects health, the environment, and*

vulnerable populations, and then associations can propose projects [related to their concerns]. Researcher, Public research institution (Tunisia)

Additionally, more than 300 scientific associations work in partnership with the Ministry of Higher Education and Scientific Research in Tunisia. Annual grants are awarded to these associations for the organisation of scientific events, the publication of scientific journals, the creation of websites, participation in conferences abroad, et cetera. Several research prizes are offered to encourage science dissemination. More than one hundred scientific events open to the general public are organised in the country every year. Furthermore, the Tunisian government has made tremendous efforts to facilitate access to scientific information. Thanks to agreements signed with publishers of scientific journals, various programmes for access to scientific information allow researchers to consult many online scientific journals and databases free of charge. The "virtual library project" managed by the National University Centre for Scientific and Technical Documentation identifies and makes available free documentation, a catalogue of periodicals, as well as a legal database containing all legislative or regulatory texts published in the Official Gazette of the Tunisian Republic since independence. These investments in strengthening research culture as a key element of NHRS aim to support the critical engagement of communities, enables the public to hold decision-makers accountable, and actively encourages participation in research as actors and/or beneficiaries. A strong research culture also complements the advocacy processes led by research leaders and decision-makers in favour of strengthening NHRS.

v. Alignment and prioritisation

Key Messages: Aligning HSR with needs and goals is a centre piece of a successful NHRS. However, in the absence of political prioritisation, HSR efforts will likely not be implemented nor will HSR priorities be used to guide decisions without sufficient commitment or funding.

The processes of prioritisation and alignment of HSR are a challenge at multiple levels of governance within an NHRS. For example, researchers and decision-makers spoke about HSR not being perceived as a priority by policy-makers as well as a resulting lack of alignment between the national government agenda and local needs. They also discussed the weak connection between HSR carried out in their country and national development needs, and the lack of use of existing HSR priorities for decisions about funding and programmatic foci within the NHRS.

- Successful NHRS have ongoing and systematic processes for developing priorities that consult a variety of local stakeholders. However, collectively generating NHRS objectives is not enough to ensure improvements. Constant political engagement through advocacy is required to maintain buy-in for programming and policy change.

- National governments can improve NHRS by strengthening the mandate for HSR governing institutions to include prioritisation and alignment processes and coordinating across sectors, provided that they also increase their funding and staffing accordingly.

Box 8. Zambia - Generating HSR priorities is insufficient without political will and mechanisms to integrate them into NHRS

The HSR prioritisation processes in Zambia since 1998 range from externally driven, ad-hoc activities to locally initiated, comprehensive processes. Over that time, there have been six priority-setting exercises led by different stakeholders. The initial exercise was conducted by the National Health Research Advisory Committee (1998 -1999), with other HSR priorities identified as part of the National Health Strategic Plan (2006–2011), which were updated and incorporated into the National Health Research Policy in 2010. Multiple other prioritisation exercises were led or facilitated by the National Science and Technology Council, the Zambia Forum for Health Research, and the Ministry of Health, in partnership with WHO. Most recently, in 2018 the National Health Research Authority facilitated a national prioritisation process in which efforts were made to ensure that the HSR priorities were in line with key national policy documents valid through 2021, namely the Seventh National Development Plan and the Ministry of Health Strategic Plan.

Despite these priority-setting initiatives, stakeholders in Zambia report that the prioritisation processes have been characterised by limited stakeholder buy-in of the resulting national HSR agenda and a lack of alignment with previous processes and wider national plans. Notably, there were no links between the different initiatives. According to researchers, there is still a gap in HSR prioritisation and alignment with health priorities, as a number of current health priorities have not been adequately addressed in the HSR agenda. Overall, it seems like prioritisation processes have had little influence on the government's commitment to implementing HSR activities, nor in budgeting for the funding of these.

> *I think there are many challenges. Does the government prioritise research? And do they know the benefits that arise from research? Because, they could be saying it, it could be documented in many polices and other government documents, but the will to fund the research may not be there... Well, I don't know if I should say this, but the issue of politics. So where are the priorities?* Researcher, Academia (Zambia)

Priority setting for HSR is handled in various ways across the cases of NHRS – either within institutions that govern HSR or through more participatory ways involving a range of stakeholders. For example, the most recent prioritisation process in Zambia aimed to generate HSR priorities aligned with the national health and development 5-year plans. However, Zambian informants shared accounts of fragmented prioritisation efforts, mainly externally driven and unsuccessful in increasing any commitment or funding to address these priorities. The 20-year journey to secure the government's support for HSR governance and create a stronger regulatory environment (see **Box 5**) has not managed to secure buy-in for HSR priorities and build capacity for Zambians (see **Box 8**).

Except for Tunisia, few processes for setting HSR priorities involve wide stakeholder engagement and participation. National consultations are organised in Tunisia to identify research priorities every five years, including extensive online consultation, workshops to discuss the priority-setting methodology, a national conference, and regional workshops. Health research is one of six programmatic areas covered in the consultations. The last consultation's participatory approach reached about 2,000 stakeholders such as researchers, administrative and technical managers, representatives of the ministries

concerned, representatives of economic and social institutions and civil society organisations. The regulatory environment of the Tunisian NHRS influences how domestic public funds are spent across HSR priorities while simultaneously holding research institutions accountable to address those identified priority issues (see **Box 4**).

Among the other cases of NHRS with health research priorities (see **Table 3**), a range of individual HSR governance institutions, like a Ministry of Health, a special committee, or National Institute of Public Health (e.g. Kenya, Liberia), were responsible for prioritisation processes – therefore reiterating questions of decision-making authority, what data or engagement is used to determine priorities, and how HSR priorities are subsequently used. It is unclear in some instances if HSR priorities are for use within institutions in particular, or for the HSR research community at large within the NHSR – which can be disputed depending on whose voices were included and how priorities were identified. The institutional capacities and representation of these organisations is important for legitimacy and integration of their work with other stakeholders in the NHRS. For example, in response to fragmentation in the NHRS in Uganda, the Uganda National Health Research Organization was established in 2011 as an umbrella organisation with a mandate to coordinate HSR research, define HSR research priorities, and ensure that knowledge and funding flow smoothly through the system. Yet, since its establishment, the institution lacks human resources and adequate funding to mobilise the coordination and cooperation needed for HSR priorities to positively impact health outcomes. In many cases, including Madagascar, the lack of coordination between various sectoral authorities responsible for the governance of HSR or scientific research (in general) reproduced a similar fragmentation of priorities – with a lack of integration or alignment between HSR, science/innovation, and development research priorities, which many stakeholders found problematic for the development of the NHRS.

We found that making HSR a national priority for policy and action may be a necessary first step in the prioritisation and alignment processes to determine specific HSR goals for the NHRS – and one in which advocacy and research leadership are instrumental to achieving. Several systems indicators for NHRS pillars like an adopted national health research policy, high level of domestic government expenditure for HSR, or the number of national HSR programmes or centres, provide one way to examine whether there is a commitment to making HSR a national priority. For example, the Programme Commissions that began in the late 1970s in Côte d'Ivoire were a decisive turning point in the NHRS because they integrated thematic research programmes across institutions to harmonise their research areas and encourage interdisciplinary work. The programme commission was a biennial consultation forum bringing together all the partners and users of the results of research; however, these were unfortunately interrupted by the socio-political unrest of the early 2000s which caused disruptions in the design, selection and conduct of HSR programmes in Côte d'Ivoire until advocacy processes successfully put HSR back on the national agenda for the health, higher education/scientific research, and development sectors. In Kenya, some prioritisation processes, particularly around HSR capacity strengthening, were facilitated and championed by research leaders. They organised a Consortium of National Health Research, which included about 15-20 stakeholders in Kenya, including the Ministry of Health, major hospitals, universities, medical schools, and other research organisations. The consortium met annually to discuss priorities for HSR capacity strengthening within the country, make institutional commitments, and speak about readiness and ongoing strategies to achieve these objectives.

The commitment of international partners to provide support (financial, technical, and political) for local prioritisation and alignment processes would be a vital step towards increasing local ownership of the NHRS while simultaneously strengthening the pillars of the system.

> *In Zambia, like many other third world countries, the owners of the money drive the agenda. That may be responsible for taking us away from what we consider as national priorities. Because even for national priorities, most likely we will still go back to the same funders to ask for resources to do more research, but at the end of the day, that may not be their priority.* Government - Regulatory agency (Zambia)

This will require changing international partnership dynamics and arrangements to jointly develop projects with local experts based on their needs, to equitably share contributions and benefits with local experts and researchers, to ensure shared leadership and governance, and to explicitly include opportunities to build local capacity and skills into the project design. But on a more fundamental structural level, it would also necessitate a major paradigm shift in how funding decisions are made by foreign donors and partners (e.g. bilateral donors, research funding agencies) as well as the rules of negotiation between governments on aid and other types of agreements.

Box 9. Uganda – Aligning collaborations on HIV/AIDS research with NHRS objectives through research leadership and political will

In Uganda, the HIV/AIDS crisis presented a window of opportunity for growth in the pillars of HSR production and creation of resources in several ways. Uganda attracted attention in part because of existing HSR capacity. Ugandan decision-makers acknowledged the disease and its impact – signalling the importance of research leadership, political will and science capacity in combination to influence decisions to prevent, control, and treat the epidemic and to strengthen the NHRS to produce knowledge for these goals. It was a priority of the country, which improved ownership of the research agenda, supported by the political will of government to improve governance structures. This enabling environment welcomed the surge of international collaborations as the crisis attracted considerable resources and capacity that benefited the NHRS as a whole.

Researchers focused on HIV/AIDS as the Ugandan government's priority and found a very fertile and open ground for not only their research but for advancing other aspects of HSR and parts of the NHRS – including the regulatory environment, human resources, and research institutions and infrastructure. Capacities were developed in areas of innovations in medicines, technologies, and system delivery methods. Several institutions were transformed into world-class centres of excellence, and important long-term collaborations were initiated, like the Makerere University Walter Reed Project. All of these have served to catapult Uganda as a leading research destination for many scientists, including social sciences and humanities disciplines too. One can find a multitude of both world-class local and visiting scientists because there are institutions to host them, connected to a regulatory environment for guidance, support and protection of their HSR pursuits.

We were able to seize opportunity. And since that period, the history [of HSR] has been really good for us. I think when people were still struggling to figure out whether they had a problem or to admit it, we were already embracing the problem. We had a problem, and everyone rushed to start to do something, because at least there was an open gate to do so. Researcher, Academia (Uganda)

Although there is critique that this focus on HIV/AIDS produced a vertical programmatic agenda, many decision-makers and researchers alike cite the opportunities, which have eventually benefitted the NHRS as a whole.

In my view, one of the big enabling factors has been the research questions that have come off of HIV scale up of programmes. Because this came with money, but also because of money, it came with bigger ambitions and very rapid expansion, which led to many practical questions. Those practical questions quickly triggered research interests, and those research interests fed off the same funding that had significantly increased. Researcher, University (Uganda)

vi. Innovation

Key Messages: Innovation can be a critical process to connect the NHRS with other key sectors and systems, however, the exact policy mechanisms to establish an enabling environment are unclear.

- National Centres of Excellence have been found to be a successful strategy for incubating innovation.
- The potential economic benefits of innovation are a useful argument to encourage political prioritisation of HSR. Research advocates also note the benefit of innovation processes on NHRS capacity and infrastructure, as well as potential benefits to health outcomes.
- Through a supportive regulatory environment, national governments can link the research and industry sectors. These links improve innovation processes within NHRS by incentivising commercialisation of HSR results and supporting HSR institutions to develop partnerships with industry.

Innovation processes were an emergent theme of great interest and importance in discussions with decision-makers, who are keen to consider what generates innovation in HSR. Informants from several NHRS cases shared examples of successful efforts to encourage innovation and achieve marketable products from HSR in public research institutes. There are numerous examples of policy frameworks and institutions dedicated to funding and supporting innovation processes in countries (e.g. Côte d'Ivoire, Kenya, Uganda – see **Table 3**), but their connections to the NHRS and to innovation from HSR are generally unknown and vague. While innovation is part of the overarching development vision to transition to a knowledge-based economy and/or to achieve an upper middle-income country classification status (e.g. Vision 2036 in Botswana, National Development Plan in Côte d'Ivoire, Vision 2030 in Kenya), the articulation, operationalisation, and integration of the overarching vision with HSR policy remains unclear. Overall, alignment processes within NHRS have largely overlooked or excluded a focus on HSR innovation, in contrast to other sectors where this features more prominently (e.g. agriculture, environment, energy, communications).

> *The facilitative environment really comes from the vision of government to move from a resource-based economy to a knowledge-based one. And inevitably when you talk about a knowledge-based economy, you are calling for research and innovation to be the major thrust in terms of developing the economy.* Decision-maker, Government - ministry (Botswana)

The vision for innovation is primarily linked to economic growth and development, while the arguments for prioritising HSR used by research leaders in advocacy processes is generally framed around improving population health and serving the local knowledge needs of health systems.

As such, the mandate for developing and incentivising innovation frequently falls under a ministry of science (or equivalent), and usually is distinguished from institutional mandates for regulating research and innovation (which often have been delegated to a semi-autonomous agency). The connections between the regulatory environment for HSR within the NHRS, and the regulatory environment for science, technology and innovation at

large is not always clear. For example, in the case of Kenya, the STI Act (which legislated a number of institutional mandates) also created the Kenya National Innovation Agency designed to be the operational arm to manage the Kenyan innovation system and work as a tripartite with the National Council for Science and Technology and the National Research Fund to intensify innovation in priority sectors. However, from our interviews, it is unclear how the political will to increase funding and accelerate Kenya as a regional centre for research and development of new technologies translates into changes that will specifically support the development of the NHRS.

Within the resource pillar of NHRS, national centres of excellence seem to be a particularly promising mechanism to encourage innovation in HSR that has been adopted in countries such as Botswana and Côte d'Ivoire. Their success in this, however, may depend on the extent to which they are financially, and otherwise, supported by government – as seen in the financing pillar of NHRS. For example, the National Research, Science and Technology Plan identified Botswana's priority areas for investment in research, including the health sector, as part of the implementation of its National Development Plan. It responds to several socio-economic challenges facing Botswana, including economic diversification, poverty, unemployment, HIV/AIDS, and the sustainable use of natural resources by introducing policy interventions to focus on multidisciplinary programs, the establishment of Centres of Excellence, the stimulation of private sector research through an Innovation Fund and research tax incentives, and the integration of a budget line for research and development coordination within the overall national innovation system. The five Centres of Excellence focus on energy for the future; infectious diseases; indigenous knowledge and technology systems; information and communications technology; and human sciences and policy research (not yet established). In addition to these Centres of Excellence, higher education institutions (e.g. University of Botswana and the recently established Botswana International University of Science and Technology), and a number of public research and technology institutes have been tasked with researching, developing and/or adapting technologies for application in Botswana. The Botswana Innovation Hub, the country's first science and technology park, opened in 2012, as part of the implementation of the national innovation policy. However, it is unclear from the data we collected whether or how it will include innovation in HSR. Furthermore, there seem to be a lack of coordination mechanisms between the Department of Health Research, Policy and Development at the Ministry of Health and Wellness and the Department of Research, Science and Technology (responsible for coordinating R&D) at the Ministry of Infrastructure, Science and Technology to ensure that the NHRS can benefit from and contribute to innovation processes.

Finally, the Tunisian case of NHRS present an interesting example of integrating national innovation processes into the NHRS through the element of the regulatory environment which supports public and private sector collaboration (see **Box 10** and **Box 4**).

Box 10. Tunisia – Innovation through government incentives for partnerships between public researchers and private industry

The Tunisian NHRS offers insights into how the government has supported innovation by facilitating links between research institutions and private enterprise. Political will to link scientific research to the country's socio-economic development is illustrated by the measures and incentives established by the government for aligning research and innovation within the NHRS. Specifically, this translated into the establishment of incentives to encourage researchers to collaborate with companies to develop HSR oriented towards the country's scientific and technological progress. Thus, the government incentivises researchers to partner with companies to develop research with innovation potential and has created interface structures with universities to support joint reflection on strategies to promote the research results they produce. Funding calls for proposals are an effective mechanism within the regulatory environment to encourage this. Partnership between a university (research sector) and industry (business sector) is a requirement to be eligible to apply for funding from the Ministry of Higher Education and Scientific Research for some national projects.

> *National projects are projects that are necessarily related to the innovation. For example, one is obliged to have a partner from the private (business) sector to be eligible for these funds, and the project must be showing impact of the research to solve a problem in order to finance it. In addition, interface structures in universities and research centres, which are developing little by little over time, have a mission to accompany researchers to support their reflection on how the research results can be used for innovation and new products/technologies.* Decision-maker, Government - ministry (Tunisia)

At the same time, measures are being taken by the government to train scientists to move towards this new approach. Therefore, these government policies, supported by the regulatory environment, are reshaping universities' structures of support for researchers within the NHRS to be able to envision, translate, and promote their research ideas into potential business opportunities.

> *The National Agency for the Promotion of Research supervises 25 technology transfer offices and located in universities and research centres. Their main mission is to establish a connection between the two worlds - the research world and the socio-economic world. The agency has made available the offices all the necessary tools for communication, contracting, and intellectual property.* Decision-maker, Government - autonomous (Tunisia)

The performance indicators for evaluating researchers now includes the number of patents of the team, as well as the impact factor of their publications and of the volume of trained students.

The government is also setting up networks of business incubators (technopoles), career development centres, and several other mechanisms to help research laboratory units open. This is intended to encourage researchers to work on the manufacturing and commercialisation of their research results, working mainly in biotechnology fields related to the agro-food industry, water sanitation and mining/energy. For example, *Institut Pasteur* is now developing vaccines that are marketed in other countries, and the government is putting in place a technological research centre that will enable the development and marketing of biological pharmaceutical products.

> *There is now a trend to develop federated research projects, to set up clinical investigation centres around clinical trials integrated into healthcare activity, in hospitals, that's a mechanism for developing potential products, expertise in the hospital environment.* Decision-maker, Government – autonomous (Tunisia)

Chapter 4. Enabling NHRS change through peer exchange and learning

This chapter turns its focus to the peer-to-peer workshops that were implemented in the third phase of the project as an innovative method to facilitate exchanges between policy actors from health, higher education/research, and science/technology who rarely interact within or between countries on issues of HSR development. The two workshops were successful in bringing these actors together as a group and stimulating dialogue and debate. Beyond that, the aim was to see how this format might support collective reflection about how decision-makers addressed challenges and to facilitate the adoption of incremental changes they could make at an individual/institutional level in a short time frame to advance their overall goals. During the first meeting held in Nairobi, participants reflected on their experiences with HSR through a mix of plenary, multi-country breakout groups, and dialogue between the two participants from each country. Groups shared their experiences, including best practices, successes, and challenges in HSR development at the national level. Finally, breakout groups outlined individual action plans to take within the mandate of their agencies to advance their respective goals. These plans were intended to support individuals who held some authority over decisions or structures within national bureaucratic or regulatory bodies to think about what concrete actions they could take to improve or achieve greater capacity in HSR in their country.

Country action plans

At the end of the first workshop, multisectoral teams from each country shared action plans that they would attempt to implement over the following six months. The capacity and influence of individuals in various administrative roles and the institutional rules and arrangements in which they work varied considerably. For some individuals without direct authority to change systems or initiate activities on their own, their realm of potential action would be to lobby for changes, or to try to convince others in their institutions of the need for strategic change. Conversely, other participants report having control over resources or autonomy to make institutional changes themselves. Similarly, some countries were already in more advanced stages of planning and strategising about how to improve HSR locally. For these individuals, plans of action were more likely to reflect continuing efforts that were already laid out in their national strategies. Others, however, did not have such specific plans in place, and as such these plans of action helped participants think through new efforts to promote HSR. Thus, the details and goals of action plans took a range of forms - including 1) undertaking new activities by the participants' agencies, 2) establishing new processes or routines within existing systems, or 3) more fundamental institutional and structural changes together.

1) Examples of new activities in action plans included to:

- Hold a consultative meeting with health and social services committees of parliament to advocate for increased financing for HSR;
- Develop capacity building programs for health practitioners, clinicians, and researchers on research methods and research proposal development;
- Organise a course on qualitative research for Master's degree students;
- Hold an intellectual property clinic for health science researchers;
- Review and update the NHSR agenda and priorities;

- Convene a meeting with private sector, NGOs, policy-makers, government agencies, and researchers to discuss knowledge translation;
- Prepare a National Survey on the perception of medical research by primary health doctors;
- Table Health Research Bill in parliament by Minister of Health;
- Review existing legal texts for HSR and consult with stakeholders on missing elements in legal framework to propose drafts for new legislation.

2) Suggested new processes or routines in action plans included to:

- Institute bi-monthly coordination meetings between research partners to minimise duplication, optimise synergy and ensure proper maintenance and management of resources in coherence with the national strategic plan on health research;
- Support the harmonisation of ethical approval processes across East African Communities (EACs);
- Exchange between multi-sectoral research teams to design collaborative research projects: visit and share experiences of other countries, and initiate Memoranda of Understanding and engagement on ways forward with interested institutions.

3) While more fundamental or institutional changes in action plans included suggestions such as the establishment of:

- A National Health Sciences Research Conference;
- An Intersectoral Research and Innovation Forum;
- A National Committee on Research for Health;
- A National Academy of Science/Health Science;
- A Health Systems and Services Evaluation and Research (HSER) unit in Ministry of Health with a mandate to act as a secretariat for research and a repository for research evidence.

Highlights of action plans' and activities' impact and influence in cases of NHRS

The second workshop, held in Addis Ababa, was designed to be more reflective, allowing feedback on action plans and broader discussions of desired future directions. As the participants from all countries discussed what they had done in the preceding six months, it became clear that few were able to show dramatic changes in this short time-period. Many reported ongoing activities, making it at times difficult to distinguish new from existing activities. However, participants were very positive about the process and felt the peer engagements highly useful. The following summarises examples that were reported by participants from a selection of countries represented.

Botswana

A National Health Research bill has been tabled in Parliament. The representative from the Ministry of Tertiary Education, Research, Science and Technology learned about the status of the health research bill from the representative of the Ministry of Health and Wellness during their meeting at the first workshop in Nairobi. This presented the education sector and HSR academics and professionals with a unique, and urgent, opportunity to influence the content of the bill and enhance alignment across sectors. The intensive revision process that followed is an example of advocacy in action for health research governance. While the bill was in the works for about ten years, there was a very short

window of opportunity to influence significant changes to it. Upon returning from the Nairobi meeting, high-level meetings were organised to access the bill's text and discuss the key issues with the Minister of Education and Minister of Health. After convincing policy-makers to wait on moving the bill through from Cabinet, a team of experts from the University of Botswana was given one week to review the bill and propose changes. Policy-makers agreed to incorporate the changes after the submission of a ten-page brief. Since then, they have spent eight months working on those revisions. The Botswana participants identified lessons learned from this experience for others:

- Developing a law is a long process, having taken over 10 years to get to this point in the bill's development.
- High-level lobbying is necessary for this type of influence from both the Ministry of Health and the Ministry of Education, but requires doing significant work for them, such as preparing the evidence and arguments and drafting the proposed changes.
- This requires an in-depth line-by-line review, and careful consideration of various policy options.

Kenya

Most activities and changes over the course of 2019 related to the implementation of the Health Act, passed in 2017. This has significantly restructured the Ministry of Health (including where HSR is situated in the ministry), created new national commissions, and formed a National Research Committee. Furthermore, since the first workshop, Kenya has elaborated and established National Health Research Priorities 2019-2023 by county and disease areas. While it is difficult and unlikely to attribute these changes to the influence of the workshop, our meetings were timely within this implementation process providing an opportunity to share challenges, ideas, and strategies with others from the region. Furthermore, this example underlines the temporal challenges related to the delays between HSR policy and legislation development, adoption, and implementation.

Liberia

Based on their action plan made at the first workshop, the Ministry of Education (MoE) focused on coordinating health research. Officials were stimulated with the question of how to better coordinate research within the MoE. The National Commission on Higher Education (NCHE) is responsible for tertiary education in Liberia, under the auspices of the MoE. The MoE has advised the NCHE to include the coordination of research, including health research, with universities and education/research institutions as part of the education sector review to be examined in November 2019 leading to an operational plan for the sector.

Madagascar

The first annual "Scientific Day" conference to share health research in Madagascar was held in April 2019. While there had been previous discussions of holding a national health research conference, efforts to organise this gathering were accelerated following the first workshop and the fieldwork conducted by the LSE research team in March. The new Minister of Health at the time, a researcher himself and in office for less than a month, facilitated this conference. With a peer of the scientific community in office, there was a renewed hope for the support of HSR development from the policy community. Through a key contact from the National Institute for Public and Community Health, the research team was able to meet and interview the Minister of Health as a key informant for the study. The

participants from the Madagascar team indicated a direct impact of the first workshop and key informant interviews on stimulating action for this national gathering of the first of its kind in Madagascar, with plans to organise the event annually. While the first one was primarily academic, they intend for future gatherings to include more community and practitioner representation to support the broader stakeholder engagement that they strive to include as part of strengthening HSR capacity.

