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African Health Research Innovation and Development Alliance

A REVIEW OF THE CAPACITY TO CONDUCT HEALTH RESEARCH, DEVELOPMENT AND INNOVATION IN AFRICA

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Strengthening Africa's Health Technologies Advocacy Coalition

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Health R&D for Better Health

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LIST OF ACRONYMS

AAS	African Academy of Sciences
AMA	African Medicines Agency
AHS	Africa Health Strategy
ALIMA	Alliance for International Medical Action
AMPATH	Academic Model Providing Access to Healthcare
AMR	Antimicrobial Resistance
AMRH	African Medicines Regulatory Harmonization
ANDI	African Network for Drugs and Diagnostics Innovation
ASRT	Egyptian Academy of Scientific Research and Technology
AUC	African Union Commission
AU	Africa Union
AUDA-NEPAD	African Union Development Agency-New Partnership for Africa's Development
AVMA	African Vaccine Manufacturing Accelerator
AWARD	Women in Agricultural Research and Development
BHSS	Basic Health Services Scheme
BMGF	Bill and Melinda Gates Foundation
CHIVPR	Centre for HIV and AIDS Prevention and Research
CIFAR	Canadian Institute for Advanced Research
CSIR	Council for Scientific and Industrial Research
COHRED	Council on Health Research for Development
CORAL	Clinical and Operational Research Alliance
CPT	Chemical Process Technologies
DSI	Department of Science and Innovation
EDCTP	European and Developing Countries Clinical Trials Partnership
EDA	Egyptian Drug Authority
EBRIN	Egyptian Biomedical Research and Innovation Network
EAKI	East African Kidney Institute
FDA	Food and Drugs Administration
FOIA	Freedom of Information Act
GSHRH	Global Strategy on Human Resources for Health: Workforce 2030
GHiGS	Global Health in the Global South
GC	Africa Grand Challenges Africa

GERD	Gross Domestic Expenditure on Research and Development
GHIA	Global Health Innovation Accelerator
GDP	Gross Domestic Product
GAVI	Global Alliance on Vaccines and Immunization
HRD &I	Health Research, Development and Innovation
H3	Africa Human Heredity and Health in Africa Consortium
H3D	Holistic Drug Discovery and Development
HRISA	Health Research and Innovation Strategy for Africa
ICT	Information and Communication Technology
IVDs	In Vitro Diagnostics
IRBs	Institutional Review Boards
KEMRI	Kenya Medical Research Institute
KIP-PRA	Kenya Institute for Public Policy Research and Analysis
LMICs	Low- and middle-income countries
MEPI	African Institutions Initiative, the Medical Education Partnership Initiative
ML3	Maturity Level 3
MMM	Mwele Malecela Mentorship
MOU	Memorandum of Understanding
NACOSTI	National Commission for Science, Technology and Innovation
NCDs	Non-Communicable Diseases
NCI	National Cancer Institute
NDP	National Development Plan
NHI	National Health Insurance
NHRA	National Health Research Authority
NHRC	National Health Research Council
NHRS	National Health Research Systems
NRC	National Research Centre
NRF	National Research Foundation
NSTC	National Science and Technology Council
PACCI	Franco-Ivorian Research Program
PPB	Pharmacy and Poisons Board
RCC	Regional Collaborating Centre
REC	Regional Economic Communities
R&I	Research and Innovation
SAHPRA	South African Health Products Regulatory Authority

SAMRC	South African Medical Research Council
SANTHE	Sub-Saharan African Network for TB/HIV Research Excellence
SDGs	Sustainable Development Goals
SFA	Science for Africa Foundation
STEM	Science, Technology, Engineering, and Mathematics
STI	Science, Technology, and Innovation
STISA	Science, Technology, and Innovation Strategy (2024)
TIA	Technology Innovation Agency
TNIMR	Tanzania National Institute for Medical Research
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNITID	University of Nairobi Institute of Tropical and Infectious Diseases
WEF	World Economic Forum
WGHLF	Women in Global Health Leadership Fellowship Program
WHO	World Health Organization
WHO-AFRO	World Health Organization Regional Office for Africa
ZAMFOHR	Zambia Forum for Health Research

EXECUTIVE SUMMARY

Africa contributes about 25% of the global disease burden, which includes both communicable and non-communicable diseases, yet Africa accounts only about 2-3% of clinical trials take place on the continent. Africa lags far behind: For example, with only 20 health researchers per million people, the continent's ratio is the lowest in the world (*Europe has 246 researchers per million*).

The continent has several initiatives aimed at improving its capacity to conduct health research, development, and innovation. Whilst there are several great initiatives, there is a lot of room to improve the coordination of these initiatives and the African Union and its agencies are well-positioned to lead capacity building on health research, development, and innovation initiatives on the continent due to their continental mandate, ability to facilitate collaboration between different stakeholders and governments, the 'licence' to operate in all 55 African Union Commission (AUC) Member States, commitment to policy development, and focus on capacity building and health security. Their leadership can help address the unique health challenges faced by African countries and promote sustainable health development.

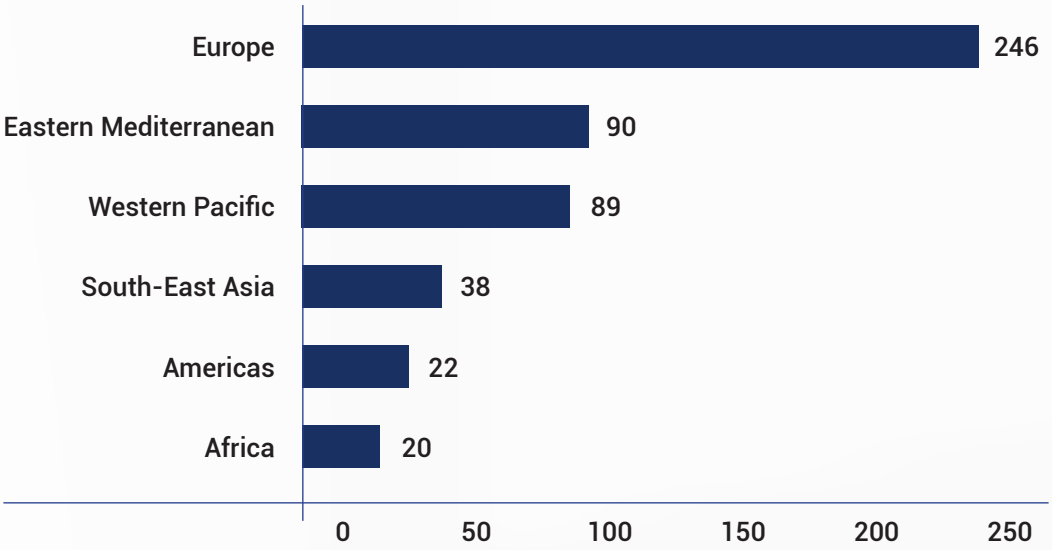
The AUC serves as a continental body that fosters unity and cooperation among African. Its mandate encompasses health and development, making it a natural leader in coordinating health initiatives across the continent. The AUC already facilitates collaboration among member states, enabling the sharing of resources, knowledge, and best practices. This regional integration is crucial for addressing health challenges that transcend national borders. Further, the AU has established partnerships with international organizations, research institutions, and funding agencies. These collaborations enhance coordination, resource mobilization and provide access to technical expertise and funding for health research initiatives.

The capacity to conduct health research, development, and innovation in Africa is hindered by several factors including:

- **Infrastructure Deficiencies:** Many African countries lack adequate research facilities, laboratories, and technology, which hampers the ability to conduct high-quality research.
- **Funding Limitations:** There is often insufficient funding for health research, both from government sources and private investments. This limits the scope and scale of research initiatives.
- **Human Resource Challenges:** A shortage of trained researchers and healthcare professionals impedes the growth of health research capabilities. Many skilled individuals migrate to other countries for better opportunities and many early-career post-doctoral African researchers cannot access training for essential technical, leadership and transferrable skills that will empower them to develop their own ideas enriched by indigenous knowledge and prevailing local health needs, into compelling fundable research proposals. They also lack access to experienced mentors, research centres of excellence, research networks and international collaborative research programmes. In addition to these challenges, francophone, lusophone and other researchers who speak the plethora of different languages used on the continent must also grapple with the fact that most African research published internationally is in English.