Tunisia

The development of an agreement between the National Agency for the Promotion of Research and the Ministry of Public Health is one key follow-up action from the first workshop reported by participants from the Tunisian team. This agreement lays out a framework for collaboration on innovative ideas and is accompanied by an annual action plan.

Uganda

Participants from the Ugandan team drew from workshop discussions to help leverage a health policy advisory meeting in the country as a catalyst to generate health research questions for more policy-relevant research/impact. The meeting was also used to inform and contribute to the repository at the Ministry of Health that is being used to help map health research actors in the country.

Zambia

Improving cross border collaboration was one of the objectives in the Zambian action plan from the first workshop. The participants from the Zambian team reported that the meeting fed into the development of a regional proposal led by Zambia that involves Zambia, Tanzania, and Uganda submitted to the European and Developing Countries Clinical Trials Partnership (EDCTP) to strengthen research ethics and regulatory capacity in Africa. the workshop also inspired them to better consider using existing opportunities from meetings and platforms to develop new collaborations.

Future work, wishes and ideas informed by these two meetings

The main ideas participants voiced about future directions and continuing areas of work centred on the priority areas of stakeholder engagement, advocacy, and institutional planning and change – with a particular focus on improving coordination. Examples of plans announced by participants include to:

- Use ideas from the meetings to engage stakeholders and further advocate for funding;
- Carry out a stakeholder workshop on HSR to develop joint objectives;
- Make an advocacy plan to encourage stakeholder participation in policy-making to enhance coordination between stakeholders.
- Add community engagement to educate the public and raise awareness about HSR, its value, and the need for communities to be involved at all levels, including agenda setting (very strong desire for wider engagement and building a research culture in the community);
- Intensify networking, resource mobilisation, and collaboration with other local, regional, and global HSR stakeholders;
- Reinforce capacity building for change management at the institutional level;

- Provide feedback to colleagues at the Ministry of Health and Ministry of Education with an aim of sharing approaches for long-term regulatory or legislative changes to HSR.

Two countries shared very specific follow-on actions related to planning with potential policy impact:

Madagascar

The participants from Madagascar will recommend adding regulation and advocacy roles, in addition to those of steering and coordination, in the decree to establish the National Health Research Council. They will propose modifications to the membership composition of the proposed national research council to reflect the range of skills and competencies needed to fulfil those roles.

Liberia

The participants from Liberia will add coordination, expansion and resource mobilisation for HSR into the implementation plan and action steps for pillar 1 of the National Pro-Poor Agenda for Prosperity and Development. Pillar 1 of the national development agenda is aimed to reduce developmental inequalities among Liberians.

At the end of the second workshop, participants discussed their wishes for future support or activities that they would find useful if a group or agency could help facilitate. In particular, there was a desire to stay connected and identify future opportunities to collaborate and share expertise. For example, they hoped that the African Academy of Science (AAS) might be able to serve such a function or provide a forum for stakeholders to continue engagement activities.

Examples of desired future activities included to:

- Stay connected more generally;
- Facilitate a forum for networking and communication;
- Explore a formalisation of network of African HSR decision-makers;
- Identify possible funding opportunities to work collaboratively towards shared goals;
- Apply for funds to establish a network/consortium;
- Identify opportunities with AAS;
- Use the same model of bringing together health and education representatives, but extend to include other relevant areas such as environment.

As well as more ambitious ideas, such as to:

- Develop an African conference of medical and health research (e.g. under AAS)
- Build a pan-African research registry;
- Establish innovative funding models, such as crowd funding of research;
- Develop an African health research leadership association.

Reflections on the peer-to-peer learning approach

The third phase of the project initially intended to help facilitate changes to improve HSR, to disseminate the project's findings, as well as to learn more about how well a peer-engagement process such as this might work for such goals. Overall, it was successful at engaging technical officials and getting them to think and plan more explicitly around the

goal of improving health sciences research. Genuine change at a programme or national level was much more limited, but this was reflective of the nature of national planning and institutional environments and the fairly limited scope that bureaucrats of this type have to make changes unilaterally.

This phase of the work, however, did highlight how important it can be to support dialogue and networking between sectors (in this case between health and higher education/science), as it creates a platform for knowledge sharing and learning with other experts and decision-makers across sectors involved in HSR. Our participants highlighted that such opportunities to meet, share, and learn from one another are rare, which reinforces the siloisation of HSR decision-makers. Many of the individuals in country team pairs had not met prior to being involved in the workshops. Strengthening connections between individuals in key sectors helps create and expand networks that can support improved coordination of NHRS. HSR capacity development requires multi-sectoral approaches, and relationship building and intersectoral cooperation can supports elements and processes like regulatory environments and innovation, and strengthen NHRS pillars such as governance. Bringing together the two sectors from each country promoted a more holistic view and discussion of HSR challenges faced, built a bridge between these two sectors, and initiated an opportunity for additional collaboration outside the meeting.

Participants were interested by stories and experiences from other countries, often commenting about how nice it was to engage with a broad range of similar individuals. Participants referred to the peer learning process as “catalytic”, and one that has stimulated reflection and awareness of their achievements, challenges, and progress to be made in country by hearing from others at different stages and with different strengths. Having Anglophone and Francophone participation, as well as continent-wide representation, was also a major strength of the project and for peer-to-peer learning, in particular, as these groups often meet in language or regional silos. They identified the support of informal or formal networks between key decision-makers in HSR to contribute to developing HSR capacity by learning from other African countries.

The mix of plenary and small group sessions also allowed for group-wide brainstorming on core concepts (such as what it means to improve HSR) while also allowing time for participants to speak in pairs or small groups about specific national or institutional challenges. Indeed, the second workshop used ideas generated in previous discussions to structure the activities, thus co-constructing the content with participants.

Overall, there was a great interest developed in collaborative work. This was unexpected in terms of the plans and goals of the workshop, but it may be that the interaction and engagement between individuals in different countries sparked this interest and illustrated the usefulness of collaboration and knowledge exchange for building research culture. This included cooperation on HSR projects (a theme returned to multiple times in discussions), as well as a desire to continue collaboration in ways raised in this workshop. One potential risk for this kind of stakeholder engagement is whether the workshops raised expectations and interest in maintaining support for the network – outside of the scope of the research project – thereby initiating something that could not be sustained and supported. The LSE facilitators were upfront about the limitations of what they could offer, but there was obvious interest in continuing engagements if support was found elsewhere. For example, there was interest in potential applications to international bodies that might support capacity development for HSR decision-makers and for NHRS. Participants expressed their desire for

regional organisations to facilitate these types of networks that build bridges between regional and sub-regional groups and to improve cross-border collaboration on HSR in Africa, including between Anglophone, Francophone, and Lusophone countries.

An important finding from this phase was that in-country stakeholders perceive regional organisations as institutional actors with increasing significance within the African HSR landscape. Stakeholders saw opportunities for regional organisations to help raise the profile of HSR and to strengthen NHRS through collective action. For example, participants identified a number of areas for potential engagement by regional bodies that could support regional scientific collaborations, policy implementation, shared research governance processes, institutional development, and advocacy for prioritising HSR on national agendas. While the exploration of multi-level HSR governance relationships including the regional level was beyond the objective and scope of this project, it has generated a data-driven justification for research that we are undertaking to examine the role of regional bodies in HSR in Africa and how these organisations are influencing the continent's HSR landscape.

The main challenges to the workshops included moving past identification of goals and barriers to developing concrete strategies or examples to overcome barriers. The peer-learning process might have benefited from more interaction with participants between the workshops as a group (although there was interaction with many of them in-country for individual case studies as part of phase 2, and one group webinar meeting was organised).

It was difficult to definitively evaluate the impact of the Phase 3 work because participants often discussed a range of activities undertaken, most of which were likely already planned. Nevertheless, there was a strong sentiment expressed in evaluations of our activities that having this forum for exchange and cross-fertilisation of ideas was valuable. The following statements expressed by participants through a survey administered at the end of the second workshop provide some indication of the value and impact of these meetings from their perspectives:

Value and impact of the workshops from participants' perspectives

- *It's a reflection time that brings realities of where we are succeeding in Africa but also challenges on which we need to focus mitigating within available resources, a call for being innovative.*
- *Learning from other countries what has worked for them and being able to identify my country's strengths from the conversations and better appreciate where we are and how to leverage those strengths.*
- *The realisation that we have faced/are facing similar challenges and we are at different levels of overcoming them.*
- *Through these workshops I greatly valued and recognised our activities in Tunisia and our efforts in this sector, despite the fact that more work is needed. So, we must continue our programs.*
- *These meetings have opened new networks of learning and future collaborations. I can reference some of the represented countries as we move forward with our health research.*
- *It was an excellent moment of lessons learned from each other and will help inform modifications of current framework back home.*

- *Being able to see what others have done, how they have done it, and using that in our country as a "template". Of longer-term importance for me is also the network developed that can continue to work together outside this project.*
- *Solutions can be shared through peer-to-peer learning. Sometimes we don't need to go too far, but to network.*
- *The need to cooperate to solve our common problems, like using the AAS for help.*
- *Learning success stories from other countries and increased awareness about what we need to improve for better performance and impact.*
- *There are so many best practices "next door" that we can always tap on and learn from, for example, Botswana and Zambia likely to have similar priorities. A research agenda in Zambia should not be overlooked as Botswana develops theirs. Problems in one country can be solved by solutions in another.*
- *These meetings should raise awareness among all current and potential partners in health research to better support financially and administratively the various actors and partners of research in Africa.*
- *I thank the initiators of this kind of workshop, but we should especially think about the follow-up to sensitise the boundary partners in African health research about needs to solve the different African problems and the visibility of the research results and their real impacts.*

Chapter 5. Recommendations and conclusion

In conclusion, we present a set of recommendations arising from this work. The recommendations are aimed at key stakeholders who have already decided to work towards improving HSR in African settings as a key priority. Nine recommendations are distilled from our empirical work detailed in previous chapters, divided into three broad areas: supporting local ownership and governance; building local infrastructure; and establishing a local research culture.

Recognising that NHRS are also part of transnational networks of knowledge production and use, the recommendation areas focus attention on action that may have the most direct benefit on NHRS in their national settings. Nevertheless, it is important to note that countries are at various phases in the development of their NHRS and face a range of contextual and historical factors that influence the kinds of action that may be needed. While some recommendations are actionable in the short term, others would likely be better incorporated into more long-term planning and viewed as part of a wider programme of NHRS building and systemic change. The complexities of such long-term action necessitate sustained dialogue and collaboration between national stakeholders, and with partners, committed to shared objectives.

5.1 Recommendations

Recommendation Area 1: Support local ownership and governance of HSR.

1.1 Define terms and conditions of partnership that secure local benefits.

As so much research is conducted through international partnerships, there is a need to establish protocols that ensure more equitable leadership with local researchers and decision-makers in programmes that fund HSR. African experts must be able to negotiate partnership arrangements that have clearly aligned local benefits, with support from donors and funders for these processes. African experts are frequently included too late, if at all (for example, to advise or plan implementation), as donor, funder, and northern research institution practices remain rooted in deep power asymmetries. This necessitates long-term structural changes to internal organisational ethos and ways of working with African governments and researchers, with mutual support, firm institutional commitment of donors and funders, and respect for new rules of collaboration.

This research shows successful examples where this has worked. It requires deliberations between senior government officials (backed by high-level political support) and a commitment from international partners, with transparent discussions to layout partnership terms and design joined up leadership and governance structures so that local actors assert the same levels of responsibility, authority, and decision-making as external actors. This will likely result in difficult conversations, raise issues that take time to resolve, and therefore potentially delay rapid advancement. But grounding future work in this paradigm for collaboration is fundamental to protect local ownership of HSR and strengthen the functions of a NHRS.

1.2 HSR international collaborations must have explicit objectives to strengthen local capacity.

To truly ensure local research capacity development, the involvement of local researchers and scientists at all levels of a collaboration needs to be a requirement, especially for decisions on competitive grants from global, regional, or national research funding bodies. Partnerships should have local Principal Investigators (PIs) to ensure that the intellectual leadership, core decisions and responsibilities for the project, and data and results are all locally owned. Leadership of a single senior local researcher is not a solution for ownership and is insufficient for building capacity and embedding ownership across the research pipeline. Funders and research partners must include the involvement of local researchers and staff at all levels of research and management. This shows commitment to long-term and sustainable collaboration. It also contributes incrementally to improving research culture with support for mentoring, building skills in scientific and grant writing, and setting out clear career pathways for local researchers.

Funders should include local involvement and capacity strengthening as part of evaluation criteria for grants and ensure that budgets provide adequate funds for institutions to support capacity development activities. In addition, researchers and partners should allocate project funds for specific capacity strengthening activities, such as education and training (including MA, MSc, PhD, and post-doc), dissemination and engagement, technology and knowledge transfer, infrastructure (i.e. labs and equipment), and research administration and management.

1.3 Establish formal collaboration mechanisms and arrangements between sectors for HSR.

Governing HSR requires significant coordination across multiple sectors – in particular higher education, health, and science-technology-innovation. However, decision-makers in HSR are often working in silos relating to their sectoral mandate, with limited resources for coordination across institutions and a lack of clarity about lines of authority. Maintaining a narrow focus on investing in research staff, infrastructure, or projects is thus insufficient to build national capacity due to the way that HSR interacts with, and relies on, institutions and arrangements in multiple sectors.

Autonomous structures, such as a National Health Research Authority, can be effective institutional mechanisms through which to coordinate across sectors, share information, and achieve a more integrated approach to HSR. Better coordination through joined up stakeholder working (e.g. joint-committee on HSR or stakeholder assembly) can create opportunities to share lessons between decision-makers and to work toward the harmonisation, implementation, and monitoring of HSR policies and priorities. To support this, governments, partners, and funders should consider investing in mechanisms that enable coordination and continuous opportunities for collective learning. Without robust coordination mechanisms and institutional mandates, a NHRS will struggle to create the enabling environment needed for HSR to thrive.

Recommendation Area 2: Build local infrastructure for HSR – including regulatory bodies, ethics committees, technical platforms, laboratories, and data management systems.

2.1. Invest in national research institutions and improving technical platforms for HSR.

Strong, well-equipped research institutions are essential to producing HSR that also supports the development and training of a critical mass of African researchers to work on problems of local, national, and regional relevance. Our findings show that infrastructure improvements are not generally prioritised in most human and institutional research capacity strengthening initiatives. Yet, these investments are crucial to NHRS and promote ownership of data collection, storage, and analysis equipment. Without sufficient infrastructure (and training to use it), scientists in high-income countries carry out analyses on data and samples from Africa. To maximise the impact of collaboration, governments and research partners can support infrastructure development so that laboratory analyses can be conducted by local scientists in-country instead of exported out. Research institutions need to be supported with knowledge and technology transfer, as well as improved access to supplies (e.g. reagents).

When there is a regulatory environment that supports and incentivises innovation, national governments can better provide services that equip universities and industry to initiate or improve partnerships. Centres of Excellence can improve research infrastructure and research outputs while raising the profile and value of health sciences research in country, which in turn attracts further external funding and increases capacity for high calibre research. While these take time (often decades) to build up, governments and universities can strategically plan for strengthening institutions to be led and staffed by local experts. Developing more research-intensive universities is an interim step in this direction, with prioritisation of training and support for grant writing to attract competitive research awards.

2.2 Strengthen resources and capacity for ethical review of HSR.

National ethics review boards provide the oversight, leadership, and guidance for ethical review conducted within Institutional Review Boards of universities, hospitals, or private organisations. However, our findings show that there are very limited financial resources available (e.g. EDTCP grants on ethics and regulatory capacities) to support the development of governance mechanisms, particularly in the absence of a national health research authority with a legislated mandate for the regulation and coordination of HSR. Ethics committees need a wide variety of specialist expertise (for clinical, quantitative, and qualitative research), including multidisciplinary perspectives and trained ethicists. They also need resources to support the administration of the committee and compensate the time of committee members. These time intensive activities to review proposals and feedback, as well as to monitor progress and commitment, are rarely covered and can delay research processes and affect the quality of the reviews.

Governments and donors can invest in strengthening health research governance structures as part of the NHRS, as well as supporting regional efforts (e.g. the Africa

Ethics Excellence Network or the Network of West African Ethics Committees) to facilitate ongoing networking and learning. The ethical review process is critical to ensure that research is carried out with respect for local ethical frameworks, includes indigenous knowledge and networks, and protects participating communities and individuals.

2.3 Centralised national repositories can track funding, investments, partners, projects, data and results.

With many countries lacking an accessible national research database, stakeholders would benefit greatly from a repository of HSR investments and partnerships in their country – who is doing what, where, with whom, and with what resources and results. Ad-hoc knowledge about local research activities and partners is not useful for building a sustainable basis for documenting and monitoring the landscape for HSR within a country – including monitoring funding. While we know that significant amounts of research funds come from international partners, there is rarely a centralised or publicly available record of this in-country.

In the absence of clear HSR coordinating responsibilities in many NHRS, consolidating and updating this information is a challenge. As governments and universities plan to strengthen data management systems, it is key to consider which stakeholders can contribute to these and who has the responsibility for maintaining them. There is much local and community-level data collected (by NGOs, or students) that is not shared, and thus not included in future analysis, decisions, or engagement. Research reports are collected (but not systematically) by the Ministry of Health or Research Ethics Committees, however there is no mechanism to ensure their secure digitisation, storage, and accessibility. In the short term, partners and research need to discuss how to expand and formalise data sharing networks. In the middle to long-term, government and research institutions should create a permanent resource to map internal and external investment in HSR activities, avoid duplication, promote the dissemination and use of research results, identify gaps, and ensure coherence of activities with local priorities.

Recommendation Area 3: Cultivate a national scientific research culture and HSR career pathways.

3.1 Local knowledge exchange platforms can share results and create demand for HSR.

Our findings show that there are few formalised knowledge exchange and translation platforms for HSR. Creating more formal and institutionalised structures is necessary as many discussions currently rely on personal and individual networks for sharing research results and discussing their implication for the health system. While data availability and access are a first step, it is also vital to build capacity within Ministries of Health to carry out knowledge translation, based on research that is submitted to them, as well as including knowledge translation skills in HSR training programmes. Sustained partnerships between government and the research sector are needed to support open and regular knowledge exchange, and to link discussions to policy problems and priorities. Since much of the research is funded by international partners, and in many cases poorly linked to national priorities or community issues,

knowledge translation and use are rarely addressed outside of academic dissemination. Results rarely reach practitioners or decision-makers due to a lack of connection with local networks, and instead are shared in international journals or conferences.

Small initial steps, such as organising local scientific conferences, can be key opportunities to disseminate research findings beyond academia – and have the potential for big returns on relatively small but strong investments. When organised in collaboration with stakeholders (including decision-makers), such conferences can also be opportunities for advocacy and discussing research use. Furthermore, these events contribute to developing a national research culture, build capacity and skills (abstract writing, scientific presentations, peer review), strengthen national and regional networks.

3.2 Encourage, equip, and mentor high-quality, skilled health sciences researchers.

Core curricula that include scientific research are important for developing a local research culture as well as for training next generations of health science researchers in Africa. Ministries of (Higher) Education can work with educators to develop scientific streams and specialisation trajectories within secondary and tertiary education curricula. It is important to educate and introduce pupils to scientific questions, methods, and processes from an early stage, which contributes to developing fundamental skills and to fostering long-term interest in careers in HSR. Due to lack of support for the bursaries of students from domestic funds, opportunities for graduate and post-graduate training stem from international collaborations or donor-sponsored programmes.

One of the barriers to applied training in HSR is that students lack opportunities to work with professors on research projects when academic environments do not incentivise or reward research as part of a career development track. Faculties of medicine, faculties of health sciences, and schools of public health – in collaboration with university leadership – can review and improve policies to support research as part of the expectations for professional advancement and faculty promotion. The creation of career development pathways within research institutions can thus catalyse growth of HSR by creating an environment where research and capacity building are mutually supportive.

3.3 Local research leaders can advocate for political prioritisation and funding commitments.

Research leaders are particularly important when they actively engage in ongoing advocacy to raise awareness, build institutions, formulate policies, and put HSR on national agendas, which contributes to raising the profile HSR and strengthening the overall NHRS. Constant political engagement through advocacy, using local data to address local problems, is necessary to maintain buy-in from government officials and enact policy change.

Research leaders can expand their advocacy networks to partner with scientific societies, professional associations, NGOs, and other researchers to increase their reach and strengthen more formal networks behind shared objectives. The role of bureaucrats in advocacy processes involves working with parliamentarians;

international development partners (e.g. aid donors); and routinely working both within and outside their ministries, including those of health, education, and finance. While this falls outside of their daily expected duties, such leadership has been shown to be effective over time and essential to convey arguments to decision-makers across sectors about prioritising HSR.

5.2 Conclusion

This project has explored how HSR capacity can be improved in African settings. We aimed to look beyond individual metrics or well-established pillars (foundations of NHRS) to better understand the systemic features that can lead to improvements at a country level. Using a whole-systems approach has been particularly useful to answer this question by highlighting the interconnectedness of the people, institutions, and activities in a NHRS through elements and processes that support the functional pillars to finance, govern, produce and use knowledge, and create and sustain resources for HSR. The findings and recommendations underscore the importance of centring HSR capacity strengthening and investment in Africa on national ownership of health research systems. They also help to illustrate the dynamic process of building HSR capacity over time: taking advantage of windows of opportunity when they arise, while also building expert-networks that can continually advocate for improvements in this area. Improving NHRS can benefit countries in a range of ways: from solving local health questions and improving health services and outcomes, to broader social benefits of developing a knowledge-based economy and public culture of scientific research. It is hoped the findings of this report can prove useful to those key stakeholders working to achieve these goals across the African continent.

Bibliography

1. Pang T, Sadana R, Hanney S, Bhutta ZA, Hyder AA, Simon J. Knowledge for better health: a conceptual framework and foundation for health research systems. Bull World Health Organ [Internet]. 2003;81(11):815–20. Available from: http://www.ncbi.nlm.nih.gov/pubmed/14758408
2. Commission on Health Research for Development. Health Research: Essential Link to Equity in Development. New York: Oxford University Press; 1990.
3. Global Forum for Health Research. The 10/90 Report on Health Research 2000. Geneva, Switzerland; 2000.
4. World Health Organization. World Health Report 2013: Research for Universal Health Coverage [Internet]. Geneva, Switzerland; 2013. Available from: https://www.who.int/whr/2013/report/en/
5. Kennedy SB, Neaton JD, Lane HC, Kieh MW, Massaquoi MB, Touchette NA, et al. Implementation of an Ebola virus disease vaccine clinical trial during the Ebola epidemic in Liberia: Design, procedures, and challenges. Clin Trials [Internet]. 2016;13(1):49–56. Available from: https://doi.org/10.1177/1740774515621037
6. Duermeijer C, Amir M, Schoombee L. Africa generates less than 1% of the world's research; data analytics can change that [Internet]. Elsevier Connect. 2018 [cited 2020 Oct 17]. Available from: https://www.elsevier.com/connect/africa-generates-less-than-1-of-the-worlds-research-data-analytics-can-change-that
7. UK Clinical Research Collaboration. Health Research Classification System [Internet]. London: Medical Research Council; 2018 [cited 2018 Sep 30]. Available from: www.hrcsonline.net
8. European Science Foundation. Health Research Classification Systems – Current Approaches and Future Recommendations [Internet]. ESF Science Policy Briefing 43. 2011 [cited 2018 Sep 30]. Available from: http://archives.esf.org/publications/science-policy-briefings.html
9. Bates I, Akoto AYO, Ansong D, Karikari P, Bedu-Addo G, Critchley J, et al. Evaluating Health Research Capacity Building: An Evidence-Based Tool. PLOS Med [Internet]. 2006;3(8):e299. Available from: https://doi.org/10.1371/journal.pmed.0030299
10. Agyepong IA, Sewankambo N, Binagwaho A, Coll-Seck AM, Corrah T, Ezeh A, et al. The path to longer and healthier lives for all Africans by 2030: the Lancet Commission on the future of health in sub-Saharan Africa. Lancet [Internet]. 2017 Dec;390(10114):2803–59. Available from: https://doi.org/10.1016/S0140-6736(17)31509-X
11. Bates I, Boyd A, Aslanyan G, Cole DC. Tackling the tensions in evaluating capacity strengthening for health research in low- and middle-income countries. Health Policy Plan [Internet]. 2015 Apr;30(3):334–44. Available from: https://doi.org/10.1093/heapol/czu016
12. Institute for Health Metrics and Evaluation. Global Burden of Disease [Internet]. 2020 [cited 2020 Dec 16]. Available from: http://ghdx.healthdata.org
13. World Bank Group. Population Estimates and Projections [Internet]. 2020 [cited 2020 Dec 16]. Available from: https://datacatalog.worldbank.org/dataset/population-estimates-and-projections
14. World Health Organization & UNICEF/UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases. Global report for research on infectious diseseas of poverty 2012 [Internet]. Geneva, Switzerland; 2012. 168 p. Available from: https://apps.who.int/iris/handle/10665/44850

15. Franzen SRP, Chandler C, Lang T. Health research capacity development in low and middle income countries: reality or rhetoric? A systematic meta-narrative review of the qualitative literature. BMJ Open [Internet]. 2017 Jan 27;7(1):e012332. Available from: http://dx.doi.org/10.1136/bmjopen-2016-012332

16. Mony PK, Kurpad A, Vaz M. Capacity building in collaborative research is essential. BMJ [Internet]. 2005 Oct 8;331(7520):843.3-844. Available from: https://doi.org/10.1136/bmj.331.7520.843-b

17. Costello A, Zumla A. Moving to research partnerships in developing countries. BMJ [Internet]. 2000 Sep 30;321(7264):827–9. Available from: https://doi.org/10.1136/bmj.321.7264.827

18. Organisation for Economic Co-operation and Development. Integrating Science & Technology into Development Policies [Internet]. Paris, France: OECD Publishing; 2007. 288 p. Available from: https://www.oecd-ilibrary.org/science-and-technology/integrating-science-technology-into-development-policies_9789264032101-en

19. Organisation for Economic Co-operation and Development. International Science and Technology Co-operation [Internet]. Paris, France: OECD; 2001. Available from: https://www.oecd-ilibrary.org/environment/international-science-and-technology-co-operation_9789264192348-en

20. Organisation for Economic Co-operation and Development. The Knowledge-Based Economy. Paris: OECD; 1996.

21. National Research Council. The Fundamental Role of Science and Technology in International Development: An imperative for the U.S. agency for international development [Internet]. The Fundamental Role of Science and Technology in International Development: An Imperative for the U.S. Agency for International Development. Washington, D.C.: The National Academies Press; 2006. 1–148 p. Available from: https://doi.org/10.17226/11583

22. Nchinda TC. Research capacity strengthening in the South. Soc Sci Med [Internet]. 2002/07/13. 2002 Jun;54(11):1699–711. Available from: https://doi.org/10.1016/S0277-9536(01)00338-0

23. Wolffers I, Adjei S, van der Drift R. Health research in the tropics. Lancet [Internet]. 1998 May;351(9116):1652–4. Available from: https://doi.org/10.1016/S0140-6736(97)10237-9

24. Regional Committee for Africa. Framework for the implementation of the Algiers Delclaration on Research for Health in the African Region [Internet]. World Health Organization Regional Office for Africa; 2009. (AFR/RC59/5). Available from: https://apps.who.int/iris/handle/10665/92233

25. Executive Board. WHO's role and responsibilities in health research: Bamako Global Ministerial Forum on Research for Health: report by the Secretariat [Internet]. World Health Organization; 2009. Available from: https://apps.who.int/iris/handle/10665/2117

26. African Union Agency for Development. Health Research and Innovation Strategy for Africa (HRISA) 2018-2030 [Internet]. 2019. Available from: https://www.nepad.org/publication/health-research-and-innovation-strategy-africa-hrisa-2018-2030

27. World Health Organization Regional Office for Africa. Research for Health: a Strategy for the African Region 2016-2025, Report of the Secretariat [Internet]. N'Djamena, Republic of Chad; 2015. Available from: https://www.who.int/evidence/africanregionstrategy.pdf?ua=1

28. African Union Commission. Science, Technology and Innovation Strategy for Africa

2024 (STISA-2024). Addis Ababas, Ethiopia; 2014.

29. The World Bank, Elsevier. A decade of development in sub-Saharan African science, technology, engineering and mathematics research [Internet]. Washington, D.C.; 2014 Sep. Available from: http://documents.worldbank.org/curated/en/237371468204551128/A-decade-of-development-in-sub-Saharan-African-science-technology-engineering-and-mathematics-research

30. Gulland A. Plan to stimulate research in developing countries is put on hold. BMJ [Internet]. 2012 May 28;344(may28 3):e3771–e3771. Available from: https://doi.org/10.1136/bmj.e3771

31. Annerstedt J, Liyanage S. Challenges when shaping capabilities for research: Swedish support to bilateral research cooperation with Sri Lanka and Vietnam, 1976–2006, and a look ahead. Stockholm, Sweden; 2008.

32. Kok MO, Rodrigues A, Silva AP, de Haan S. The emergence and current performance of a health research system: lessons from Guinea Bissau. Heal Res Policy Syst [Internet]. 2012 Dec 9;10(1):5. Available from: https://doi.org/10.1186/1478-4505-10-5

33. Sitthi-Amorn C, Somrongthong R. Strengthening health research capacity in developing countries: a critical element for achieving health equity. BMJ [Internet]. 2000 Sep 30;321(7264):813–7. Available from: https://doi.org/10.1136/bmj.321.7264.813

34. Coloma J, Harris E. From Construction Workers to Architects: Developing Scientific Research Capacity in Low-Income Countries. Rowland-Jones S, editor. PLoS Biol [Internet]. 2009 Jul 21;7(7):e1000156. Available from: https://doi.org/10.1371/journal.pbio.1000156

35. Olufadewa II, Adesina MA, Ayorinde T. From Africa to the World: Reimagining Africa's research capacity and culture in the global knowledge economy. J Glob Health [Internet]. 2020 Jun;10(1):1–3. Available from: https://doi.org/10.7189%2Fjogh.10.010321

36. The Lancet Global Health. Closing the door on parachutes and parasites. Lancet Glob Heal [Internet]. 2018 Jun;6(6):e593. Available from: http://doi.org/10.1016/S2214-109X(18)30239-0

37. Heymann DL, Liu J, Lillywhite L. Partnerships, Not Parachutists, for Zika Research. N Engl J Med [Internet]. 2016 Apr 21;374(16):1504–5. Available from: https://doi.org/10.1056/NEJMp1602278

38. Yozwiak NL, Happi CT, Grant DS, Schieffelin JS, Garry RF, Sabeti PC, et al. Roots, Not Parachutes: Research Collaborations Combat Outbreaks. Cell [Internet]. 2016 Jun;166(1):5–8. Available from: https://doi.org/10.1016/j.cell.2016.06.029

39. Aksoy S. Solutions to Neglected Tropical Diseases Require Vibrant Local Scientific Communities. PLoS Negl Trop Dis [Internet]. 2010 Mar 30;4(3):e662. Available from: https://doi.org/10.1371/journal.pntd.0000662

40. Cole DC, Boyd A, Aslanyan G, Bates I. Indicators for tracking programmes to strengthen health research capacity in lower- and middle-income countries: a qualitative synthesis. Heal Res Policy Syst [Internet]. 2014/04/15. 2014 Dec;12(1):17. Available from: https://doi.org/10.1186/1478-4505-12-17

41. The United Kingdom Department for International Development. Capacity building in research: A DFID practice paper. [Internet]. London: Department for International Development; 2010. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/187568/HTN_Capacity_Building_Final_21_06_10.pdf

42. ESSENCE on Health Research. Planning, Monitoring and Evaluation: Framework for Research Capacity Strengthening [Internet]. Geneva; 2016. (TDR/ESSENCE/16.1). Available from: https://www.who.int/tdr/publications/essence-framework-2016/en/

43. Lansang MA, Dennis R. Building capacity in health research in the developing world. Bull World Health Organ [Internet]. 2005/01/13. 2004 Oct;82(10):764–70. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2623028/

44. Bates I, Phillips R, Martin-Peprah R, Kibiki G, Gaye O, Phiri K, et al. Assessing and Strengthening African Universities' Capacity for Doctoral Programmes. PLoS Med [Internet]. 2011 Sep 13;8(9):e1001068. Available from: https://doi.org/10.1371/journal.pmed.1001068

45. Bates I, Taegtmeyer M, Squire SB, Ansong D, Nhlema-Simwaka B, Baba A, et al. Indicators of sustainable capacity building for health research: analysis of four African case studies. Heal Res Policy Syst [Internet]. 2011 Dec 28;9(1):14. Available from: https://doi.org/10.1186/1478-4505-9-14

46. Khisa AM, Gitau E, Pulford J, Bates I. A Framework and Indicators to Improve Research Capacity Strengthening Evaluation Practice [Internet]. Liverpool School of Tropical Medicine Centre for Capacity Research and African Population and Health Research Centre; 2019. Available from: https://assets.publishing.service.gov.uk/media/5d10a77de5274a0663251590/A_Framework_and_Indicators_to_Improve_Research_Capacity_Strengthening_report_14jun19_FINAL_to_EM.pdf

47. Dean L, Gregorius S, Bates I, Pulford J. Advancing the science of health research capacity strengthening in low-income and middle-income countries: a scoping review of the published literature, 2000–2016. BMJ Open [Internet]. 2017 Dec 6;7(12):e018718. Available from: https://doi.org/10.1136/bmjopen-2017-018718

48. Bowsher G, Papamichail A, El Achi N, Ekzayez A, Roberts B, Sullivan R, et al. A narrative review of health research capacity strengthening in low and middle-income countries: lessons for conflict-affected areas. Global Health [Internet]. 2019 Dec 26;15(1):23. Available from: https://doi.org/10.1186/s12992-019-0465-y

49. Lee K, Mills A. Strengthening governance for global health research. BMJ [Internet]. 2000 Sep 30;321(7264):775–6. Available from: https://dx.doi.org/10.1136%2Fbmj.321.7264.775

50. Fosci M, Loffreda L, Velten L, Johnson R. Research Capacity Strengthening in LMICs: A Rapid Evidence Assessment [Internet]. London: Research Consulting; 2019. Available from: https://assets.publishing.service.gov.uk/media/5d42be4eed915d09d8945db9/SRIA_-_REA_final__Dec_2019_Heart___003_.pdf

51. Simpkin V, Namubiru-Mwaura E, Clarke L, Mossialos E. Investing in health R&D: where we are, what limits us, and how to make progress in Africa. BMJ Glob Heal [Internet]. 2019 Mar 4;4(2):e001047. Available from: http://doi.org/10.1136/bmjgh-2018-001047

52. Kennedy A, IJsselmuiden C. Building and strengthening national health research systems [Internet]. The Council on Health Research for Development. 2006. Available from: http://www.cohred.org/downloads/cohred_publications/NHRS_Assessment_manual_review_version_FINAL.pdf

53. Hanney S, Kanya L, Pokhrel S, Jones T, Boaz A. What is the evidence on policies, interventions and tools for establishing and/or strengthening national health research systems and their effectiveness? [Internet]. Copenhagen: World Health Organization

Regional Office for Europe; 2020. Available from: https://www.ncbi.nlm.nih.gov/books/NBK558505/

54. Hanney SR, Kanya L, Pokhrel S, Jones TH, Boaz A. How to strengthen a health research system: WHO's review, whose literature and who is providing leadership? Heal Res Policy Syst [Internet]. 2020 Dec 23;18(1):72. Available from: https://doi.org/10.1186/s12961-020-00581-1

55. Kirigia JM, Kathyola DD, Muula AS, Ota MMO. National health research system in Malawi: dead, moribund, tepid or flourishing? BMC Health Serv Res [Internet]. 2015 Dec 31;15(1):126. Available from: https://doi.org/10.1186/s12913-015-0796-1

56. Kirigia JM, Ota MO, Motari M, Bataringaya JE, Mouhouelo P. National health research systems in the WHO African Region: current status and the way forward. Heal Res Policy Syst [Internet]. 2015 Dec 30;13(1):61. Available from: https://doi.org/10.1186/s12961-015-0054-3

57. Kirigia JM, Ota MO, Senkubuge F, Wiysonge CS, Mayosi BM. Developing the African national health research systems barometer. Heal Res Policy Syst [Internet]. 2016 Dec 22;14(1):53. Available from: https://doi.org/10.1186/s12961-016-0121-4

58. Kirigia JM, Wambebe C. Status of national health research systems in ten countries of the WHO African Region. BMC Health Serv Res [Internet]. 2006 Dec 19;6(1):135. Available from: https://doi.org/10.1186/s12961-015-0054-3

59. Mbondji PE, Kebede D, Zielinski C, Kouvividila W, Sanou I, Lusamba-Dikassa P-S. Overview of national health research systems in sub-Saharan Africa: results of a questionnaire-based survey. J R Soc Med [Internet]. 2014/06/11. 2014 May 9;107(1_suppl):46–54. Available from: https://doi.org/10.1177/0141076814530600

60. Rusakaniko S, Makanga M, Ota MO, Bockarie M, Banda G, Okeibunor J, et al. Strengthening national health research systems in the WHO African Region – progress towards universal health coverage. Global Health [Internet]. 2019 Dec 26;15(1):50. Available from: https://doi.org/10.1186/s12992-019-0492-8

61. Hanney SR, González Block MA. Building health research systems to achieve better health. Heal Res Policy Syst [Internet]. 2006 Dec 6;4(1):10. Available from: https://doi.org/10.1186/1478-4505-4-10

62. Hanney SR, A González Block M. Why national health research systems matter. Heal Res Policy Syst [Internet]. 2008 Dec 11;6(1):1. Available from: https://doi.org/10.1186/1478-4505-6-1

63. Carey G, Malbon E, Carey N, Joyce A, Crammond B, Carey A. Systems science and systems thinking for public health: a systematic review of the field. BMJ Open [Internet]. 2015 Dec 30;5(12):e009002. Available from: https://doi.org/10.1136/bmjopen-2015-009002

64. Peters DH. The application of systems thinking in health: why use systems thinking? Heal Res Policy Syst [Internet]. 2014 Dec 26;12(1):51. Available from: https://doi.org/10.1186/1478-4505-12-51

65. D'Souza C, Sadana R. Why do case studies on national health research systems matter? Identifying common challenges in low- and middle-income countries. Soc Sci Med [Internet]. 2006 Apr;62(8):2072–8. Available from: https://doi.org/10.1016/j.socscimed.2005.08.022

66. Chanda-Kapata P, Campbell S, Zarowsky C. Developing a national health research system: participatory approaches to legislative, institutional and networking dimensions in Zambia. Heal Res Policy Syst [Internet]. 2012 Dec 6;10(1):17. Available from: https://doi.org/10.1186/1478-4505-10-17

67. Cole DC, Nyirenda LJ, Fazal N, Bates I. Implementing a national health research for development platform in a low-income country – a review of Malawi's Health Research Capacity Strengthening Initiative. Heal Res Policy Syst [Internet]. 2016 Dec 1;14(1):24. Available from: https://doi.org/10.1186/s12961-016-0094-3

68. Cabrera D, Colosi L, Lobdell C. Systems thinking. Eval Program Plann [Internet]. 2008 Aug;31(3):299–310. Available from: https://doi.org/10.1016/j.evalprogplan.2007.12.001

69. Swanson RC, Cattaneo A, Bradley E, Chunharas S, Atun R, Abbas KM, et al. Rethinking health systems strengthening: key systems thinking tools and strategies for transformational change. Health Policy Plan [Internet]. 2012 Oct 1;27(suppl 4):iv54–61. Available from: https://doi.org/10.1093/heapol/czs090

70. Adam T, de Savigny D. Systems thinking for strengthening health systems in LMICs: need for a paradigm shift. Health Policy Plan [Internet]. 2012 Oct 1;27(suppl 4):iv1–3. Available from: https://doi.org/10.1093/heapol/czs084

71. Rusoja E, Haynie D, Sievers J, Mustafee N, Nelson F, Reynolds M, et al. Thinking about complexity in health: A systematic review of the key systems thinking and complexity ideas in health. J Eval Clin Pract [Internet]. 2018 Jun;24(3):600–6. Available from: https://doi.org/10.1111/jep.12856

72. Peters DH. The application of systems thinking in health: why use systems thinking? Heal Res Policy Syst [Internet]. 2014 Dec 26;12(1):51. Available from: https://doi.org/10.1186/1478-4505-12-51

Appendix 1: Research Methods

1. Phase 1 – Mapping health science research performance

The most widely available indicator of health research capacity and productivity is arguably the production of scientific research outputs represented by scientific journal publications. Bibliometric studies have mapped the numbers of publications coming out of African countries on a wide range of topics, including cardiovascular diseases (1,2), genomics (3), health economic evaluations (4), health policies and systems (5,6), human immunodeficiency virus (7), neglected tropical diseases (8), and public health (9). Four studies have examined the total number of African publications on any health-related topic indexed in major bibliographic databases.(10–13)

Other studies, however, have used alternative metrics as well. Papers have collected data on investments in research and development (R&D) (10), clinical trial infrastructure (10,14), healthcare workforces (15), and numbers of universities and so-called centres of excellence (15,16) in African countries to estimate HSR capacity. These past studies informed our broad approach which looked for multiple data sources that could be used to inform conclusions about HSR capacity across the African continent. Only a few indicators could be found with comprehensive coverage of all included nations (discussed in limitations below), but we still included relevant indicators even if some countries were missing data.

Geographic scope

Our study included the 54 internationally recognized sovereign states in Africa. This excluded any foreign departments (e.g., Mayotte), regions (e.g., Réunion), or territories (e.g., Saint Helena) located in Africa, as well as the disputed territory of Western Sahara. We collected population and gross domestic product (GDP) data from the World Bank.(17)

Indicator selection

The indicator selection was developed through discussions between the authors and members of an international oversight committee coordinated by the Wellcome Trust. We sought to find a range of proxy indicators which could show us what current level of capacity there is for health sciences research in each country, using indicators from the WHO Global Observatory on Health R&D as a starting point. These included: Gross domestic R&D expenditure on health (health GERD) as a percent of GDP; health researchers per million inhabitants; number of institutions and official development assistance for medical research; and basic health sectors as a percentage of gross national income.(18) We then supplemented this with benchmarking activities, including data on the number of clinical trials regulatory environment data, intellectual property controls and research output data, and bibliometric and citation data. Finally, we included research funding values. All data were acquired between June and September 2018.

To classify and conceptualise the various indicators available, we followed the Donabedian model of health care quality measurement to categories our indicators into one of three types: structural, process, and output measures related to HSR. Structural measures capture inputs into the system and thus comprised metrics such as workforce numbers, budget allocation to R&D, and numbers of organizations, regulations, and guidelines on human subject protections. Process

measures are indicators of on-going HSR activities, including numbers of clinical trials registered and patent applications. Finally, output measures capture the outputs of research activities including numbers of peer-reviewed publications and citations for these publications.

Publications

To systematically collect publication data, we searched Scopus, the world's largest abstract and citation database of peer-reviewed literature.(19) Scopus has full coverage of articles indexed in Embase and MEDLINE, and it includes a larger volume of non-English language journals than many other major bibliographic databases, such as Web of Science. (19)

All searches were conducted in June and July 2018. We searched for any articles published in the following Scopus subject areas: health sciences (medicine, nursing, veterinary, dentistry, health professions) and life sciences (agricultural and biological sciences, biochemistry, genetics and molecular biology, immunology and microbiology, neuroscience, and pharmacology, toxicology and pharmaceutics). We included the following types of publications: articles, in press, books, chapters, and conference papers.

We searched for articles published with at least one author based at an institution in each of the 54 countries, using the "Affiliation country" field in Scopus. We searched the names of each country in English, French, and Portuguese, as well as variant spellings of country names. We restricted the searches to publications published between 2008 and 2017. The search strategy, including the country names, can be found in **Appendix 1. Box 1** below.

Appendix 1. Box 1. Search terms for phase 1

1. SUBJAREA(medi OR nurs OR vete OR dent OR heal OR mult OR agri OR bioc OR immu OR neur OR phar)
2. DOCTYPE(ar OR ip OR bk OR ch OR cp)
3. PUBYEAR AFT 2007
4. PUBYEAR BEF 2018
5. AFFILCOUNTRY([insert the country lists below individually])
6. 1 AND 2 AND 3 AND 4 AND 5

For the Republic of Congo and Democratic Republic of Congo, we included an additional filter based on city, as shown below. This was to differentiate between the two Congos. We used the five most populous cities in each country, based on recent estimates.

For South Sudan, we also included an additional filter based on affiliation city. This was because many of the South Sudanese publications were incorrectly classified as Sudanese. We also only included publications published from 2011 onwards (year of independence).

In the searches, we enclosed the names of countries consisting of more than one word with curly brackets, rather than quotation marks, to improve the accuracy of the searches. The names are shown below with quotation marks for ease of reading.

* These entries show the exact Scopus code for line 5 in the search. In the South Sudan search, the PUBYEAR was changed to after 2010 in line 3 of the search, since the country gained independence from Sudan in 2011.

Number	Country terms
1	(Algeria OR Algérie OR Argélia)
2	(Angola)
3	((Benin OR Bénin OR Benim) AND NOT (Nigeria OR Nigéria))
4	(Botswana)
5	(“Burkina Faso”)
6	(Burundi)
7	(Cameroon OR Cameroun OR Camarões)
8	(“Cape Verde” OR “Cap-Vert” OR “Cabo Verde”)
9	(“Central African Republic” OR “République centrafricaine” OR “República Centro-Africana”)
10	(Chad OR Tchad OR Chade)
11	(Comoros OR Comores)
12*	(AFFILCOUNTRY((Brazzaville OR “Congo Brazzaville” or “Congo-Brazzaville” OR “República do Congo” OR “République du Congo” OR “Congo Republic”) AND NOT (Zaire OR “Democratic Republic of the Congo” OR “DR Congo” OR “République démocratique du Congo” OR “República Democrática do Congo” OR “Congo-Kinshasa” OR “Congo Kinshasa” OR “DRC” OR “Democratic Republic Congo” OR “Democratic Republic of Congo”)) OR (AFFILCOUNTRY(“Congo” OR “The Congo”) AND AFFILCITY(“Brazzaville” OR “Pointe-Noire” OR “Dolisie” OR “Nkayi” OR “Kindamba”)))
13	(“Côte d'Ivoire” OR “Ivory Coast” OR “Costa do Marfim”)
14*	(AFFILCOUNTRY((Zaire OR “Democratic Republic of the Congo” OR “DR Congo” OR “République démocratique du Congo” OR “República Democrática do Congo” OR “Congo-Kinshasa” OR “Congo Kinshasa” OR “DRC” OR “Democratic Republic Congo” OR “Democratic Republic of Congo”) AND NOT (Brazzaville OR “Congo Brazzaville” or “Congo-Brazzaville” OR “República do Congo” OR “République du Congo” OR “Congo Republic”)) OR (AFFILCOUNTRY(“Congo” OR “The Congo”) AND AFFILCITY(“Kinshasa” or “Lubumbashi” OR “Mbuji-Mayi” OR “Bukavu” OR “Kananga”)))
15	(Djibouti)
16	(Egypt OR Égypte OR Egito)
17	(Eritrea OR Érythrée OR Eritreia)
18	(Ethiopia OR Éthiopie or Etiópia)
19	(“Equatorial Guinea” OR “Guinée équatoriale” OR “Guiné Equatorial”)
20	(Gabon or Gabão)
21	(Gambia OR Gambie OR Gâmbia)
22	(Ghana OR Gana)
23	((Guinea OR Guinée OR Guiné) AND NOT (“Guinea-Bissau” OR “Guiné-Bissau” OR “Guinea Bissau” OR “Guinée-Bissau” OR “Equatorial Guinea” OR “Guinée équatoriale” OR “Guiné Equatorial”))
24	(“Guinea-Bissau” OR “Guinée-Bissau” OR “Guiné-Bissau”)
25	(Kenya OR Quénia)
26	(Lesotho OR Lesoto)
27	(Liberia OR Libéria)
28	(Libya OR Libye OR Líbia OR “Libyan Arab Jamahiriya”)
29	(Madagascar OR Madagáscar)
30	(Malawi)
31	(Mali)
32	(Mauritania OR Mauritanie OR Mauritânia)
33	(Mauritius OR Maurice OR Maurícia)
34	(Morocco OR Maroc)
35	(Mozambique OR Moçambique)
36	(Namibia OR Namibie OR Namíbia)
37	((Niger OR Níger) AND NOT (Nigeria OR Nigéria))
38	(Nigeria OR Nigéria)
39	(Rwanda OR Ruanda)
40	(“Sao Tome and Principe” OR “São Tomé and Príncipe” OR “São Tomé-et-Principe” OR “São Tomé e Príncipe”)
41	(Senegal OR Sénégal)

42	(Seychelles)
43	(“Sierra Leone” OR “Serra Leoa”)
44	(Somalia OR Somalie OR “Somália”)
45	(“South Africa” OR “Afrique du Sud” OR “África do Sul”)
46*	AFFILCOUNTRY(“South Sudan” OR “Soudan du Sud” OR “Sudão do Sul”) OR (AFFILCITY(Juba)
47*	(AFFILCOUNTRY(Sudan OR Soudan OR Sudão) AND NOT AFFILCOUNTRY(“South Sudan” OR “Soudan du Sud” OR “Sudão do Sul”)) AND NOT (AFFILCITY(Juba) AND PUBYEAR > 2010)
48	(Swaziland OR Swasiland OR Suazilândia)
49	(Tanzania OR Tanzanie OR Tanzânia)
50	(Togo)
51	(Tunisia OR Tunisie OR Tunísia)
52	(Uganda OR Ouganda)
53	(Zambia OR Zambie OR Zâmbia)
54	(Zimbabwe)

For each country, we extracted data on the number of publications with at least one author based in the country, as well as the number of publications first authored by a local researcher. We also collected citation data for all articles.

For publications published in the five-year period from 2013 to 2017, we collected data on the proportion of publications with international, institutional, and national collaborators. These data were obtained in SciVal, a research information tool developed by Elsevier to synthesize bibliometric data from Scopus.