Health researchers by WHO region

(FTE per million inhabitants) *Based on 82 countries*



Source: Carlos Rivero (https://africaresearchexcellencefund.org.uk/) 2024.

- **Gender Imbalance:** African women research scientists also face gender inequality issues in the research arena. Gender imbalance, cultural expectations and lack of senior women to act as role models and mentors have all been identified as challenges to gender equality in African research institutions, which is affecting women researchers' research and innovation (R&I) output (such as publications, patents and citations).
- **Regulatory Barriers:** Complex and varying regulatory frameworks across countries can hinder collaborative research efforts and slow down the approval processes for research projects.
- **Data Collection and Management Issues:** Inconsistent data collection methods and poor data management systems limit the ability to generate reliable evidence for health interventions.
- **Collaboration and Networking:** There is often a lack of effective networking and collaboration among researchers, institutions, and international partners, which can reduce the impact and visibility of African research.
- **Public and Private Sector Engagement:** Insufficient engagement between the public health sector and private industries limits innovation and the translation of research findings into practical applications.
- **Focus on Communicable Diseases:** While there is significant research on communicable diseases, less attention is given to non-communicable diseases and mental health issues, leading to an imbalanced health research agenda.
- **Ethical Considerations:** There are ongoing challenges related to ethical standards in research, including participant consent and the equitable distribution of research benefits.

To effectively develop capacity for health research, development and innovation, the following solutions are essential for the African continent:

- **Increased Funding:** Mobilizing financial resources from governments, international organizations, and private sectors is crucial. This includes establishing dedicated funds for health research and incentivizing investments in innovation.
- **Fostering Collaboration:** Encouraging partnerships among African countries, as well as between African researchers and international institutions, can promote knowledge sharing and resource pooling. Initiatives aimed at capacity building and knowledge sharing, such as Grand Challenges Africa, African Clinical Trials Ecosystem, the African STARS Fellowship Programme and others need to be coordinated and supported.
- **Training and Retaining Talent:** Implementing training programs for researchers, healthcare professionals, and technicians will enhance skills and knowledge. Strategies to retain talent within the continent, such as offering competitive salaries and career advancement opportunities, are also vital. Examples of Africa's capacity building initiatives for health research, development, and innovation include: the Human Heredity and Health in Africa (H3Africa) consortium, the Sub-Saharan African Network for TB/HIV Research Excellence (SANTHE), the African Institutions Initiative, the Medical Education Partnership Initiative (MEPI), Grand Challenges Africa, African Clinical Trials Ecosystem, The African STARS Fellowship Programme and initiatives focused on strengthening regulatory systems like the African Medicines Regulatory Harmonisation (AMRH) under the African Union
- **Strengthening Research Infrastructure:** Developing and upgrading research facilities, laboratories, and technological resources is essential to support high-quality health research
- **Developing Regulatory Frameworks:** Streamlining and harmonizing regulatory processes for conducting research can facilitate faster approvals and promote ethical standards in health research.
- **Promoting Public-Private Partnerships:** Engaging the private sector in health research and innovation can stimulate investment and drive the development of new health technologies and interventions.
- **Leveraging Technology:** Utilizing digital health technologies, telemedicine, and data analytics can improve research efficiency and accessibility, particularly in remote areas.

By implementing these solutions, Africa can enhance its capacity for health research, development, and innovation, ultimately improving health outcomes and contributing to global health security.

1. INTRODUCTION

Africa is the world's second-most populous continent, home to approximately 1.4 billion people as of 2025, representing about 18.3% of the global population (**worldometer.com**). The continent is experiencing rapid population growth, with projections showing that it will double by 2050, adding 1.2 billion people to the current population. Africa carries a disproportionate share of the world's global burden of disease, estimated at 25%. The continent is currently grappling with a triple burden of communicable diseases, non-communicable diseases (NCDs), and injuries and trauma. The health challenges faced by the African continent are diverse, complex and massive. Whilst the continent through diverse stakeholders continues to implement several strategies and policies to address the health challenges, there is a glaring need for robust health research, development, and innovation (HRD&I) capacities.