R&D expenditures and personnel

Data on R&D expenditure and personnel were obtained from the United Nations Educational, Scientific, and Cultural Organization (from 2016, or the most recent available year) (20). We collected data on the number of full-time equivalent staff in the following categories: (i) R&D personnel (per million inhabitants), (ii) researchers (per million inhabitants), and (iii) researchers with doctoral or equivalent degrees (as a proportion of total number of researchers).

From the same database, we also collected data on gross domestic expenditure on R&D in ‘000 current PPP$; these figures were also shown as a proportion of GDP and per capita. Whenever possible, we collected expenditure and personnel data specific to medical and health sciences.

Clinical trial infrastructures, intellectual property rights, and regulatory capacities

Data on the numbers of clinical trials and records, as of 4 August 2018, were extracted from the WHO International Clinical Trials Registry Platform (ICTRP) (21) and US National Institutes of Health database (ClinicalTrials.gov).(22).

ClinicalTrials.gov indexes trials of new investigational drugs, whereas the ICTRP indexes data from several sources, including the European Union Clinical Trials Register, ClinicalTrials.gov, International Standard Randomised Controlled Trial Number register, and Pan African Clinical Trial Registry. A full list of data providers can be found on the ICTRP website (21). The ICTRP registry accepts all types of clinical research studies (e.g., trials of public health interventions).

We also collected information on the number of organisations, regulations, and guidelines on human subjects protections in each country. These data, which are collected annually by the U.S. Department of Health and Human Services, reflect protections in each of the following categories:

"general (i.e., applicable to most or all types of human subjects research)", "drugs and devices", "clinical trial registries", "research injury", "social-behavioural research", "privacy/data protection", "human biological materials", "genetic", and "embryos, stem cells, and cloning". We used the 2018 edition of the compilation of protections.

Finally, we collected data from the World Intellectual Property Organization on the numbers of patents issued to residents in each country (from 2016, or most recent available year). (17)

Research institutions

We collected data on the number of universities in each country based on a list compiled by a researcher at the University of Innsbruck in Austria, using information from the International Association of Universities (23). We also identified the number of African universities listed on the most recent global university rankings of three influential publishers: Quacquarelli Symonds Limited (QS World University Rankings) (24), Times Higher Education (THE World University Rankings) (25), Shanghai Ranking Consultancy (Academic Ranking of World Universities).(26)

We collected data on the number of institutional review boards (27) and WHO Collaborating Centres (28) in each country, and noted whether or not there exists a national ethics committee (29) and national public health institute.(30).

Research funding

We collected data on funding awarded to researchers in each country (2008-2017) from the ten largest public and philanthropic funders of health research globally (listed in order) (31): (1) U.S. National Institutes of Health, (2) European Commission, (3) U.K. Medical Research Council, (4) French National Institute of Health and Medical Research, (5) U.S. Department of Defense (including the Congressionally Directed Medical Research Program), (6) Wellcome Trust, (7) Canadian Institutes of Health Research, (8) Australian National Health and Medical Research Council, (9) Howard Hughes Medical Institute, and (10) German Research Foundation.

The data were collected from each funder's website. We only counted funding allocated to researchers based at institutions in African countries. We excluded funding for research projects in which the principal investigators were based at non-African institutions, even if these projects included collaborators, field sites, or locations of research in Africa.

All amounts were reported in 2017 U.S. dollars based on consumer price index adjustments to account for inflation. Foreign currencies were converted to dollars based on the yearly average exchange rates published by the World Bank.(17)

Limitations

There are some inherent limitations with a study of this nature. First, there is of course no single indicator for health sciences research, so we have had to use metrics that serve as proxy indicators using only those data which are actually available. Thus there is a risk that these proxies do not capture the full landscape we sought to map.

Further, a key issue we encountered was the lack of data for several indicators, as well as issues of reliability and comparability between sources for the data we did collect. The most

comprehensive data sources were for publications and clinical trials, but many other categories of data had numerous countries missing results. Furthermore, whilst we aimed to collect data from 2008-2017 across indicators, some data points come from before this time frame—such as the patent data and the UNESCO data we used for human resource information. These additional data points were necessary to provide a more comprehensive and accurate picture of the health sciences research landscape.

Research is not always published in peer-reviewed journals, and therefore limiting our research output data to bibliometrics from SciVal could also pose limitations. First, Scopus does not index all journals published in African states. Further, for some countries, including Democratic Republic of Congo, Republic of Congo, South Sudan and Sudan, the indexing of affiliation countries on journal articles is incomplete. Finally, this method would not include research published outside of peer-reviewed journals, including government or non-governmental literature such as policy reports, open data sets, software, other grey literature.

We were also unable to find a consistent data source across the African continent to measure government budget allocation to health sciences research. Our proxy for this was GERD (i.e. for research and development as a whole, rather than disaggregated by health sciences). Similarly, when measuring the number of universities in each state, we were not able to ascertain whether these universities undertake research or offer degrees or training in health sciences.

These issues can ultimately make development of a single ranking or scoring of country capacity for health research challenging. Moreover, these crude descriptive metrics offer limited understanding for the intersecting factors which drive a functioning and efficient HSR landscape, such as history, colonial developments, political will and international engagement. However, they provide an important mapping exercise as a starting point for analysis. These offer a snapshot of current capacity and offer a point of departure to understand how HSR enabling environments are built, through further research on how these systems, processes and indicators are developed contextually.

2. Phase 2 – In-depth qualitative case studies

We conducted a multiple case study of health sciences research in Africa. For this, we adopt a broad definition of health sciences research (HSR) as basic, clinical, and applied science on human health and well-being and the determinants, prevention, detection, treatment, and management of disease.(32,33) HSR is carried out in public or private institutions (such as universities, national institutes, centres of excellence, ministries and government agencies, NGOs, and private enterprise / industry). We define a case of HSR as the system of combined structures, activities, processes, groups and individuals that operate in a national jurisdiction wherein health research policies, governance, and funding support training, producing, and utilising health sciences research in that context.

Research design

We used a holistic, multiple-case, replication design to carry out qualitative case studies in nine African countries: Botswana, Côte d'Ivoire, Ethiopia, Kenya, Liberia, Madagascar, Tunisia, Uganda, and Zambia.(34) The in-depth qualitative cases were part of a multi-component project to investigate how to increase and improve investment in health sciences research in Africa. We

selected cases based on preliminary results from the first phase of the wider project, which mapped available data on indicators of standard domains of HSR performance for all 54 sovereign African states. The nine case studies were chosen as a representative sample (see **Appendix 1. Figure 1**) against three criteria: level of health sciences research activity and performance (high, medium, low), language (French and English-speaking countries), and geographical sub-regions of the African continent (Northern, Eastern, Southern, and Western Africa).

Appendix 1. Figure 1. Map of cases selected for qualitative research component

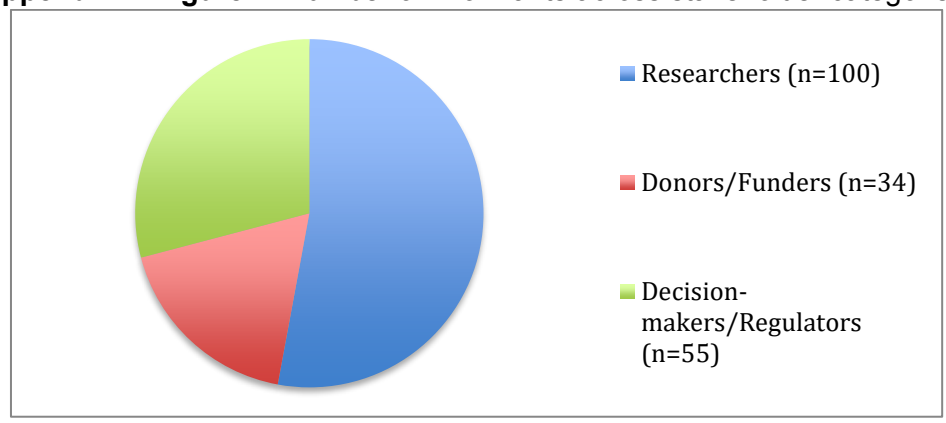
Data collection

Data was collected between September 2018 and October 2019. Firstly, we undertook a documentary review of scientific and grey literature (e.g. policy & strategy documents, evaluations, working papers) to establish a baseline understanding of the context and history of health sciences research in the countries, including the policy and governance framework, research institutions, and financing. Secondly, we carried out semi-structured interviews either in person, by telephone, or online with 189 key informants who fund, undertake, or regulate HSR in the nine case countries. We identified key informants in consultation with local collaborators through stakeholder mapping to inventory government and public bodies, regulatory agencies, public and private research institutions, funders, and regional and global organisations involved in HSR in case countries. Our sampling strategy included three types of actors (funders, researchers, and decision-makers) across multiple stakeholder categories because a range of perspectives within NHRS is vital to answering our research question. Snowball sampling supplemented this strategy in the field with recommendations from participants.

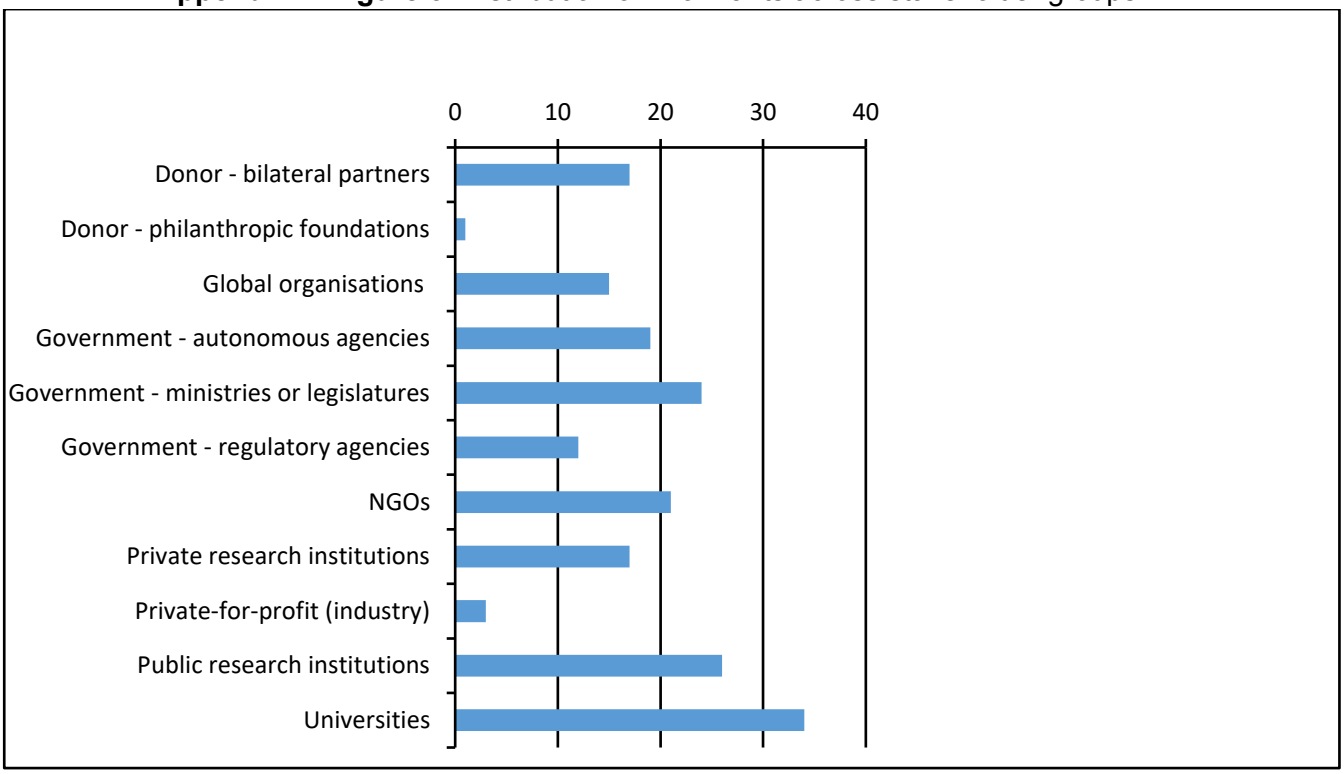
We asked participants about their individual and institutional experience in health sciences research in the respective case country as well as the barriers, facilitators, and challenges to their

work. We tailored the interview guide to ask specific questions to each type of actor depending on their function as funders, researchers, or decision-makers (see **Appendix Insert 1 and Appendix Insert 2** at the end of this appendix for interview guides in English and French languages). Of the 189 key informants, 18% were funders, 53% were researchers, and 29% were decision-makers (see **Appendix 1. Figure 2**); 36% of our data is in French and 64% is in English language. **Appendix 1. Figure 3** shows the distribution of informants interviewed across stakeholder groups.

Appendix 1. Figure 2. Number of informants across stakeholder categories



Appendix 1. Figure 3. Distribution of informants across stakeholder groups



Interviews lasted 30-60 minutes. They were recorded with permission of participants and transcribed in the original language. We obtained informed consent from all participants in accordance with ethical guidelines. The project received ethical approval from the Research Ethics Committee at the London School of Economics and Political Science [REC 000757]. Each case study also received ethical approval from the local institutional review boards (IRBs) or national ethics committee (**Appendix 1. Table 1**).

Appendix 1. Table 1. National research ethics approvals for case studies

Case Country	Research ethics approval bodies and certificates
Botswana	University of Botswana IRB, Office of Research and Development Ethics certificate: Ref: UBR/RES/IRB/BIO/130 Ministry of Health and Wellness, Health Research and Development Division Research permit Reference No: HPDME: 13/18/1
Côte d'Ivoire	Ministère de la Santé et de l'Hygiène Publique Comité National d'Ethique des Sciences de la Vie et de la Santé (CNESVS) Ethics certificate: N/REF 160-18/MSHP/CNESVS-km) N/REF 160-18/MSHP/CNESVS-km)
Ethiopia	Ethiopian Public Health Institute Institutional Review Board (EPHI-IRB) Ethics certificate: EPHI-IRB-166-2019
Kenya	Kenya Medical Research Institute (KEMRI), Scientific and Ethics Review Unit (SERU) Ethics certificate: Ref: KEMRI/RES/7/3/1 National commission for Science, Technology and Innovation (NACOSTI) Research permit: Reference No. NACOSTI/P/19/49577/28306
Liberia	University of Liberia, UL-PIRE AFRICA Africa Center Ethics certificate: protocol 18-11-144
Madagascar	Authorisation for the study by the Comité d'Ethique de la Recherche Biomédicale de Madagascar (CERBM)
Tunisia	Comité d'Ethique Bio-Médicale de l'Institut Pasteur de Tunis Ethics certificate: Dossier référence 2018/30/E/LSEPS/V2 Letters of authorisation for the study from: - le Ministère de l'Enseignement Supérieur et de la Recherche Scientifique, Direction générale de la recherche scientifique - le Ministère de la Santé, Direction générale de la santé et Direction générale de la recherche médicale - L'instance nationale de la protection des données personnelles
Uganda	Makerere University, College of health sciences, School of Medicine Research Ethics Committee Ethics certificate: REC REF 2018-153
Zambia	ERES CONVERGE IRB, University of Zambia Ethics certificate: Ref. No. 2018-Nov-014 Authorisation for the study to be conducted received by the National Health Research Authority

Data analysis

All interview data was imported into *Dedoose* software for collaborative coding. We co-produced a thematic framework to include the researcher-generated codes based on experiences and data from 60% of the fieldwork completed. We provisionally coded samples of data from all cases, and moderated one another's coding to identify differences in understanding and applying the codes in order to categorise and interpret the data.(35) Collectively, we inductively further refined and modified them through multiple discussions informed by emerging themes. The final framework consisted of 13 codes including advocacy, alignment, collaboration, community participation/engagement, funding, health crisis, ownership, political will/leadership, private sector involvement, and research use with sub-codes developed for the three largest categories of capacity, context, and governance (see **Appendix 1. Table 2** for analysis codebook).

We wrote an analysis story about each case of HSR capacity by focusing on what supports the development and functioning of a NHRS, including the challenges faced by these systems. Each story was produced by creating a narrative for individual NHRS based on the intra-case thematic analysis, whilst adopting a whole system perspective to look at the system elements and processes which support (or challenge) the development, establishment, and functioning of the core NHRS pillars and whether they are mutually reinforcing.(36–39) We recognise the pillars of health research systems included in the African Barometer national health research system framework (Strengthening research governance; Creating & sustaining resources; Producing and using health research; Financing health research) as essential building blocks. These pillars are essential to the system, but our analysis focused on how an NHRS functions beyond these pillars, including identifying the elements and processes that lead to, support, and explain the development of NHRS in Africa.

To compile a story of NHRS' development by country, we used the following analysis questions:

- What allowed the pillars of a system to be built up in cases where there have been successes? How did countries arrive at this, or why they are not there yet?
- What are the elements that tie the NHRS components together?
- What systems elements mattered and how?
- How are these elements mutually reinforcing?
- How do they work to improve/strengthen NHRS as a whole?
- What is the role of history of NHRS in countries?
- How does the NHRS interact with other systems (higher education, health, innovation, others?)
- What is the role/s of key individuals in change? How were they able to do it in that context?
- What enabled these changes to happen? Why did these changes happen at a particular time?
- How did timing influence the evolution of the NHRS? i.e.: Placement of key people, International attention, Change in government, Focusing events (summit, crisis, etc.)

These stories sought to go beyond the recognition of important parts of NHRS (e.g. building blocks), instead exploring how they come about, why they do so in a given context, and what enables or hinders change.

The research team held nine virtual meetings to check data analysis quality, review analysis progress, and sustain collective reflection and a critical approach to our analysis while discussing and questioning the stories as they developed iteratively for all cases. In line with the recommended methodology for a holistic, multiple-case, replication design, each case was analysed separately.(34) Replication in analysis, which is a considerable challenge in collaborative qualitative research, is recommended to support the trustworthiness of claims issued from this research design.(34) We did not pool findings across cases, but rather used individual case analysis stories to look at insights across the cases.(40) For the inter-case analysis, the case stories were comparatively analysed in two waves. First, we analysed each story to look for the prominent elements that were found in the development of each NHRS (e.g. research leadership, research culture, political will) building on a list that had been compiled in earlier analyses. We then looked at all the elements and processes on the list mapped across all cases to see where there were similarities and differences in what factors matter for the development of NHRS. Second, we conducted pattern matching to assess patterns in the data and to identify those elements and processes that were most influential in building up the NHRS.(34) Then we examined how and why those mattered within each case, as well as how they were interrelated in supporting the NHRS – while acknowledging that their significance and influence on the development of NHRS differ across contexts.

Appendix 1. Table 2. Interview analysis codebook

Category - groups of related concepts	Code - descriptive or conceptual label	Definitions and examples of data covered by this code
	1. Advocacy	Ability and arguments to communicate with and convince senior policy-makers and politicians for HSR support and HSR use (about relevance/significance of health research and for financing)
	2. Alignment/harmonisation	Alignment of health research with the context, Re linking the strategic visions to empirical realities on the ground, linking research to population needs / health priorities, linking research to improving health programmes and health system, need for local data and researchers with programmatic view and understanding of implications of their research.
		Alignment of health research with other policies, programmes (health, development, etc.) at local, national, regional and/or international levels
HSR Capacity	**3.1 Capacity - Institutional**	research management systems (including coordination of)
		research institutions – national research centres, universities, laboratories, and private research institutions
		infrastructure, equipment, labs, technology, and tools
		curricula (standardised curriculum to ensure HE institutions are giving HSR due attention)
		training (quality, mentorship/supervision, competency-based, curriculum, research methods, mentorship/supervision)
	3.2 Capacity - Research leadership	Leadership within research institutions (e.g. universities, etc.) support research priorities and provide vision, leadership, and mentoring to develop and institutionalize a research culture. While research leadership is important to grow capacity or manage existing capacity and resources, it may not be from an institution as a whole, and rather linked to individuals.
	3.3 Capacity - Human	Individual technical capacity for grant writing, research methods
		human resources: training, retention/attractiveness, ethics, next gen, right mix/missing skills sets,
	3.3.a Capacity - Human - Motivation	The reasons why individual researchers remain dedicated and driven to pursue a career in research in their given country/institution. Some examples of these include specific interests, commitment to country/community/research area, passion, sense of purpose, sense of duty to develop health research in country, students, family, etc.
	3.4 Capacity - other	culture of scientific research (perception of research and its value, understanding the research process, reflection, publication, strong research community, confidence, institutionalisation of research practices)
		interdisciplinary/multidisciplinary research for health
		competitive environment / competitive according to international standards
		availability (how much capacity is available in the given jurisdiction at any given point in time)
		building (efforts to build the capacity to meet the particular country's needs)
	4. Collaboration / Partnership / Networking	(between stakeholders and partners: national / international, NGOs, international agencies, funders, local and international universities, private sector)
		skills/competencies transfer
		agenda-setting/influence on agenda of health research in Africa
		financing
		networks/networking - learning, exchange, training, support, mobility
		North-South, South-South, Anglophone-Francophone, African region, sub-regional (e.g. Indian Ocean Commission)
		transversal approaches – breaking silos (disciplinary, sectoral, but also disease-specific/vertical programmes)
		conferences, seminars, or other partner meetings, and stakeholder platforms in the country and internationally
		institutional or individual arrangements

	5. Community participation/engagement	relevance, understanding, and acceptability of research by community
		community involvement in problematising, developing, conducting, analysing, translating, or using research
Context	**6.1 Sociocultural**	social status; language; cultural beliefs, values, and traditions
	6.2 Political	politics, political change, political crisis
	6.3 Economic	economic status, change
	6.4 Epidemiological	health/disease status and distribution, emerging and re-emerging diseases (NTDs)
	6.5 Geographical	physical environment, roads/transport, climate/weather
	6.6 Technological	electricity, phone/internet, also new technologies for research
		Additional cost of research related to the context: access to advanced equipment / inputs (purchase, tariffs, transport, maintenance) / field work needs in challenging contexts
	7. Crises - health	HIV, Ebola, etc.
		outbreaks of measles, pneumonic plague, cholera, etc.
		severe undernourishment
		climate change and heath
		major public health crises
	8. Funding	resource mobilization, management and sustainability
		financing / funding mechanisms (domestic and international)
		e.g. budgets, grants, calls for proposals, scholarships, aid/cooperation instruments, etc.
HSR Governance	**9.1 Governance - Policy**	policies, plans, and other strategic guidance (presence of national and institutional policies)
		priority/agenda setting, policy change, policy gaps, policy implementation/evaluation
	9.2 Governance - Legislation	laws, decrees
	9.3 Governance - Regulation	regulatory capacity
		coordination mechanisms
		ethical regulation and governance
	9.4 Governance - Institutions	structures and institutional change
		coordination structures
	9.5 Governance - other	
	10. Ownership	The sense of ownership over any aspect of research or the research process or outcomes (agenda, ideas, results, resources, etc.).
	11. Political will/Leadership	prioritisation given to health research
	12. Private sector involvement	private-for-profit industry sector
	13. Research use / knowledge translation	packaging
		use / application / adoption
		visibility and dissemination (including scientific publications and conferences, multi-stakeholder platforms, and community health workers, district health centres, and the public)
		access, availability to research - including coordination of research and knowledge – i.e. database/inventory clearing houses for all research in the country
		impact
		documentation of KT and examples of research use
	14.Other	

Strengths and limitations

We assess the strengths and limitations of this work against D'Souza and Sadana's recommendations for strengthening case studies on health research systems: provide methods, incorporate quantitative data, view health research from a broad perspective, give details, and present recommendations.(41) The comprehensive approach to the multiple case replication design is one of the strengths of the second phase of this research conducted by an interdisciplinary team. The preliminary stakeholder, policy, and context mapping prior to the key informant interviews prepared a shared understanding of the cases across the research team, which was also richly informed by the quantitative data from the first phase of the research. Working with local collaborators supported the understanding of the local contexts for each case and ensured that the key national stakeholders were invited to participate in the study. The multilingual inclusion of English-speaking and French-speaking countries and the geographic diversity of the cases ensured a strong representation across the sub-regions, and we think provides a basis for strengthening the potential for application of the findings and recommendations in countries across the African continent. Taking a broad view of HSR, as we defined it for the purpose of this study, offered a wide range of possibilities for the types of informants targeted in different areas or specialisations of HSR. The results benefited from having included perspectives from those who fund, govern, and conduct HSR. Although, researcher's perspectives outnumbered those of the other two groups in the data, we accounted for this in the analysis approach to ensure that we included views on key themes from the perspectives of all types of key actors. However, there is a potential for a selection bias in the sample of our participants, being those who are most interested and engaged in improving HSR in Africa. The research-based recommendations from the comparative work in this phase target key stakeholders who have already decided to work towards improving HSR in African settings as a key priority. We are also engaging more closely with stakeholders in a few countries to assess the relevance of the findings specific to their respective case studies and work together to see how this research may be useful to advance their goals and objectives for NHRS strengthening.

3. Phase 3 – Peer-to-peer learning among decision-makers

The third component of the project involved facilitation of peer-to-peer learning and exchange for bureaucratic officials who had some official mandate or responsibility for planning health sciences research. This phase comprised two workshops with policymakers from the countries of the nine case studies involved in the second phase of the project. We invited two participants involved in HSR from each country to participate in the workshops – one from ministries of health, and one from ministries of higher education (or equivalent). The aim was to help these officials identify ways to improve HSR and strengthen the NHRS in their country; this was achieved through group identification of goals and strategies, and collective brainstorming of challenges or possible solutions from peers in other settings. The agendas for both workshops can be found at the end of this Appendix.

3.1 Workshop 1 – Nairobi

The first workshop took place in Nairobi, Kenya, from 28th February to 1st March 1019. It was facilitated by team members from the London School of Economics and Political Science (LSE) in collaboration with the African Academy of Sciences (AAS) and co-facilitated by Rose Oronje of the African Institute of Development Policy (AFIDEP).

Specific objectives of the first workshop were to:

- Introduce stakeholders to the Health Science Research in Africa project;
- Identify the roles and goals of different stakeholders in relation to health sciences research in Africa;
- Discuss what it means to improve health sciences research capacity;
- Collectively discuss what is important to programme officials in achieving national goals of health science research;
- Participate in a conjoint analysis exercise to help gauge relative importance of different components of national research capacity;
- Share experiences – including good practices, success and challenges in HSR development at country levels;
- Reflect on challenges faced, with collective discussion;
- Develop action plans of next steps to take within the mandate of individuals' agencies that might help to work towards their agency goals.

Workshop 1 (Nairobi) – Programme

***Day 1 – February 28, 2019* - in Tulipa A Meeting Room – Eka Hotel – Nairobi**

Health sciences research in Africa: state of the environment and experiences

8.30-9.00	Arrivals, Registration & Networking	
9.00-10.00	Welcome and Introductions Workshop Objectives	Co-chairs: Rose Oronje Justin Parkhurst
10.00-10.45	State of the Health Sciences Research environment in each country: context, policies, investments *Format: lightning presentations 5 min./each in plenary*	Chair: Samson Kinyanjui Presenters: country representatives
10.45-11.00	***Break***	
11.00-11.45	Previous session continued	
11.45-12.15	Health Sciences Research on the continent: current data and indicator development *Format: presentation in plenary, questions*	Presenters: Clare Wenham Justin Parkhurst
12.45-1.45	***Lunch***	
1.45-2.30	The Vision and Goals of Health Sciences Research Development in the Region *Format: facilitated brainstorming in plenary*	Facilitators: Rose Oronje Justin Parkhurst
2.30-3.30	Discuss what works well, challenges and lessons from different settings *Format: small group breakouts (3)* Group 1: Cote d'Ivoire, Madagascar, Tunisia Group 2: Ethiopia, Liberia, Uganda Group 3: Botswana, Kenya, Zambia	Brief intro: Justin Parkhurst Group 1: JS+CJ Group 2: RM+JP Group 3: PA+CW

3.30-4.20	Groups report back	Facilitator: Rose Oronje
	Format: facilitated discussion in plenary	
4.20-4.35	***Break***	
4.35-5.15	Country teams pair up to discuss their challenges	Country team activity
	Format: country team discussion groups (9)	
5.15-5.30	Wrap up of Day 1 in Plenary	Justin Parkhurst
	End of Day 1	

Day 2 - March 1, 2019 **- in Tulipa A Meeting Room – Eka Hotel – Nairobi**

Strengthening health sciences research in the region: challenges, strategies, and actions

9.00-9.30	Reflections from Day 1	Co-chairs: Pamela Juma
	Format: feedback in plenary	Clare Wenham
9.30-9.45	Online Survey Exercise	Justin Parkhurst
	Format: participants complete questionnaire online	
9.45-11.15	Brainstorming solutions to country's challenges	Brief intro: Justin Parkhurst
	Format: small group breakouts (3)	
	Group 1: Cote d'Ivoire, Liberia, Kenya	Group 1: RM+CJ
	Group 2: Botswana, Madagascar, Uganda	Group 2: JS+CW
	Group 3: Ethiopia, Tunisia, Zambia	Group 3: PA+JP
11.15-11.30	***Break***	
11.30-12.00	Reflections on challenges – issues and novel ideas from session above	Co-facilitators: Rose Oronje Justin Parkhurst
	Format: facilitated brainstorming in plenary	
12.00-1.15	Identifying country-specific recommendations for improving health sciences research; define country action plans	Country team activity
	Format: country team discussion groups (9)	
1.15-2.15	***Lunch***	
2.15-3.30	Country presentations on action plan exercise (5)	Co-facilitators: Rose Oronje Justin Parkhurst
	Format: each country team has 15 minutes - *10 min. to present plan and 5 min. discussion in plenary*	Presenters: Country teams
3.30-3.45	***Break***	
3.45-4.45	Country presentations (continued) (4)	Co-facilitators: Rose Oronje Justin Parkhurst
	Format: each country team has 15 minutes - *10 min. to present plan and 5 min. discussion in plenary*	Presenters: Country teams
4.45-5.00	Next steps	Co-chairs: Tom Kariuki Clare Wenham

5.00-5.15	Wrap-Up	Co-chairs: Rose Oronje Justin Parkhurst

3.2 Workshop 2 – Addis Ababa

The second workshop was held from 7-8th October 2019 in Addis Ababa, Ethiopia. The goal was to return to themes from the first workshop, discuss progress or challenges in meeting the action plan goals, and continue peer-to-peer learning. A goal was to have as many of the same participants from the first workshop participate as possible. In the end, due to staffing changes and other issues, 10 participants were returning and 7 were new. The workshop was facilitated by LSE team members but co-hosted with AAS, with Allen Mukhwana, AAS Research Systems Manager, participating in the full workshop agenda.

Workshop 2 (Addis Ababa) - Programme

***Day 1 – October 7, 2019* - in Jacaranda Meeting Room – Hilton Hotel – Addis Ababa**

Health sciences research in Africa: feedback on plans and preliminary insights from the field

8.30-9.00	Arrivals, Registration & Networking	
9.00-9.45	Welcome and Introductions Workshop Objectives and Programme	Chair: Justin Parkhurst
9.45-10.00	Overview of African Academy of Sciences programs and activities to promote and build health science research capacity in Africa	Presenter: Allen Mukhwana
10.00-11.00	Update on state of the Health Sciences Research context in each country and feedback on action plans *Format: lightning presentations 10 min./country in plenary with 5 min. for questions*	Chair: Pamela Juma Presenters: country participants
11.00-11.15	***Break***	
11.15-12.30	Previous session continued	Chair: Pamela Juma (TBC) Presenters: country participants
12.30-1.30	***Lunch***	
1.30-2.45	Updates on the other components of the project 1) Feedback on paper on mapping indicators of health science research performance (10 min) 2)	Presenters: Justin Parkhurst

	2) Highlighting insights and stories of success of HSR capacity strengthening from cases (45 min.) 3) Bringing out surprising findings to discuss and debate (5 min.) *Format: presentation in plenary, questions for 15 min.*	Research team members
2.45-4.00	Semi-structured discussion groups on today's presentations from participants and researchers - Which themes are the most interesting or relevant for your context? - Do you think this research found something new or surprising? - What is missing from initial findings that would be helpful for your work?	Brief intro: Justin Parkhurst
	Format: small group breakouts (3) Group 1: Cote d'Ivoire, Madagascar, Tunisia Group 2: Ethiopia, Liberia, Uganda Group 3: Botswana, Kenya, Zambia	Facilitators: Group 1: JST Group 2: RM-D+CJ Group 3: PJ
4.00-4.15	***Break***	
4.15-4.45	Groups share highlights and discussions *Format: facilitated discussion in plenary*	Facilitator: Cat Jones
4.45-5.15	Country teams pair up to discuss issues with progress and barriers on their action plans and decide which two themed sub-plenary groups they will participate in tomorrow *Format: country team discussion groups (9)*	Country team activity
5.15-5.30	Wrap up of Day 1 in Plenary	Chair: Justin Parkhurst
5.30	***End of Day 1***	

***Day 2 – October 8, 2019* - in Jacaranda Meeting Room – Hilton Hotel – Addis Ababa**

Strengthening health sciences research in the region: reflections and brainstorming

9.00-9.30	Reflections from Day 1 Introduction to the sub-plenary breakout groups themes and objectives *Format: feedback in plenary*	Chair: Joëlle Sobngwi
9.30-10.45	Reflecting and brainstorming on barriers to achieving goals in action plans (1/2) *Format: sub-plenary breakouts (2)* Group 1 theme: TBD collectively from Day 1 discussion Group 2 theme: TBD collectively from Day 1 discussion	Facilitators: Group 1: TBC Group 2: TBC
10.45-11.00	***Break***	
11.00-12.15	Reflecting and brainstorming on barriers to achieving goals in action plans (2/2) *Format: sub-plenary breakouts (2)* Group 1 theme: TBD collectively from Day 1 discussion Group 2 theme: TBD collectively from Day 1 discussion	Facilitators: Group 1: TBC Group 2: TBC
12.15-12.30	Recap session Sharing highlights of progress and barriers from sub-plenaries Introduce questionnaire for the afternoon individual activity	Chair: Pamela Juma
12.30-1.30	***Lunch***	
1.30-2.15	Reflections on opportunities – issues and novel ideas from session above *Format: facilitated brainstorming in plenary*	Facilitator: Rhona Mijumbi-Deve Discussant: Allen Mukhwana
2.15-2.45	More in-depth presentation of African Academy of Sciences programs and activities to promote and build health science research capacity in Africa, and links to workshop discussion *Format: presentation in plenary, discussion and questions*	Presenter: Allen Mukhwana
3.30-3.45	***Break***	

3.45-4.15	Evaluation to assess whether and how this process has facilitated learning and change *Format: questionnaire*	Individual participant activity
4.15-4.45	Future wishes of participants (ongoing work, network building, cross-border collaboration, funding opportunities)	Co-facilitators: TBC
4.45-5.15	Wrap-Up	Chair: Justin Parkhurst
5.15	***End of meeting***	

Appendix 1. Insert 1. Semi-structured interview guide (English)

Semi-structured guide for interviews with informants about Health Science Research in Africa

This project investigates how health sciences research (HSR) capacity can be improved and increased on the African continent. HSR refers to basic, clinical, and applied science on human health and well-being and the determinants, prevention, detection, treatment, and management of disease. The objective of the project is to identify what promotes an enabling environment for HSR to thrive - exploring several key areas such as (but not limited to) the policy environment, funding mobilization, and the regulatory and coordinating systems for HSR conducted in the public and private sectors. For each of our case studies, we the research team will be speaking with the key "funders, doers and regulators" of research across the continent.

In the semi-structured in-depth interviews for each case, we will ask a set of seven general questions to all informants about their individual and institutional experiences with HSR system in the respective case country to gain insight, through their own work and perspective, into the issues and capacities involved in developing HSR whether in terms of policy, funding, or regulation. We will ask more specific questions to each type of actor depending on their function (funder, researcher, regulator) and their sectoral sphere (governmental, non-governmental, public, private for profit, international organisation/agency).

Through the analysis of the data collected from these interviews, we aim to learn lessons about what drives and supports HSR, where are the gaps, and what are the challenges and barriers, and the strategies being used in different case settings to improve and increase HSR.

Guide for interviews with researchers and academics
(in public or private institutions)

General questions

1. Who are you? What do you do? Where do you work? What is your role?

2. What is your experience (doing, funding, regulating/governing) HSR in [country]?

3. What have been the main facilitators and barriers to your work?

4. What has supported investment in HSR or capacity for HSR in [country]? Why has this/ have these been successful?

5. What are the biggest challenges to establishing a vibrant HSR environment in [country]? How are you addressing these?

6. Have any external factors had a particular impact on the HSR environment in [country]? If so, how?

7. Who do you think is doing well in HSR?

Specific questions
Why have you chosen to work in HSR here (in this country, field of HSR, institution)?

How do you access funding?

What has working in HSR here (in this country, field of HSR, institution) allowed you to achieve?

What can be done to improve / increase HSR?

What are the long terms plans or concerns regarding sustainability of HSR?

Guide for interviews with funders, international donors, and philanthropists

(in public, public-private, foundations, or private not-for-profit institutions)

General questions

1. Who are you? What do you do? Where do you work? What is your role?

2. What is your experience (doing, funding, regulating/governing) HSR in [country]?

3. What have been the main facilitators and barriers to your work?

4. What has supported investment in HSR or capacity for HSR in [country]? Why has this/ have these been successful?

5. What are the biggest challenges to establishing a vibrant HSR environment in [country]? How are you addressing these?

6. Have any external factors had a particular impact on the HSR environment in [country]? If so, how?

7. Who do you think is doing well in HSR?

Specific questions

What mechanisms do you use to fund research /or/ invest in HSR in [country]?

Who or what do you fund or invest in?

Why do you fund research /or/ invest in HSR (or why not) in [country]?

What would make you increase /or/ begin funding HSR in [country] (push/pull mechanisms)?

What challenges do you face?

What has kept you here?

What sustainability plans do you have with government to strengthen HSR?

Do you support HSR in other countries?

What makes a country attractive environment to invest in HSR?

Guide for interviews with government policy-makers

(in public institutions)

General questions

1. Who are you? What do you do? Where do you work? What is your role?

2. What is your experience (doing, funding, regulating/governing) HSR in [country]?

3. What have been the main facilitators and barriers to your work?

4. What has supported investment in HSR or capacity for HSR in [country]? Why has this/ have these been successful?

5. What are the biggest challenges to establishing a vibrant HSR environment in [country]? How are you addressing these?

6. Have any external factors had a particular impact on the HSR environment in [country]? If so, how?

7. Who do you think is doing well in HSR?

Specific questions

To policy-makers about technical matters (i.e. Ministries of Health and/or Education):

What policies and practices are in place to support HSR?

What are the funding mechanisms for HSR?

What challenges have you faced?

What are you doing to make HSR investment attractive for private or international donors / to researchers?

And what would you hope / or / like to do to improve or increase HSR in your country?

To policy-makers about financing matters/budgets (i.e. Ministries of Finance, parliamentary (health/research) committees, health permanent secretary):

Do you co-finance HSR?

- If yes, what funding mechanisms do you use to fund research /or/ invest in HSR? Who or what do you fund or invest in?
- If no, what would increase your financing?

How do you decide what to spend /or/ invest in HSR?

Guide for interviews with private industry

(e.g. pharmaceutical companies, private health care organisations)

General questions

1. Who are you? What do you do? Where do you work? What is your role?

2. What is your experience (doing, funding, regulating/governing) HSR in [country]?

3. What have been the main facilitators and barriers to your work?

4. What has supported investment in HSR or capacity for HSR in [country]? Why has this/ have these been successful?

5. What are the biggest challenges to establishing a vibrant HSR environment in [country]? How are you addressing these?

6. Have any external factors had a particular impact on the HSR environment in [country]? If so, how?

7. Who do you think is doing well in HSR?

Specific questions

Do you invest in HSR in country x and how much? Why?

What funding mechanisms do you use to fund research /or/ invest in HSR in [country]?

Who or what do you invest in?

What has kept you here?

What would make you increase your investment?

How does this compare with your experience with other countries?

Do you invest in HSR elsewhere / regionally?

Do you have a long-term strategy for investing in HSR? Is it country-specific?

Appendix 1. Insert 2: Semi-structured interview guide (French)

Guide d'entretien semi-structuré avec des informateurs-clé sur la recherche en sciences de la santé en Afrique

Ce projet vise à apprendre comment améliorer et accroître les capacités de recherche en sciences de la santé (RSS) sur le continent africain. Nous définissons la RSS comme les sciences fondamentales, cliniques, et appliquées sur la santé et le bien-être humains et sur les déterminants, la prévention, la détection, le traitement, et la gestion de la maladie. L'objectif du projet est d'identifier ce qui favorise un environnement favorable à la RSS à travers l'exploration de plusieurs domaines clés, tels que l'environnement politique, la mobilisation de fonds, et les systèmes de réglementation et de coordination de la RSS dans les secteurs public et privé. Pour chacune de nos études de cas, l'équipe de recherche s'adressera aux principaux bailleurs de fonds, chercheurs, et régulateurs dans les systèmes de la RSS sur le continent.

En ce qui concerne les entretiens approfondis semi-structurés de chaque cas, nous poserons à tous les informateurs une série de sept questions générales sur leurs expériences individuelles et institutionnelles avec le système de RSS dans le pays du cas concerné afin de mieux comprendre, à travers leur travail et leur point de vue, les enjeux et les ressources impliquées dans le développement de la RSS, que ce soit en termes de politique, de financement ou de réglementation. Nous poserons des questions plus spécifiques à chaque type d'acteur en fonction de leur statut (bailleur de fonds, chercheur, régulateur) et de leur domaine sectoriel (gouvernemental, non gouvernemental, public, privé à but lucratif, organisation internationale).

En analysant les données recueillies lors de ces entretiens, nous visons à tirer des leçons sur ce qui motive et soutient la RSS, où se trouvent les lacunes, quels sont les défis et les obstacles, et sur les stratégies utilisées dans différents contextes pour améliorer et augmenter l'investissement dans la RSS.

Guide d'entretien :
Discussions avec des chercheurs et des universitaires

Questions générales

1. Qui êtes-vous? Qu'est ce que vous faites? Où travaillez vous? Quel est votre rôle?

2. Quelle est votre expérience dans la recherche en science de la santé (sa mise en œuvre, son financement, sa régulation, sa gouvernance) dans votre pays?

3. Quels ont été (ou quels sont) les principaux facilitateurs et obstacles à votre travail?

4. Qu'est-ce qui soutient l'investissement dans la RSS ou la capacité de RSS dans votre pays? Pourquoi cela a-t-il réussi?

5. Quels sont les principaux défis à relever pour créer un environnement dynamique de RSS dans votre pays? Comment abordez-vous ces problèmes?

6. Des facteurs externes ont-ils eu un impact particulier sur l'environnement de la recherche dans votre pays? Si c'est le cas, comment?

7. Quelles sont les systèmes en place pour l'utilisation des résultats de la recherche pour améliorer les politiques ou le système de santé et développement ? Qu'est-ce qui pourrait être mis en place en ce sens (e.g. pour combler ces besoins) ?

8. Quelles sont des collaborations de la recherche auxquelles vous ou votre institution participez ?

9. Quels sont les exemples de succès dans la RSS que vous pouvez citer ?

Questions spécifiques
Pourquoi avez-vous choisi de travailler dans la RSS ici (dans ce pays, dans ce domaine de RSS, dans cette institution)?

Comment accédez-vous à des financements ?

Qu'est-ce qui rend facile / difficile de travailler dans le domaine de la RSS ici?

Qu'est-ce que le travail dans la RSS ici (dans ce pays, dans ce domaine de RSS, dans cette institution) vous a permis de réaliser?

Que peut-on faire pour améliorer / augmenter la RSS ici?

Quels sont les projets à long terme ou les préoccupations concernant la durabilité/pérennité de la RSS?

Guide d'entretien :
Discussions avec des bailleurs internationaux et des philanthropes

Questions générales
1. Qui êtes-vous? Qu'est ce que vous faites? Où travaillez vous? Quel est votre rôle?

2. Quelle est votre expérience dans votre pays avec la recherche en science de la santé (sa mise en œuvre, son financement, sa régulation, sa gouvernance)?

3. Quels ont été (ou quels sont) les principaux facilitateurs et obstacles à votre travail?

4. Qu'est-ce qui soutient l'investissement dans la RSS ou la capacité de RSS ici?

5. Quels sont les principaux défis à relever pour créer un environnement dynamique de RSS dans votre pays? Comment abordez-vous ces problèmes?

6. Des facteurs externes ont-ils eu un impact particulier sur l'environnement de la recherche dans votre pays? Si c'est le cas, comment?

7. Quelles sont les systèmes en place pour l'utilisation des résultats de la recherche pour améliorer les politiques ou le système de santé et développement ? Qu'est-ce qui pourrait être mis en place en ce sens (e.g. pour combler ces besoins) ?

8. Quelles sont des collaborations de la recherche auxquelles vous ou votre institution participez ?

9. Quels sont les exemples de succès dans la RSS que vous pouvez citer ?

Questions spécifiques
Quels mécanismes de financement utilisez-vous pour financer la recherche / ou pour investir dans la RSS dans ce pays?

Qui ou quoi financez-vous ? ou Dans qui ou dans quoi investissez-vous?
Pourquoi financez-vous la recherche ou investissez-vous dans la RSS (ou pourquoi pas) dans ce pays?

Qu'est-ce qui vous ferait augmenter votre financement ou commencer à financer la RSS dans ce pays (mécanismes push / pull)?

Quels défis rencontrez-vous?

Qu'est-ce qui vous fait que rester ici et maintenir vos financements/investissements?

Quels plans de pérennisation avez-vous avec le gouvernement pour renforcer la RSS?

Soutenez-vous la RSS dans d'autres pays?

A votre avis, qu'est-ce qui rend un pays attrayant pour investir dans la RSS?

Guide d'entretien :
Discussions avec des décideurs politiques du gouvernement

Questions générales

1. Qui êtes-vous? Qu'est ce que vous faites? Où travaillez vous? Quel est votre rôle?
2. Quelle est votre expérience dans la recherche en science de la santé (sa mise en œuvre, son financement, sa régulation, sa gouvernance) dans votre pays ?
3. Quels ont été (ou quels sont) les principaux facilitateurs et obstacles à votre travail?
4. Qu'est-ce qui soutient l'investissement dans la RSS ou la capacité de RSS ici?
5. Quels sont les principaux défis à relever pour créer un environnement dynamique de RSS dans votre pays? Comment abordez-vous ces problèmes?
6. Des facteurs externes ont-ils eu un impact particulier sur l'environnement de la recherche dans votre pays? Si c'est le cas, comment?
7. Quelles sont les systèmes en place pour l'utilisation des résultats de la recherche pour améliorer les politiques ou le système de santé et développement ? Qu'est-ce qui pourrait être mis en place en ce sens (e.g. pour combler ces besoins) ?
8. Quelles sont des collaborations de la recherche auxquelles vous ou votre institution participez ?
9. Quels sont les exemples de succès dans la RSS que vous pouvez citer ?

Questions spécifiques

<u>Pour les décideurs politiques sur des questions techniques</u> (i.e. aux ministères de la santé et / ou de l'enseignement supérieur):

Quelles politiques et pratiques sont en place pour soutenir la RSS?

Quels sont les mécanismes de financement de la RSS?

Quels défis rencontrez vous? Quels sont des défis liés à la mise en œuvre des plans/stratégies/politiques que vous élaborez ?

Que faites-vous pour rendre les investissements en RSS attractifs aux bailleurs privés ou internationaux / aux chercheurs?

Et qu'espérez-vous ou aimeriez-vous faire pour améliorer ou augmenter la RSS dans votre pays?

Comment fait vous du plaidoyer au près du gouvernement pour sécuriser le financement en faveur de la recherche ?

<u>Pour les décideurs politiques en matière de financement / budgets</u> (i.e. aux ministères des finances, comités parlementaires (santé / recherche), secrétaire permanent à la santé):

Co-financez-vous la RSS?

Si oui :

- Quels mécanismes de financement utilisez-vous pour financer la recherche ou investir dans la RSS?
- Quels sont les domaines/acteurs de la RSS que vous financez ? dans lesquels vous investissez ?

Si non :

- Qu'est-ce qui augmenterait votre financement?
- Comment décidez-vous quoi dépenser ou investir dans la RSS ?
- Comment fait vous du plaidoyer au près du gouvernement pour sécuriser le financement en faveur de la recherche ?

Guide d'entretien :
Discussions avec le secteur privé (industrie)

Questions générales

1. Qui êtes-vous? Qu'est ce que vous faites? Où travaillez-vous? Quel est votre rôle?

2. Quelle est votre expérience dans la recherche en science de la santé (sa mise en œuvre, son financement, sa régulation, sa gouvernance) dans votre pays?

3. Quels ont été (ou quels sont) les principaux facilitateurs et obstacles à votre travail?

4. Qu'est-ce qui soutient l'investissement dans la RSS ou la capacité de RSS ici?

5. Quels sont les principaux défis à relever pour créer un environnement dynamique de RSS dans votre pays? Comment abordez-vous ces problèmes?

6. Des facteurs externes ont-ils eu un impact particulier sur l'environnement de la recherche dans votre pays? Si c'est le cas, comment?

7. Quelles sont les systèmes en place pour l'utilisation des résultats de la recherche pour améliorer les politiques ou le système de santé et développement ? Qu'est-ce qui pourrait être mis en place en ce sens (e.g. pour combler ces besoins) ?

8. Quelles sont des collaborations de la recherche auxquelles vous ou votre institution participez ?

9. Quels sont les exemples de succès dans la RSS que vous pouvez citer ?

Questions spécifiques

Investissez-vous dans la RSS dans ce pays et combien? Pourquoi?

Quels mécanismes de financement utilisez-vous pour financer la recherche ou investir dans la RSS dans ce pays?

Quels sont les domaines/acteurs de la RSS que vous financez ? dans lesquels vous investissez ?

Qu'est-ce qui vous ferait augmenter votre investissement?

Qu'est-ce qui vous fait rester ici et maintenir vos investissements?

Comment comparez-vous votre expérience avec celle d'autres pays?

Est-ce que vous investissez dans la RSS ailleurs / dans autres régions d'Afrique?