Africa faces unique public health challenges that require tailored solutions driven by research, development and innovation. However, the continent's capacity to conduct health research, development, and innovation remains underdeveloped, hindered by limited resources, shortage of skilled researchers, scientists, insufficient funding, and fragmented collaborations. In many sub-Saharan African countries, there is a non-conducive environment for research: the legislative framework has not kept pace with new trends in research, such as genetics research, ethical conduct of clinical trials, material exchange, artificial intelligence, and intellectual property rights. These legislative gaps hamper multi-institutional research such as clinical trials. Building the necessary capacity to conduct HRD&I is critical for developing evidence-based solutions that address Africa's most pressing health issues and contribute to global health knowledge. African governments should recognise that funds allocated for research are a good investment. More appreciation of the benefits of research might lead to greater commitment to providing dedicated funding to national research budgets.

There is an urgent need to increase funding for research in Africa and ensure capacity-building programs. Africa has barely 1% of the world's global research output and averagely contributes about 0.4% of its GDP to research and development. Global standards, such as those set by the United Nations Educational, Scientific and Cultural Organization (UNESCO), recommend that countries should aim to spend at least 2-3% of their GDP on R&D to drive innovation and development. This underinvestment has significant implications for the capacity to conduct health research, technology development, and innovation across the continent. Increasing the percentage of GDP allocated to R&D is considered essential for strengthening scientific and technological advancement, especially in addressing public health challenges.

This report will outline a review aimed at assessing the capacity for Health Research, Development, and Innovation (HRD&I) across African research and academic institutions, with a focus on gender considerations in at least 7 African countries with representation from East, South, West, and North Africa with the intention of strengthening Africa's HRD&I policy landscape, and resource capacity for HRD&I and to accelerate the development of, access to, and uptake of innovations with the highest potential for health impact. The selected countries for the consultancy are South Africa and Zambia in Southern Africa; Kenya and Tanzania in East Africa; and Senegal and Nigeria in West Africa, and Egypt in North Africa.

1.1 Objectives

This review was guided by the following objectives:

1. Identify current gaps in HRD&I capacity across African Countries and propose strategies for addressing these challenges.
2. Document the strengths and best practices that have enabled some African institutions to excel in HRD&I
3. Highlight the importance of building capacity for HRD&I in Africa as a key driver for improving public health outcomes.
4. Identify strategic investments that are essential for developing and sustaining HRD&I capacity, including infrastructure, human capital, and institutional support.
5. Highlight opportunities for collaborations among the research institutions, academic institutions, and industry stakeholders to enhance technical capabilities and innovation potential.
6. Examine the gender disparities in HRD&I capacity, particularly in leadership roles, research output, and access to funding, and propose strategies for gender equity in HRD&I across African countries.
7. Develop a draft roadmap for HRD&I capacity building, focusing on attracting, absorbing, and retaining talent within the continent.

1.2 Methodology

Both a desk review of academic papers and reports; and a survey to confirm some of the patterns identified in the literature review were utilized. The survey sample size was 11 respondents in total. Purposive sampling was used wherein the researcher identified participants based on the judgement of the researcher. These participants were identified and approached at the 2nd Vaccine and Other Health Products Manufacturing Forum for African Union Member States in Cairo. Data was therefore collected between 4th – 10th February 2025 before the survey was closed. While this was not enough time, the quality of the respondents (***in that they are in the field***) helped to validate the study. The data was analysed manually by the researcher. The analysis included identifying key themes from the responses, grouping these accordingly and analysing them as guided by the literature.

1.3 Limitations

Compiling this research came with limitations:

- The unavailability or inaccessibility of reliable data was a limitation. There was general information at times and not enough examples.
- Country specific data was not always available, and when accessed, there were some details that were missing.
- Health Research Development and Innovation (HRD&I) and Research and Development (R&D) are used interchangeably in this study. Where information on HRD&I was unavailable or limited, information on R&D was used.
- The study is made up of information sourced from academic articles, and these did not always share sources or names, therefore, while data sources are in Africa, there were instances where specifics were missing.
- The roadmap is based on the literature review, responses from the survey, and understanding of HRD&I initiatives in the continent. This work would benefit from having a session with relevant professionals to discuss the report and have in-depth interviews to get proposals on how to build on the report recommendations.