Avez-vous une stratégie à long terme pour investir dans la RSS? Est-ce spécifique au pays?

Bibliography

1. Bloomfield GS, Baldridge A, Agarwal A, Huffman MD, Colantonio LD, Bahiru E, et al. Disparities in Cardiovascular Research Output and Citations From 52 African Countries: A Time-Trend, Bibliometric Analysis (1999–2008). J Am Heart Assoc [Internet]. 2015 Apr 22;4(4). Available from: https://doi.org/10.1161/JAHA.114.001606
2. Ettarh R. Patterns of international collaboration in cardiovascular research in sub-Saharan Africa. Cardiovasc J Afr [Internet]. 2016/11/15. 2016 Jul 6;27(3):194–200. Available from: https://doi.org/10.5830/CVJA-2015-082
3. Adedokun BO, Olopade CO, Olopade OI. Building local capacity for genomics research in Africa: recommendations from analysis of publications in Sub-Saharan Africa from 2004 to 2013. Glob Health Action [Internet]. 2016;9:31026. Available from: https://doi.org/10.3402/gha.v9.31026
4. Hernandez-Villafuerte K, Li R, Hofman KJ. Bibliometric trends of health economic evaluation in Sub-Saharan Africa. Global Health [Internet]. 2016 Dec 24;12(1):50. Available from: https://doi.org/10.1186/s12992-016-0188-2
5. Adam T, Ahmad S, Bigdeli M, Ghaffar A, Røttingen J-A. Trends in Health Policy and Systems Research over the Past Decade: Still Too Little Capacity in Low-Income Countries. Noor AM, editor. PLoS One [Internet]. 2011 Nov 22;6(11):e27263. Available from: https://doi.org/10.1371/journal.pone.0027263
6. Gilson L, Raphaely N. The terrain of health policy analysis in low and middle income countries: a review of published literature 1994-2007. Health Policy Plan [Internet]. 2008/07/25. 2008 Jul 22;23(5):294–307. Available from: https://doi.org/10.1093/heapol/czn019
7. Uthman OA. Pattern and determinants of HIV research productivity in sub-Saharan Africa: bibliometric analysis of 1981 to 2009 PubMed papers. BMC Infect Dis [Internet]. 2010 Mar 5;10(1):47. Available from: https://doi.org/10.1186/1471-2334-10-47
8. Breugelmans JG, Makanga MM, Cardoso AL V, Mathewson SB, Sheridan-Jones BR, Gurney KA, et al. Bibliometric Assessment of European and Sub-Saharan African Research Output on Poverty-Related and Neglected Infectious Diseases from 2003 to 2011. Diemert DJ, editor. PLoS Negl Trop Dis [Internet]. 2015 Aug 11;9(8):e0003997. Available from: https://doi.org/10.1371/journal.pntd.0003997
9. Chuang K-Y, Chuang Y-C, Ho M, Ho Y-S. Bibliometric analysis of public health research in Africa: The overall trend and regional comparisons. S Afr J Sci [Internet]. 2011 May 3;107(5/6):54–9. Available from: https://doi.org/10.4102/sajs.v107i5/6.309
10. Røttingen J-A, Regmi S, Eide M, Young AJ, Viergever RF, Årdal C, et al. Mapping of available health research and development data: what's there, what's missing, and what role is there for a global observatory? Lancet [Internet]. 2013 Oct;382(9900):1286–307. Available from: http://www.doi.org/10.1016/S0140-6736(13)61046-6
11. Uthman OA, Uthman MB. Geography of Africa biomedical publications: An analysis of 1996–2005 PubMed papers. Int J Health Geogr [Internet]. 2007 Oct;6(1):46. Available from: https://doi.org/10.1186/1476-072X-6-46
12. Uthman OA, Wiysonge CS, Ota MO, Nicol M, Hussey GD, Ndumbe PM, et al. Increasing the value of health research in the WHO African Region beyond 2015—reflecting on the past, celebrating the present and building the future: a bibliometric analysis. BMJ Open [Internet]. 2015;5(3):e006340. Available from: https://doi.org/10.1136/bmjopen-2014-006340
13. NEPAD Planning and Coordinating Agency. African Innovation Outlook II. Pretoria; 2014.
14. International Vaccines Task Force. Money & Microbes: Strengthening Clinical Research Capacity to Prevent Epidemics. Washington, D.C.; 2018.
15. Allard G. Science and technology capacity in Africa: A new index. J African Stud Dev [Internet]. 2015;7(6):137–47. Available from: https://doi.org/10.5897/JASD2014.0322
16. Nwaka S, Ochem A, Besson D, Ramirez B, Fakorede F, Botros S, et al. Analysis of pan-African Centres of excellence in health innovation highlights opportunities and challenges for local innovation and financing in the continent. BMC Int Health Hum Rights [Internet]. 2012 Dec

27;12(1):11. Available from: https://doi.org/10.1186/1472-698X-12-11

17. The World Bank. Open Data [Internet]. 2018. Available from: https://data.worldbank.org

18. World Health Organization. Global Observatory on Health R&D. WHO. World Health Organization; 2018.

19. Burnham JF. Scopus database: A Review. Biomed Digit Libr [Internet]. 2006 Dec 8;3(1):1. Available from: doi.org/10.1186/1742-5581-3-1

20. UNESCO. UIS Statistics (Category: science, technology, and innovation). [Internet]. 2018. Available from: http://data.uis.unesco.org

21. International Clinical Trials Registry Platform. Trial List By Countries [Internet]. 2018. Available from: https://www.who.int/ictrp/en/

22. U.S. National Library of Medicine. ClinicalTrials.gov [Internet]. 2000. Available from: Clinicaltrials.gov

23. Förster K. Universities Worldwide [Internet]. 2018. Available from: https://univ.cc

24. QS World University. Worldwide university rankings, guides & events. 2018.

25. Times Higher Education. Academic & University News [Internet]. 2018. Available from: https://www.timeshighereducation.com

26. Shanghai Ranking Consultancy. ARWU World University Rankings 2018 [Internet]. 2018. Available from: http://www.shanghairanking.com

27. Council on Health Research for Development. Regulation and Ethics Review of Research. 2018.

28. World Health Organization. WHO Collaborating Centres Database and Portal [Internet]. 2018. Available from: https://www.who.int/collaboratingcentres/database/en/

29. World Health Organization. National Ethics Committees Database [Internet]. 2018. Available from: https://apps.who.int/ethics/nationalcommittees/Default.aspx

30. The International Associaton of National Public Health Institutes. Our Members - IANPHI [Internet]. 2018. Available from: https://www.ianphi.org/about/member-countries.html

31. Viergever RF, Hendriks TCC. The 10 largest public and philanthropic funders of health research in the world: what they fund and how they distribute their funds. Heal Res Policy Syst [Internet]. 2016 Dec 18;14(1):12. Available from: doi.org/10.1186/s12961-015-0074-z

32. European Science Foundation. Health Research Classification Systems – Current Approaches and Future Recommendations [Internet]. ESF Science Policy Briefing 43. 2011 [cited 2018 Sep 30]. Available from: http://archives.esf.org/publications/science-policy-briefings.html

33. UK Clinical Research Collaboration. Health Research Classification System [Internet]. London: Medical Research Council; 2018 [cited 2018 Sep 30]. Available from: www.hrcsonline.net

34. Yin RK. Case Study Research: Design and Methods. 4th ed. Applied Social Research Methods Series. Los Angeles: Sage; 2009. 219 p.

35. Saldana J. The Coding Manual for Qualitative Researchers. 2nd ed. London: Sage; 2013. 303 p.

36. Creswell JW. Qualitative Inquiry and Research Design: Choosing among Five Approaches. 2nd ed. Thousand Oaks: Sage; 2007.

37. Polkinghorne DE. Narrative configuration in qualitative analysis. Int J Qual Stud Educ [Internet]. 1995 Jan;8(1):5–23. Available from: doi.org/10.1080/0951839950080103

38. Carey G, Malbon E, Carey N, Joyce A, Crammond B, Carey A. Systems science and systems thinking for public health: a systematic review of the field. BMJ Open [Internet]. 2015 Dec 30;5(12):e009002. Available from: https://doi.org/10.1136/bmjopen-2015-009002

39. Peters DH. The application of systems thinking in health: why use systems thinking? Heal Res Policy Syst [Internet]. 2014 Dec 26;12(1):51. Available from: https://doi.org/10.1186/1478-4505-12-51

40. Gilson L. Health Policy and Systems Research: A Methodology Reader. Geneva: Alliance HPSR/WHO; 2012. p. 474.

41. D'Souza C, Sadana R. Why do case studies on national health research systems matter? Identifying common challenges in low- and middle-income countries. Soc Sci Med [Internet]. 2006 Apr;62(8):2072–8. Available from: https://doi.org/10.1016/j.socscimed.2005.08.022

Appendix 2 – Phase 1 results tables and figures

Appendix 2 Table 1: Bibliometric data

Country	GDP (million)	Pop. (thousand)	Pubs.	Cit.	F-a pubs.	F-a cit.	2008 pubs.	2017 pubs.	Int. Coll.	Nat. Coll.	Inst. Coll.	Single author
Algeria	159,049	40,606	8,043	57,188	6,473	28,931	437	1,138	52.7	10.1	34.4	2.7
Angola	95,335	28,813	446	4,827	120	489	21	85	92.5	0.3	7.2	0.0
Benin	8,583	10,872	2,427	22,042	1,166	7,435	161	290	80.7	1.0	17.8	0.6
Botswana	15,581	2,250	1,766	28,298	756	4,583	113	245	79.7	3.5	12.9	3.8
Burkina Faso	11,693	18,646	3,104	36,231	1,336	8,663	216	388	84.5	0.8	14.2	0.4
Burundi	3,007	10,524	243	2,250	67	311	6	40	87.4	0.0	11.4	1.2
Cameroon	32,218	23,439	5,973	69,384	3,356	21,499	376	814	73.7	7.5	17.0	1.8
Cape Verde	1,617	540	124	1,052	19	52	6	20	94.4	1.1	3.3	1.1
Central African Republic	1,756	4,595	333	4,490	137	797	19	40	77.7	1.0	15.8	5.4
Chad	9,601	14,453	203	2,105	55	357	15	41	94.8	0.0	5.2	0.0
Comoros	617	796	61	419	13	33	2	7	77.8	2.8	19.4	0.0
Democratic Republic of the Congo	35,382	78,736	1,535	26,099	609	3,330	64	261	86.2	0.5	12.2	1.2
Djibouti	1,727	942	61	419	30	166	2	7	77.8	2.8	19.4	0.0
Egypt	332,791	95,689	60,693	-	-	-	2,481	8,206	46.4	14.1	32.7	6.9
Equatorial Guinea	10,685	1,221	114	1,714	12	43	6	12	100.0	0.0	0.0	0.0
Eritrea	2,608	4,475	154	1,252	54	176	15	18	83.3	0.0	14.6	2.1
Ethiopia	72,374	102,403	9,926	95,131	6,630	43,786	398	1,768	57.1	6.5	32.2	4.2
Gabon	14,214	1,980	1,203	20,122	446	6,199	84	141	89.5	0.0	9.3	1.1
Gambia	965	2,039	1,175	32,033	363	6,243	92	156	95.7	0.3	2.0	2.0
Ghana	42,690	28,207	7,005	96,341	3,681	19,958	307	1,118	68.7	5.1	22.6	3.6
Guinea	8,200	12,396	1,547	28,939	418	3,416	126	231	91.2	0.2	6.4	2.2
Guinea-Bissau	1,165	1,816	333	5,016	111	1,963	18	48	99.1	0.5	0.0	0.5
Ivory Coast	36,373	23,696	2,622	31,674	1,573	5,637	251	284	67.8	1.1	30.4	0.7

Table 1: Bibliometric data

Country	GDP (million)	Pop. (thousand)	Pubs.	Cit.	F-a pubs.	F-a cit.	2008 pubs.	2017 pubs.	Int. Coll.	Nat. Coll.	Inst. Coll.	Single author
Kenya	70,529	48,462	14,286	243,026	6,071	61,021	943	1,909	83.2	5.6	9.0	2.2
Lesotho	2,291	2,204	186	2,581	64	478	14	22	88.6	0.0	9.5	1.9
Liberia	2,101	4,614	258	3,733	45	296	7	57	92.8	1.4	3.4	2.4
Libya	34,699	6,293	1,513	14,307	735	3,379	77	151	81.3	0.2	14.9	3.5
Madagascar	10,001	24,895	1,999	23,688	680	4,113	157	264	86.2	0.3	12.5	0.9
Malawi	5,433	18,092	3,442	56,398	1,204	13,344	228	540	90.5	1.1	6.0	2.3
Mali	14,035	17,995	1,691	26,428	495	4,014	114	244	89.9	0.3	9.4	0.4
Mauritania	4,739	4,301	227	1,719	83	400	13	32	90.9	0.0	8.4	0.7
Mauritius	12,168	1,263	737	8,004	404	2,294	37	104	65.3	0.2	30.4	4.0
Morocco	103,606	35,277	12,051	80,662	9,514	32,877	744	1,537	36.8	14.2	47.3	1.8
Mozambique	11,015	28,829	1,731	39,885	542	5,014	81	290	93.4	1.2	3.8	1.6
Namibia	10,948	2,480	1,026	10,156	337	1,386	44	154	83.9	0.4	8.3	7.4
Niger	7,528	20,673	804	9,075	278	1,808	56	99	84.7	1.3	12.4	1.7
Nigeria	404,653	185,990	31,023	205,135	25,853	109,386	2,443	3,369	36.3	14.1	45.1	4.5
Republic of the Congo	7,834	5,126	921	11,026	351	1,496	50	102	80.9	0.3	17.1	1.6
Rwanda	8,376	11,918	1,519	23,953	538	4,022	50	245	90.1	0.5	7.1	2.4
Sao Tome and Principe	343	200	25	335	4	56	0	7	100.0	0.0	0.0	0.0
Senegal	14,684	15,412	3,667	37,424	1,759	10,138	234	473	73.1	4.5	21.1	1.3
Seychelles	1,427	95	339	5,631	57	567	31	44	83.0	0.5	4.5	2.0
Sierra Leone	3,737	7,396	530	7,489	102	975	15	114	94.5	0.2	4.2	1.0
Somalia	6,217	14,318	73	685	24	74	3	21	96.2	0.0	1.9	1.9
South Africa	295,456	56,015	63,171	-	-	-	4,210	8,325	57.2	10.6	26.3	5.9

Table 1: Bibliometric data

Country	GDP (million)	Pop. (thousand)	Pubs.	Cit.	F-a pubs.	F-a cit.	2008 pubs.	2017 pubs.	Int. Coll.	Nat. Coll.	Inst. Coll.	Single author
Sudan	95,584	39,579	3,620	46,793	1,949	10,599	214	442	76.2	0.1	20.1	3.6
Swaziland	3,721	1,343	542	5,871	199	1,727	31	92	86.8	0.7	7.9	4.6
Tanzania	47,340	55,572	7,716	119,936	3,167	26,771	429	1,061	83.2	1.4	13.3	2.0
Togo	4,400	7,606	924	6,331	562	1,739	51	107	65.2	0.0	34.5	0.3
Tunisia	42,063	11,403	20,532	182,898	17,138	117,263	1,592	2,373	47.6	7.8	43.5	1.1
Uganda	24,079	41,488	8,250	145,435	3,496	34,353	441	1,171	85.6	2.2	10.8	1.5
Zambia	21,064	16,591	2,758	49,329	861	8,047	218	446	90.8	2.2	5.5	1.5
Zimbabwe	16,620	16,150	3,005	45,515	1,320	9,604	205	469	75.2	1.8	19.6	3.4

Cit., citations; coll., collaboration; F-A, first-author; GDP, gross domestic product; inst., institutional; int., international; nat., national; pop., population; pubs., publications

Collaboration figures are from SciVal and reflect outputs published in 2013-2017. All other data cover outputs published in 2008-2017.

Appendix 2 Table 2: Clinical trial infrastructures and intellectual property rights

	GDP (million)	Pop. (thousand)	Trials (ICTRP)	Trials per 1 mill.	Trials (ct.gov)	Patent apps	Patent apps per 1 mill.
Algeria	159,049	40,606	165	4.06	95	106	2.61
Angola	95,335	28,813	16	0.56	3	-	-
Benin	8,583	10,872	54	4.97	38	-	-
Botswana	15,581	2,250	93	41.33	64	1	0.44
Burkina Faso	11,693	18,646	186	9.98	126	2	0.11
Burundi	3,007	10,524	19	1.81	11	-	-
Cameroon	32,218	23,439	113	4.82	68	-	-
Cape Verde	1,617	540	0	0.00	0	-	-
Central African Republic	1,756	4,595	13	2.83	6	-	-
Chad	9,601	14,453	12	0.83	7	-	-
Comoros	617	796	3	3.77	1	-	-
Democratic Republic of the Congo	35,382	78,736	87	1.10	55	-	-
Djibouti	1,727	942	4	4.24	1	1	1.06
Egypt	332,791	95,689	3,711	38.78	2,409	918	9.59
Equatorial Guinea	10,685	1,221	6	4.91	3	-	-
Eritrea	2,608	4,475	6	1.34	0	-	-
Ethiopia	72,374	102,403	188	1.84	124	12	0.12
Gabon	14,214	1,980	63	31.82	44	-	-
Gambia	965	2,039	119	58.38	67	-	-
Ghana	42,690	28,207	238	8.44	137	14	0.50
Guinea	8,200	12,396	31	2.50	20	-	-
Guinea-Bissau	1,165	1,816	62	34.15	51	-	-
Ivory Coast	36,373	23,696	72	3.04	39	26	1.10

Table 2: Clinical trial infrastructures and intellectual property rights

	GDP (million)	Pop. (thousand)	Trials (ICTRP)	Trials per 1 mill.	Trials (ct.gov)	Patent apps	Patent apps per 1 mill.
Kenya	70,529	48,462	639	13.19	417	144	2.97
Lesotho	2,291	2,204	22	9.98	16	-	-
Liberia	2,101	4,614	25	5.42	16	-	-
Libya	34,699	6,293	19	3.02	6	-	-
Madagascar	10,001	24,895	27	1.08	15	6	0.24
Malawi	5,433	18,092	317	17.52	201	3	0.17
Mali	14,035	17,995	170	9.45	128	-	-
Mauritania	4,739	4,301	10	2.33	1	-	-
Mauritius	12,168	1,263	34	26.91	20	2	1.58
Morocco	103,606	35,277	191	5.41	96	237	6.72
Mozambique	11,015	28,829	97	3.36	68	15	0.52
Namibia	10,948	2,480	7	2.82	3	-	-
Niger	7,528	20,673	34	1.64	26	-	-
Nigeria	404,653	185,990	342	1.84	139	50	0.27
Republic of the Congo	7,834	5,126	52	10.14	37	-	-
Rwanda	8,376	11,918	97	8.14	71	2	0.17
Sao Tome and Principe	343	200	2	10.00	0	-	-
Senegal	14,684	15,412	103	6.68	75	-	-
Seychelles	1,427	95	3	31.69	1	-	-
Sierra Leone	3,737	7,396	39	5.27	17	-	-
Somalia	6,217	14,318	14	0.98	0	-	-
South Africa	295,456	56,015	4,341	77.50	2,505	2,783	49.68
South Sudan	9,015	12,231	2	0.16	0	-	-

Table 2: Clinical trial infrastructures and intellectual property rights

	GDP (million)	Pop. (thousand)	Trials (ICTRP)	Trials per 1 mill.	Trials (ct.gov)	Patent apps	Patent apps per 1 mill.
Sudan	95,584	39,579	71	1.79	34	284	7.18
Swaziland	3,721	1,343	22	16.38	13	-	-
Tanzania	47,340	55,572	433	7.79	290	1	0.02
Togo	4,400	7,606	16	2.10	8	-	-
Tunisia	42,063	11,403	426	37.36	255	235	20.61
Uganda	24,079	41,488	651	15.69	447	16	0.39
Zambia	21,064	16,591	262	15.79	171	14	0.84
Zimbabwe	16,620	16,150	190	11.76	111	8	0.50

Apps, applications; GDP, gross domestic product; ICTRP, International Clinical Trials Registry Platform.

Appendix 2 Table 3: R&D personnel

	GDP (million)	Pop. (thousand)	R&D staff per mill.	Researchers per mill.	Researchers (% M&HS)	Researchers (% PhD)
Algeria	159,049	40,606	220.23	168.02	6.87	16.22
Angola	95,335	28,813	84.15	47.48		20.09
Benin	8,583	10,872	-	-	-	-
Botswana	15,581	2,250	570.35	179.47	18.31	29.37
Burkina Faso	11,693	18,646	131.33	47.58	46.37	41.85
Burundi	3,007	10,524	-	-	-	-
Cameroon	32,218	23,439	-	-	-	-
Cape Verde	1,617	540	72.83	49.21	0.00	72.00
Central African Republic	1,756	4,595	-	-	-	-
Chad	9,601	14,453	75.90	58.33	6.49	29.72
Comoros	617	796	-	-	-	-
Democratic Republic of the Congo	35,382	78,736	19.45	7.23	7.68	11.95
Djibouti	1,727	942	-	-	-	-
Egypt	332,791	95,689	1,208.51	680.30	29.80	55.86
Equatorial Guinea	10,685	1,221	-	-	-	-
Eritrea	2,608	4,475	-	-	-	-
Ethiopia	72,374	102,403	121.21	44.97	12.98	16.66
Gabon	14,214	1,980	-	-	-	-
Gambia	965	2,039	603.31	33.56	40.96	55.63
Ghana	42,690	28,207	122.57	38.37	14.40	34.39
Guinea	8,200	12,396	-	-	-	-
Guinea-Bissau	1,165	1,816	-	-	-	-
Ivory Coast	36,373	23,696	-	69.21	-	-

Table 3: R&D personnel

Country GDP	(million)	Pop. (thousand)	R&D staff per mill.	Researchers per mill.	Researchers (% M&HS)	Researchers (% PhD)
Kenya	70,529	48,462	1,029.40	225.03	25.82	6.07
Lesotho	2,291	2,204	32.90	22.83	0.00	28.06
Liberia	2,101	4,614	-	-	-	-
Libya	34,699	6,293	-	-	-	-
Madagascar	10,001	24,895	113.00	24.70	13.17	46.99
Malawi	5,433	18,092	113.44	48.27	18.99	9.89
Mali	14,035	17,995	73.45	30.79	11.25	61.79
Mauritania	4,739	4,301	-	-	-	-
Mauritius	12,168	1,263	500.18	181.83	6.59	27.58
Morocco	103,606	35,277	1,149.30	1,068.96	9.22	16.24
Mozambique	11,015	28,829	82.83	41.48	11.65	13.99
Namibia	10,948	2,480	235.68	143.32	3.47	21.76
Niger	7,528	20,673	43.69	7.42	-	-
Nigeria	404,653	185,990	77.38	38.77	-	34.11
Republic of the Congo	7,834	5,126	67.27	31.54	-	-
Rwanda	8,376	11,918	-	12.35	-	37.66
Sao Tome and Principe	343	200	-	-	-	-
Senegal	14,684	15,412	622.86	549.32	14.07	38.68
Seychelles	1,427	95	2,028.31	146.49		15.38
Sierra Leone	3,737	7,396	-	-	-	-
Somalia	6,217	14,318	-	-	-	-
South Africa	295,456	56,015	742.51	473.12		35.22
South Sudan	9,015	12,231	-	-	-	-

Table 3: R&D personnel

Country	GDP (million)	Pop. (thousand)	R&D staff per mill.	Researchers per mill.	Researchers (% M&HS)	Researchers (% PhD)
Sudan	95,584	39,579	-	-	-	-
Swaziland	3,721	1,343	308.97	119.14	33.93	24.98
Tanzania	47,340	55,572	38.84	18.34	-	32.78
Togo	4,400	7,606	42.42	31.77	16.11	68.88
Tunisia	42,063	11,403	2,068.71	1,964.97	-	35.07
Uganda	24,079	41,488	41.54	26.47	19.55	30.51
Zambia	21,064	16,591	162.81	40.97	-	-
Zimbabwe	16,620	16,150	118.34	88.72	0.23	13.45

GDP, gross domestic product; M&HS, medical and health sciences; mill., million; pop., population; PhD, doctor of philosophy; R&D, research and development.

All data are from 2016 or most recent year available.