2. HEALTH RESEARCH DEVELOPMENT AND INNOVATION IN AFRICA: GAPS

The Abuja Declaration, adopted in 2001 by African Union member states, commits countries to allocate at least 15% of their annual budgets to improve healthcare, whilst United Nations Educational, Scientific and Cultural Organization (UNESCO) advocates for countries to invest 1 -3 percent of their Gross Domestic Product (GDP) towards R&D. Most African countries invest below 1% of their GDP towards R&D (World Economic Forum, 2023). Country commitments towards investments into R&D can significantly support Human Resources for Development and Innovation (HRD&I) in many ways. However, Africa's capacity to conduct health research, development, and innovation (HRD&I) is low due to several factors including lack of adequate funding. There currently exist gaps in health research development and innovation capacities across African countries which hinder health research and development in the continent. These gaps are outlined below:

2.1 Investment

There is only a small amount invested by African countries in health research and development when compared to the rest of the world. African governments invest an average of about 0.5% of their GDP in research and development (R&D) (World Economic Forum, 2023). This figure varies significantly across the continent, with some countries investing more heavily in R&D (such as South Africa, which invests around 0.8% to 1% of its GDP) while others invest much less. Notably, domestic research funding for health was low when compared to GDP, this is despite the World Health Organisation (WHO) recommending that member states invest 2% of total GDP to health research (World Health Organisation, 2023). This means that African governments are not investing enough for the continent to have increased capacity for health research development and innovation.

African governments currently spend $4.5 billion annually in health infrastructure, despite this sector requiring $26 billion in the next decade (African Development Bank, 2022). Further, community health force programs are currently underfunded by $4.4 billion in the continent (Africa CDC, 2023). While the African Vaccine Manufacturing Accelerator (AVMA) has pledged to provide $1 billion towards sustainable vaccine manufacturing in Africa, the African healthcare market is worth $50 billion per year (World Economic Forum, 2024).

2.2 Research Capacity

There is limited capacity for research in Africa when compared to other continents. The continent of Africa is home to 18.3% of the global population that carries 25% of the global disease burden. Yet globally, it accounts for less than 2% of genomic data used in medical innovation and less than 3% of clinical trials. Despite having 18.1% of the world's population, Africa produces less than 1% of the world's research output (Wits University, 2020). This leads to there being a low number of African journals included in international citation databases, resulting in African health sciences research having a low impact when compared to the rest of the world (Selemani et al., 2024; Asubiaro & Onalapo, 2023). Initiatives aid at increasing research capacity need to be increased and coordinated. These include the African Academy of Sciences (AAS)-funded Sub-Saharan African Network for TB/HIV Research Excellence (SANTHE) consortium, Grand Challenges Africa, European and Developing Countries Clinical Trials Partnership (EDCTP), and other similar initiatives.

2.3 Research Output

Africa has a lower research output when compared to other countries. Despite having over 18.3% of the world's population and about a quarter of the global burden of disease, Africa has less than 3% of the world's health care professionals and barely 1% of global research output. Sub-Saharan Africa averagely contributes about 0.4% of its Gross Domestic Product (GDP) to scientific research, while Europe, Asia, and North America contribute about 27%, 31% and 37% respectively to R&D. In 2023 Africa hosted only 819 out of the 20 825 clinical trials held globally, accounting for just 4% of the total and about 2% of genetic data analysed in genomic data globally (World Economic Forum, 2024). Furthermore, only a third of African journals had a Creative Commons license, most journals were not indexed (Agyei et al., 2023). More worrying is that Africa's research and innovation output is only 1 - 2% of the global total (Universities South Africa, 2023). Further compounding this low output, Africa had only contributed 3% to the global COVID-19 publications by the 10th month since the pandemic had been declared (Kana, Laporte & Jaye, 2021).

2.4 Collaboration and research networks

Whilst African scientists tend to collaborate with European and American researchers more than they do with each other, in recent years there are several initiatives that are developing into best practices and encourage inter-continental collaboration amongst researchers. The African STARS Fellowship Program, a structured programmes providing up to 2 years training and fostering partnership with big industry and biotechnology innovation hubs with the ultimate objective to create jobs and retaining African scientist. This is an example of how public sector, private sector and academia are moving together to build capacity in HRD&I.