Appendix 2 Table 4: R&D expenditure

Country	GDP (million)	Pop. (thousand)	GERD	GERD (% GDP)	GERD per capita	GERD (M&HS)	GERD per researcher	GERD (M&HS %)
Algeria	159,049	40,606	241,204.78	0.07	7.25	-	43.13	-
Angola	95,335	28,813	-	-	-	-	-	-
Benin	8,583	10,872	-	-	-	-	-	-
Botswana	15,581	2,250	184,247.17	0.54	86.56	23,143.69	482.32	30.04
Burkina Faso	11,693	18,646	65,025.67	0.22	3.70	2,910.88	-	4.48
Burundi	3,007	10,524	8,460.33	0.12	0.94	-	-	-
Cameroon	32,218	23,439	-	-	-	-	-	-
Cape Verde	1,617	540	2,211.43	0.07	4.35		88.46	-
Central African Republic	1,756	4,595	-	-	-	-	-	-
Chad	9,601	14,453	91,046.10	0.32	6.30	14,722.82	108.00	16.17
Comoros	617	796	-	-	-	-	-	-
Democratic Republic of the Congo	35,382	78,736	10,234.03	0.02	0.13	-	18.58	-
Djibouti	1,727	942	-	-	-	-	-	-
Egypt	332,791	95,689	7,562,293.01	0.71	79.03	-	116.17	-
Equatorial Guinea	10,685	1,221	-	-	-	-	-	-
Eritrea	2,608	4,475	-	-	-	-	-	-
Ethiopia	72,374	102,403	787,274.45	0.60	8.30	34,522.66	184.52	15.50
Gabon	14,214	1,980	131,865.44	0.58	83.10	-	-	-
Gambia	965	2,039	3,543.77	0.13	2.03	-	60.47	-
Ghana	42,690	28,207	276,671.79	0.38	11.29	-	294.14	-
Guinea	8,200	12,396	-	-	-	-	-	-
Guinea-Bissau	1,165	1,816	-	-	-	-	-	-
Ivory Coast	36,373	23,696	-	-	-	-	-	-

Table 4: R&D expenditure

Country	GDP (million)	Pop. (thousand)	GERD	GERD (% GDP)	GERD per capita	GERD (M&HS)	GERD per researcher	GERD (M&HS %)
Kenya	70,529	48,462	788,176.89	0.79	19.06	216,530.58	84.70	27.47
Lesotho	2,291	2,204	3,018.33	0.05	1.39	0.00	60.79	0.00
Liberia	2,101	4,614	-	-	-	-	-	-
Libya	34,699	6,293	-	-	-	-	-	-
Madagascar	10,001	24,895	5,626.29	0.01	0.23	768.68	9.15	13.66
Malawi	5,433	18,092						
Mali	14,035	17,995	112,531.28	0.31	6.44	9,256.23	209.22	8.23
Mauritania	4,739	4,301	-	-	-	-	-	-
Mauritius	12,168	1,263	38,856.48	0.18	31.00	1,714.62	170.50	4.41
Morocco	103,606	35,277	1,483,610.29	0.71	45.78		63.73	
Mozambique	11,015	28,829	112,790.11	0.34	4.03	32,234.22	97.08	28.58
Namibia	10,948	2,480	81,658.45	0.34	34.44	1,585.30	240.31	1.94
Niger	7,528	20,673	-	-	-	-	-	-
Nigeria	404,653	185,990	1,374,848.32	0.22	9.39	142,133.56	242.20	10.34
Republic of the Congo	7,834	5,126	-	-	-	-	-	-
Rwanda	8,376	11,918	-	-	-	-	-	-
Sao Tome and Principe	343	200	-	-	-	-	-	-
Senegal	14,684	15,412	275,579.68	0.75	18.40	-	33.50	-
Seychelles	1,427	95	5,961.26	0.22	63.26	-	305.37	-
Sierra Leone	3,737	7,396	-	-	-	-	-	-
Somalia	6,217	14,318	-	-	-	-	-	-
South Africa	295,456	56,015	5,823,288.67	0.80	105.32	905,563.36	222.61	18.19
South Sudan	9,015	12,231	-	-	-	-	-	-

Table 4: R&D expenditure

Country	GDP (million)	Pop. (thousand)	GERD	GERD (% GDP)	GERD per capita	GERD (M&HS)	GERD per researcher	GERD (M&HS %)
Sudan	95,584	39,579	281,296.26	0.30	9.10	-	-	-
Swaziland	3,721	1,343	29,493.90	0.27	22.36	8,923.15	187.68	30.25
Tanzania	47,340	55,572	623,754.21	0.53	12.32	-	671.75	-
Togo	4,400	7,606	27,209.82	0.27	3.76	4,317.74	100.19	15.87
Tunisia	42,063	11,403	794,749.43	0.60	69.70	-	35.47	-
Uganda	24,079	41,488	114,149.62	0.17	2.94	14,811.03	111.06	12.98
Zambia	21,064	16,591	100,756.29	0.28	7.70	-	187.98	-
Zimbabwe	16,620	16,150	-	-	-	-	-	-

GERD, gross expenditure on research and development; GDP, gross domestic product; M&HS, medical and health sciences; pop., population; PhD, doctor of philosophy; R&D, research and development.

All data are from 2016 or most recent year available.

Appendix 2 Table 5: Regulatory capacities

Country	GDP (million)	Pop. (thousand)	Organizations	Legislation	Regulations	Guidelines	NPHI	NEC	IRBs
Algeria	159,049	40,606	1	0	2	0	-	Y	1
Angola	95,335	28,813	-	-	-	-	Y	-	0
Benin	8,583	10,872	0	1	0	0	-	Y	3
Botswana	15,581	2,250	3	2	1	5	-	Y	4
Burkina Faso	11,693	18,646	1	0	2	0	-	Y	4
Burundi	3,007	10,524	-	-	-	-	Y	-	0
Cameroon	32,218	23,439	1	0	1	1	Y	-	8
Cape Verde	1,617	540	-	-	-	-	Y	Y	0
Central African Republic	1,756	4,595	-	-	-	-	-	-	1
Chad	9,601	14,453	-	-	-	-	-	-	0
Comoros	617	796	-	-	-	-	-	-	0
Democratic Republic of the Congo	35,382	78,736	0	1	0	0	-	Y	4
Djibouti	1,727	942	-	-	-	-	-	-	0
Egypt	332,791	95,689	2	1	1	0	-	Y	23
Equatorial Guinea	10,685	1,221	-	-	-	-	-	-	0
Eritrea	2,608	4,475	-	-	-	-	-	-	0
Ethiopia	72,374	102,403	3	1	1	2	Y	Y	7
Gabon	14,214	1,980	-	-	-	-	-	Y	1
Gambia	965	2,039	1	0	0	1	-	Y	1
Ghana	42,690	28,207	1	1	1	4	Y	Y	3
Guinea	8,200	12,396	2	2	1	1	Y	-	0
Guinea-Bissau	1,165	1,816	-	-	-	-	Y	-	0
Ivory Coast	36,373	23,696	1	0	1	0	Y	Y	1

Table 5: Regulatory capacities

Country	GDP (million)	Pop. (thousand)	Organizations	Legislation	Regulations	Guidelines	NPHI	NEC	IRBs
Kenya	70,529	48,462	4	3	2	2	Y	-	4
Lesotho	2,291	2,204	-	-	-	-	-	-	1
Liberia	2,101	4,614	2	0	2	1	Y	-	2
Libya	34,699	6,293	-	-	-	-	Y	-	1
Madagascar	10,001	24,895	0	1	0	0	Y	Y	2
Malawi	5,433	18,092	8	5	2	8	Y	Y	2
Mali	14,035	17,995	1	1	0	0	-	Y	1
Mauritania	4,739	4,301	-	-	-	-	-	-	0
Mauritius	12,168	1,263	-	-	-	-	-	Y	2
Morocco	103,606	35,277	-	-	-	-	Y	-	2
Mozambique	11,015	28,829	0	0	0	1	Y	-	0
Namibia	10,948	2,480	-	-	-	-	-	-	1
Niger	7,528	20,673	-	-	-	-	-	-	1
Nigeria	404,653	185,990	5	2	0	6	Y	Y	26
Republic of the Congo	7,834	5,126	-	-	-	-	-	Y	2
Rwanda	8,376	11,918	1	0	0	1	Y	Y	3
Sao Tome and Principe	343	200	-	-	-	-	Y	-	0
Senegal	14,684	15,412	1	1	0	0	-	Y	2
Seychelles	1,427	95	-	-	-	-	-	-	0
Sierra Leone	3,737	7,396	3	0	3	3	Y	-	0
Somalia	6,217	14,318	-	-	-	-	Y	-	0
South Africa	295,456	56,015	11	5	7	9	Y	Y	30
South Sudan	9,015	12,231	-	-	-	-	-	-	0

Table 5: Regulatory capacities

Country	GDP (million)	Pop. (thousand)	Organizations	Legislation	Regulations	Guidelines	NPHI	NEC	IRBs
Sudan	95,584	39,579	5	3	0	4	Y	Y	7
Swaziland	3,721	1,343	-	-	-	-	-	-	0
Tanzania	47,340	55,572	5	5	3	3	Y	-	5
Togo	4,400	7,606	2	0	1	2	Y	Y	1
Tunisia	42,063	11,403	-	-	-	-	-	Y	2
Uganda	24,079	41,488	2	2	0	1	Y	Y	9
Zambia	21,064	16,591	2	3	0	1	Y	-	3
Zimbabwe	16,620	16,150	5	6	3	4	-	-	3

GDP, gross domestic product; IRB, institutional review board; NEC, national ethics committee NPHI, national public health institute; pop., population.

Appendix 2 Table 6: Funding

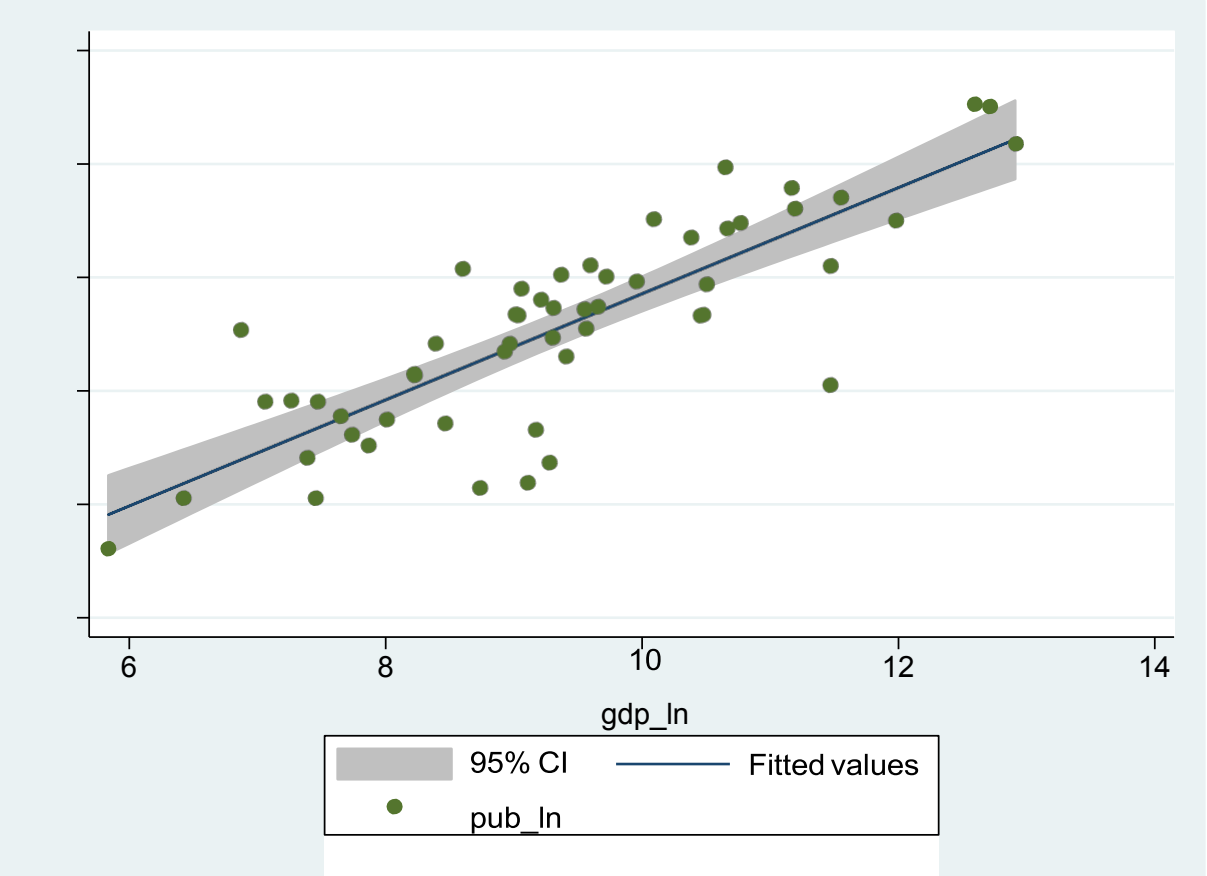
Country	WT	MRC	NIH	CIHR	NHMRC	INSERM	DFG	HHMI	EC	CDMRP
Algeria	-	-		-	-	-	-	-	1,568,955.24	-
Benin	-	-	1,446,653.00	-	-	-	-	-	-	-
Botswana	184,186.00	-	7,356,998.00	-	-	-	-	-	-	-
Burkina Faso	39,300.00	-		-	-	-	-	-	-	-
Cameroon	133,593.80	-		-	-	-	-	-	2,315,190.99	-
Ivory Coast	9,177,381.85	-		-	-	-	-	-	-	-
Democratic Republic of the Congo	0.00	-	451,242.00	-	-	-	-	-	-	-
Egypt	0.00	-	384,112.00	-	-	-	-	-	5,710,715.90	-
Ethiopia	0.00	156,726.38	4,045,740.00	-	-	-	-	-	-	-
Gambia	2,201,155.01	93,350,867.24	220,300.00	-	-	-	-	-	-	-
Ghana	6,802,150.11	-	19,915,940.00	-	-	-	-	-	17,641.05	-
Kenya	120,959,548.23	762,618.20	23,965,606.00	-	-	-	-	-	2,532,293.26	-
Libya	-	-	-	-	-	-	-	-	694,291.15	
Madagascar	0.00	-	269,867.00	-	-	-	-	-	-	-
Malawi	8,620,144.53	-	3,239,240.00	-	-	-	-	-	-	-
Mali	1,317,039.94	-	7,315,257.00	-	-	-	-	-	-	-
Morocco	-	-	-	-	-	-	-	-	3,357,582.35	
Mozambique	0.00	-	14,014,017.00	-	-	-	-	-	-	-
Namibia	0.00	-		-	-	-	-	-	-	-
Nigeria	1,002,984.47	-	34,273,898.00	-	-	-	-	-	17,641.05	-
Rwanda	0.00	-	1,539,861.00	-	-	-	-	-	-	-
Senegal	1,373,601.81	1,720,283.81	-	-	-	-	-	-	21,006.48	-
South Africa	77,994,865.15	13,302,915.07	388,950,849.00	-	-	-	-	-	2,513,725.77	-
Sudan	0.00	-	-	-	-	-	-	-	-	-
Tanzania	16,673,318.44	-	4,764,355.00	-	-	-	-	-	-	-
Tunisia	0.00	-	2,178,511.00	-	-	-	-	-	7,307,461.63	-
Uganda	17,943,085.72	40,607,133.72	35,999,665.00	-	-	-	-	-	17,641.05	-

Table 6: Funding

Country	WT	MRC	NIH	CIHR	NHMRC	INSERM	DFG	HHMI	EC	CDMRP
Zambia	15,720.00	-	13,073,179.00	-	-	-	-	-	-	-
Zimbabwe	1,389,486.87	-	21,663,497.00	-	-	-	-	-	-	-

CIHR, Canadian Institutes of Health Research; CDMRP, Congressional Directed Medical Research Programs (Department of Defence); DFG, German Research Foundation (Deutsche Forschungsgemeinschaft); EC, European Commission; HHMI, Howard Hughes Medical Institute; INSERM, Institut national de la santé et de la recherche médicale; MRC, Medical Research Council; NHMRC, National health and Medical Research Council; NIH, National Institutes of Health; WT, Wellcome Trust

*Cells for CIHR, NHMRC, INSERM, HHMI, CDMRP, DFG are empty because data did not meet inclusion criteria. We excluded funding for research projects in which the principal investigators were based at non-African institutions, even if these projects included collaborators, field sites, or locations of research in Africa.



Appendix 2 Figure 1. The relationship between gross domestic product and publications

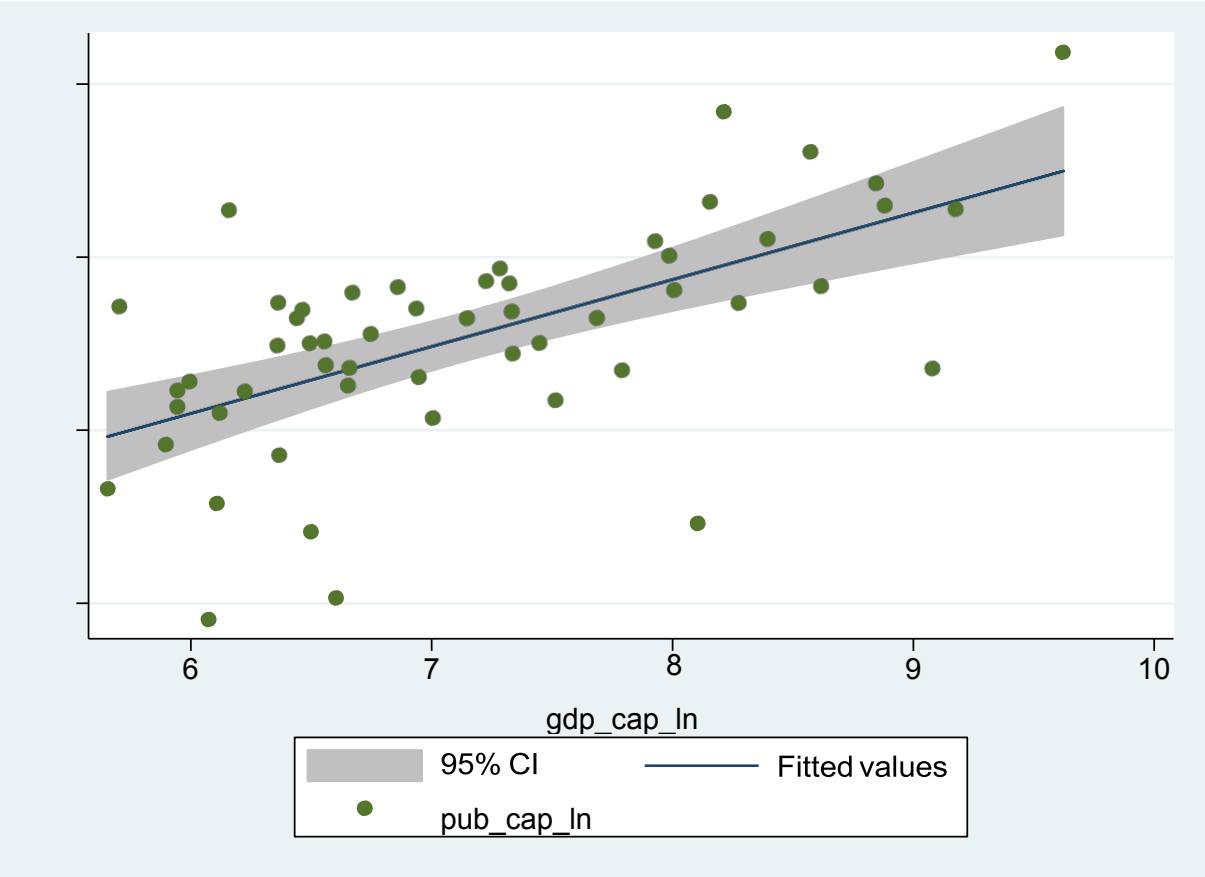
Note: Both variables are expressed as natural logs.

Appendix 2 Table 7. Regression summary for gross domestic product and number of publications

	(1) pub_ln
gdp_ln	0.934***
	(10.52)
Constant	−1.630
	(−1.93)
Observations	54
R^2	0.680
Adjusted R^2	0.674

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$



Appendix 2 Figure 2. The relationship between gross domestic product per capita and publications per capita

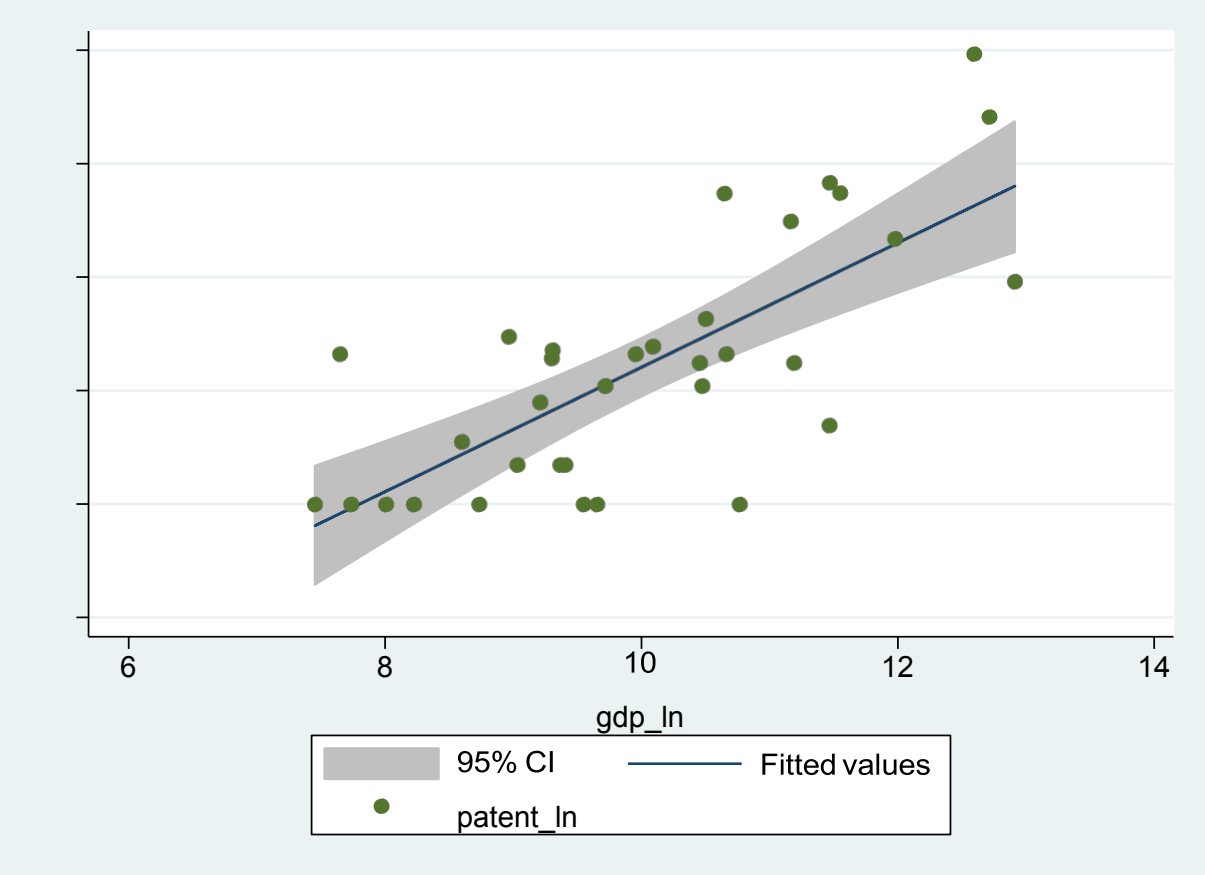
Note: Both variables are expressed as natural logs.

Appendix 2 Table 8. Regression summary for gross domestic product per capita and the number of publications per capita

	(1) pub_cap_ln
gdp_cap_ln	0.771***
	(5.56)
Constant	−14.42***
	(−14.39)
Observations	54
R^2	0.373
Adjusted R^2	0.361

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$



Appendix 2 Figure 3. The relationship between gross domestic product and patent applications

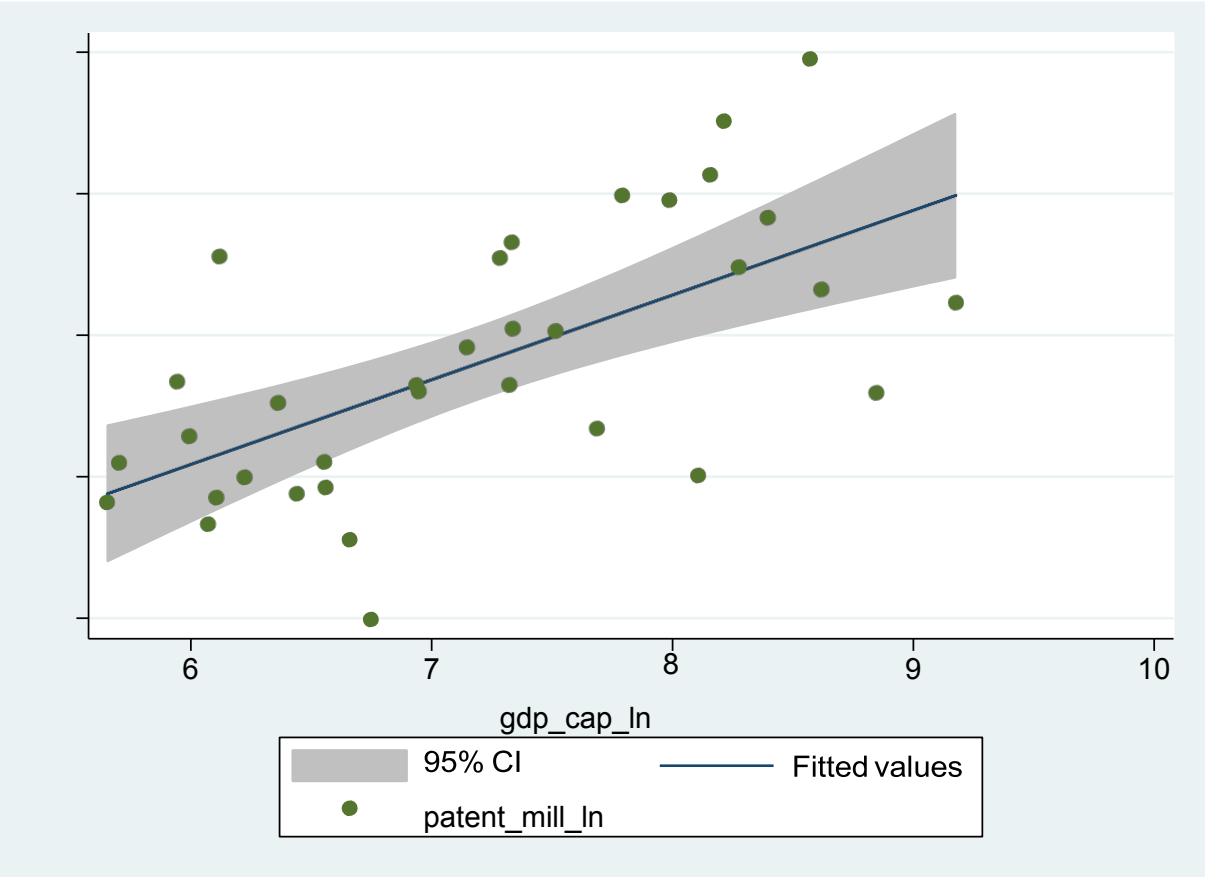
Note: Both variables are expressed as natural logs.

Appendix 2 Table 9. Regression summary for gross domestic product and patent applications

	(1) patent_ln
gdp_ln	1.093***
	(6.27)
Constant	−8.519***
	(−4.83)
Observations	34
R^2	0.551
Adjusted R^2	0.537

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$



Appendix 2 Figure 4. The relationship between gross domestic product per capita and patent applications per capita

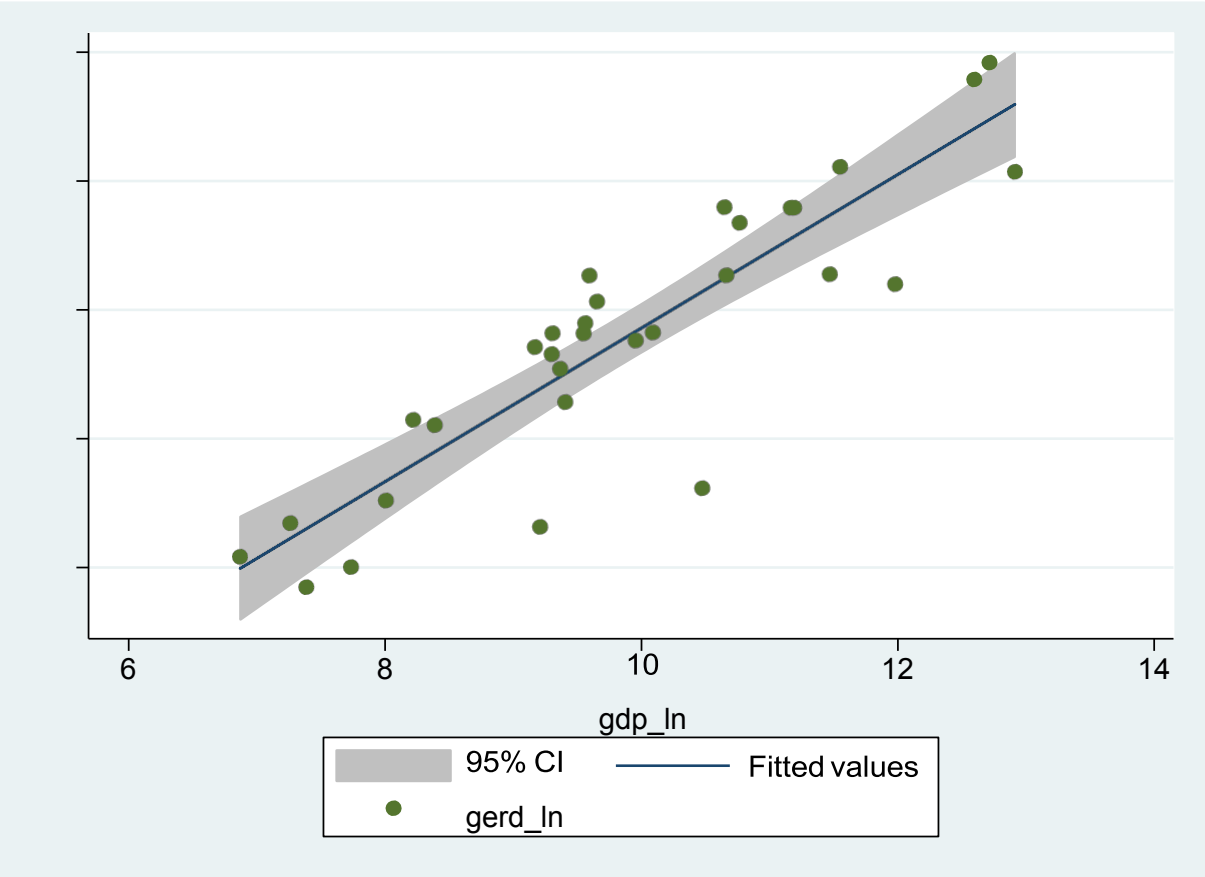
Note: Both variables are expressed as natural logs.

Appendix 2 Table 10. Regression summary for gross domestic product per capita and patent applications per capita

	(1) patent_mill_ln
gdp_cap_ln	1.196***
	(4.65)
Constant	−8.996***
	(−4.81)
Observations	34
R^2	0.403
Adjusted R^2	0.384

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$



Appendix 2 Figure 5. The relationship between gross domestic product and GERD

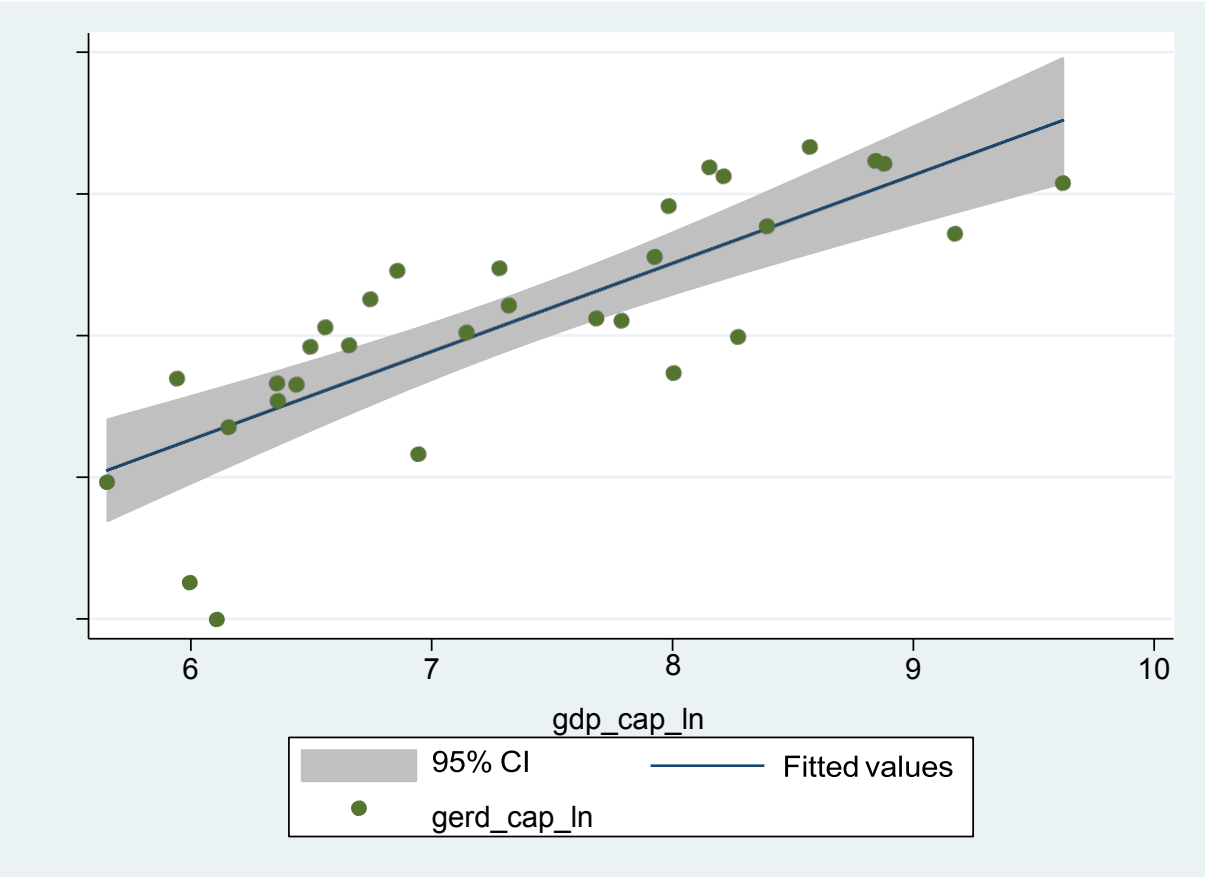
Note: Both variables are expressed as natural logs.

Appendix 2 Table 11. Regression summary for gross domestic product and GERD

	(1) gerd_ln
gdp_ln	1.190*** (10.38)
Constant	−0.188 (−0.16)
Observations	31
R^2	0.788
Adjusted R^2	0.781

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$



Appendix 2 Figure 6. The relationship between gross domestic product per capita and GERD per capita

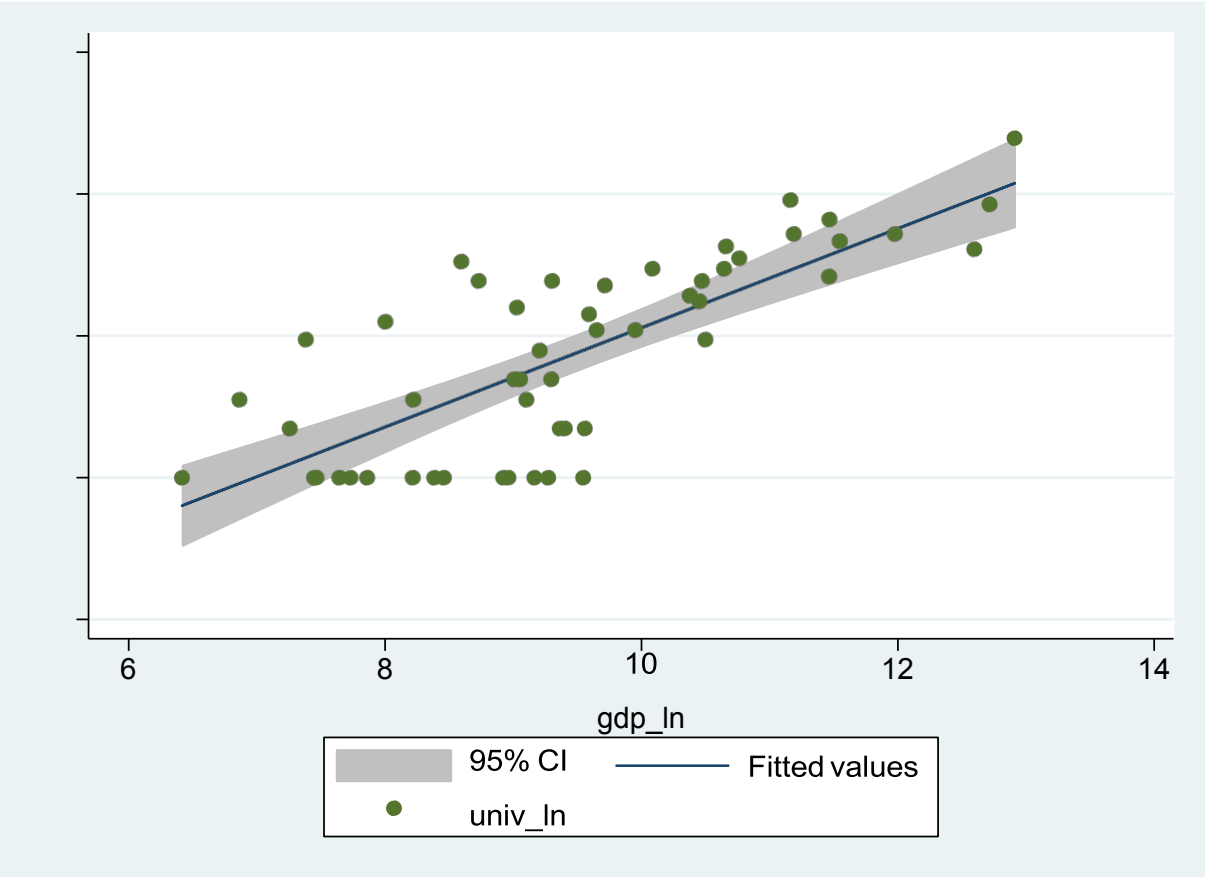
Note: Both variables are expressed as natural logs.

Appendix 2Table 12. Regression summary for gross domestic product per capita and GERD per capita

	(1) gerd_cap_ln
gdp_cap_ln	1.244*** (7.17)
Constant	−6.935*** (−5.37)
Observations	31
R^2	0.639
Adjusted R^2	0.627

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$



Appendix 2 Figure 7. The relationship between gross domestic product and universities

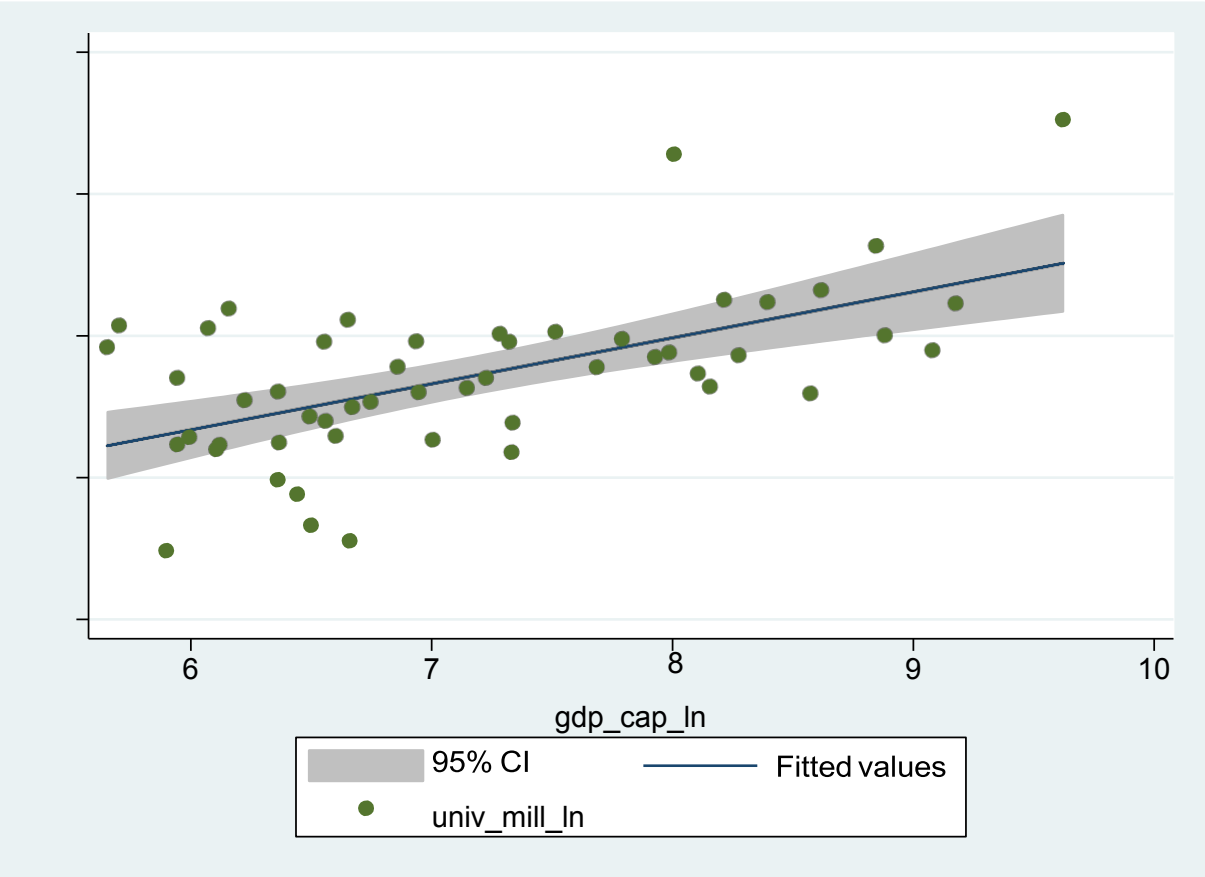
Note: Both variables are expressed as natural logs.

Appendix 2 Table 13. Regression summary for gross domestic product and universities

	(1) univ_ln
gdp_ln	0.700***
	(8.55)
Constant	−4.893***
	(−6.22)
Observations	52
R^2	0.594
Adjusted R^2	0.586

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$



Appendix 2 Figure 8. The relationship between gross domestic product per capita and universities per capita

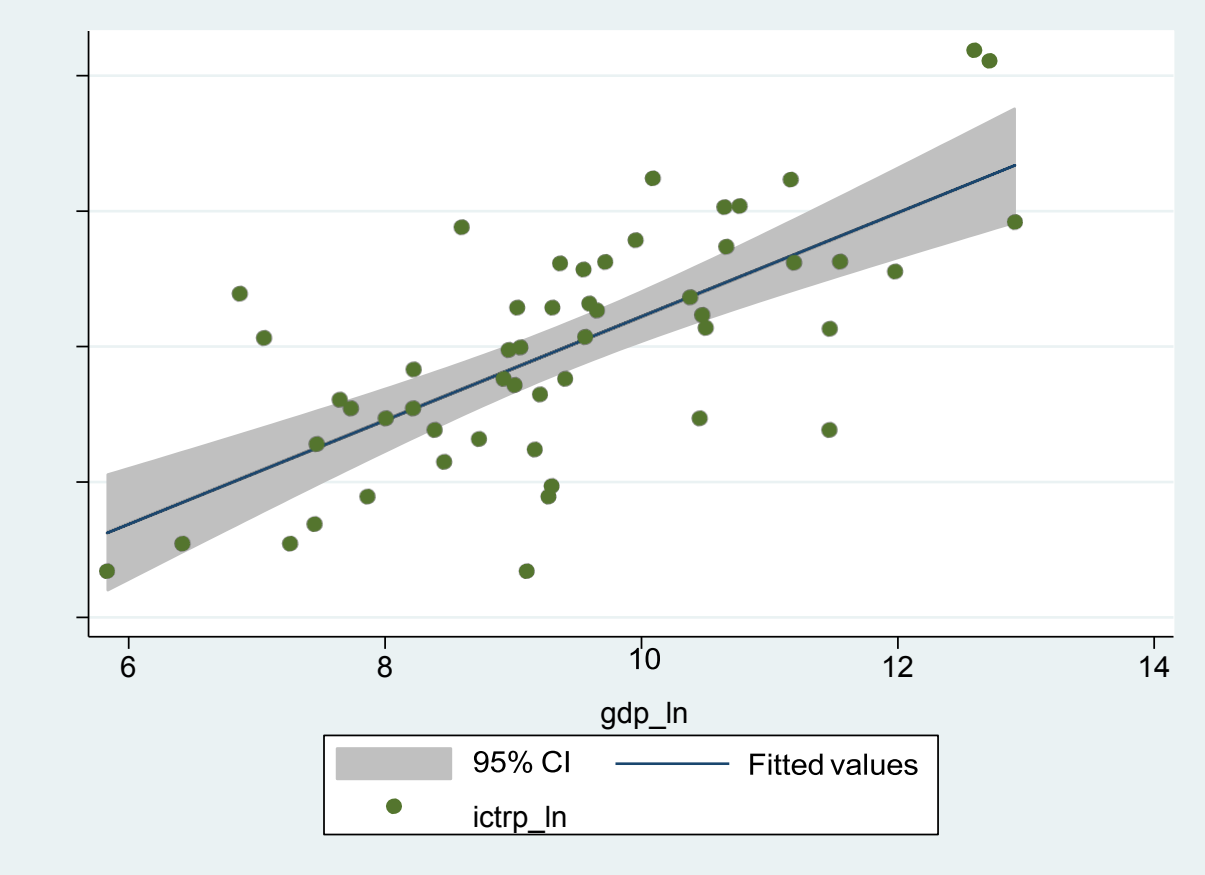
Note: Both variables are expressed as natural logs.

Appendix 2 Table 14. Regression summary for gross domestic product per capita and universities per capita

	(1) univ_mill_ln
gdp_cap_ln	0.648***
	(5.06)
Constant	−5.207***
	(−5.62)
Observations	52
R^2	0.339
Adjusted R^2	0.326

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$



Appendix 2 Figure 9. The relationship between gross domestic product and clinical trials

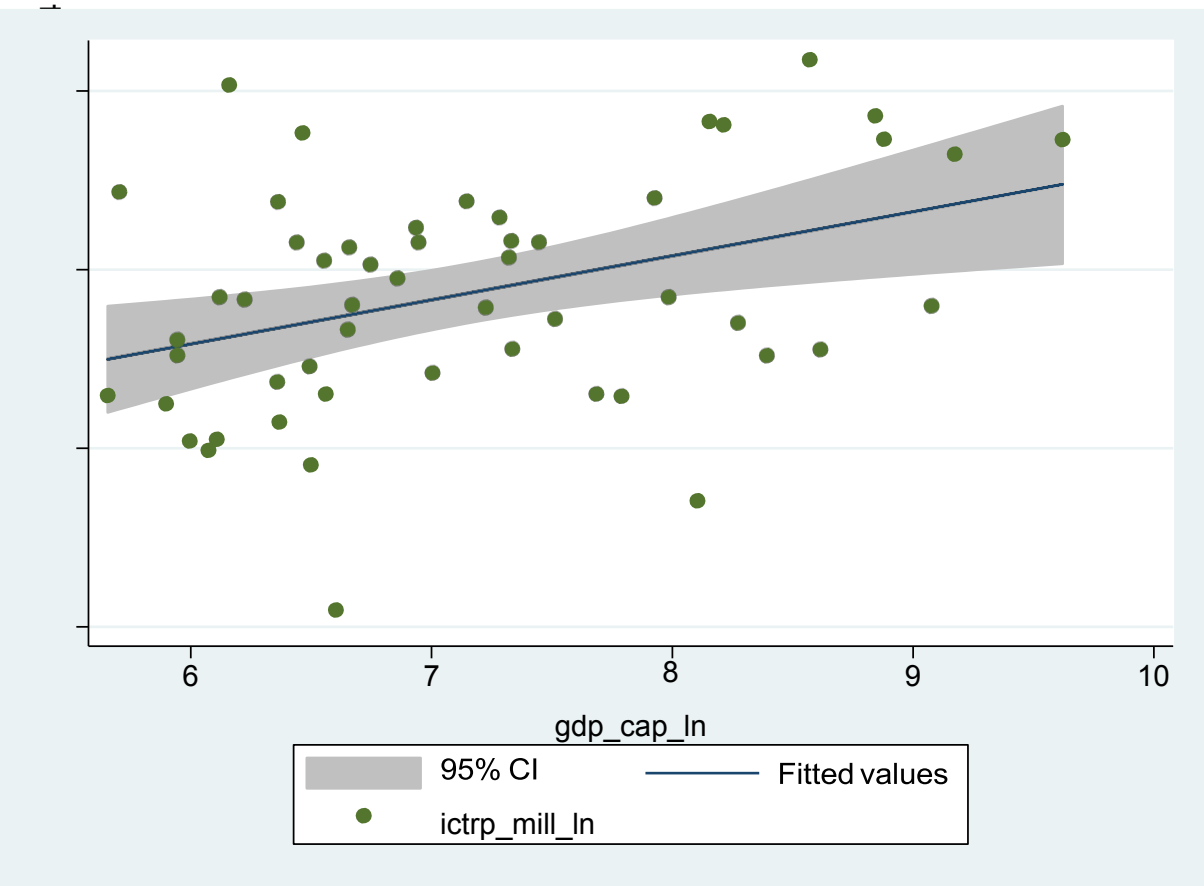
Note: Both variables are expressed as natural logs.

Appendix 2 Table 15. Regression summary for gross domestic product and clinical trials

	(1) ictrp_ln
gdp_ln	0.765***
	(7.03)
Constant	−3.212**
	(−3.09)
Observations	53
R^2	0.492
Adjusted R^2	0.482

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$



Appendix 2 Figure 10. The relationship between gross domestic product per capita and clinical trials per capita

Note: Both variables are expressed as natural logs.

Appendix 2Table 16. Regression summary for gross domestic product per capita and clinical trials per capita

	(1) ictrp_mill_ ln
gdp_cap_ln	0.492** (2.98)
Constant	−1.789 (-1.50)
Observations	53
R^2	0.149
Adjusted R^2	0.132

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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