Collaboration and research networks affected by regulatory dilemmas and cultural barriers (Olatunji et al., 2023). This may in part be caused by limited access to cutting-edge technologies and research infrastructure (Aderinto et al., 2023). International and even regional collaborators may also be deterred by visa application protocols (Gaye et al., 2023). There may also be structural biases in international development research (Mutapi, Banda & Woolhouse, 2023).

2.5 Training

The state of infrastructure and policies for Health Research Development and Innovation (HRD&I) training in Africa varies significantly across countries and regions. While many African countries have universities and vocational training centres, the quality and number of these institutions can be inconsistent. Some countries have well-established institutions, while others struggle with inadequate facilities and resources. Access to modern technology and the internet is uneven. Urban areas may have better access, while rural regions often face significant challenges, limiting participation in online training and digital learning. There is a growing recognition of the importance of collaboration between the public and private sectors in developing country and regional training programs. However, several such partnerships are still in the early stages in many countries.

Currently there are gaps in training in the health research development and innovation field in Africa. These are perpetuated by several factors. There is a low demand for research by policy makers in Africa (Aiyede & Muganda, 2023), this means that there is no support and policy makers do not see the benefit of research. Furthermore, under-resourced educational institutions (Adebisi et al., 2024) mean that research training needs are not met. There are limited opportunities for advanced research training (CARTA, 2024) and this hinders the research output in Africa. Ng'oda et al., (2024) state that health research training is further affected by a lack of motivation and mentors. Given the foregoing, there is a lack of writing skills (NSTF, 2024) which compounds the situation.

2.6 Language

Language causes a gap in health research development and innovation. Many African researchers are not fluent in the English language, which is the dominant language of science globally. This limits the academic careers and the influence of these researchers (Yarmoshuk, 2021). It is also difficult to recruit participants from different linguistic groups, this leads to underrepresentation of linguistic minorities in health research (Heffernan et al., 2023). Ransing et al., (2021) state that translating and validating study tools in local languages can be time-consuming and expensive, it can be especially difficult if the language only exists in verbal form (Ransing et al., 2021). All these factors hinder the health research development and innovation capacity in Africa and need to be addressed if the continent is to improve capacity and make a meaningful contribution to the global health research development and innovation field.

2.7 Regulatory

Regulatory gaps in Health Research Development and Innovation (HRD&I) capacity in Africa include gaps in lack of comprehensive HRD&I policies, inconsistent regulatory standards, underdeveloped regulatory bodies, regulatory lag in Digital Skills Development, and weak intellectual property rights (IPR) framework. Addressing these regulatory gaps is essential for enhancing HRD&I capacity in Africa. Comprehensive, coherent policies, strong institutional frameworks, effective funding mechanisms, and a focus on capacity building and innovation are crucial for fostering a robust HRD&I ecosystem on the continent.

3. HEALTH RESEARCH DEVELOPMENT AND INNOVATION IN AFRICA: OPPORTUNITIES

There are opportunities for African governments to mitigate the gaps which currently exist in health research development and innovation capacities in Africa. These are discussed in the next section.

3.1 Increasing budgetary allocation to health

African governments are not spending enough on health and health research. This is despite these governments committing to set financial spend targets for healthcare and health research. In 2001, African Union (AU) governments adopted the Abuja Declaration, which set a target of allocating at least 15 percent of their national budgets to improve health care (World Health Organisation, 2010). Further, the World Health Organisation encourages African member states to allocate 2% of their total GDP to health research development and innovation (AUDA-NEPAD, 2019). Abubakar et al., (2022) state that there is a need for African governments to establish predetermined health research development and innovation budgets which are legally ring-fenced and are not affected by the electoral cycle. This would ensure sustainable funding which would not be affected by a change in country leadership.

Doherty et al., (2018) state that a study was carried out which established that increasing the tax on tobacco would result in a 4% increase in health sector funding globally. This empirical study supports the assertion that improving tax collection capacity to increase the fiscal space would result in governments having more money to dedicate to health research development and innovation. Qui et al., (2023) assert that improving resource flows to health facilities and improving resource use would be one way in which governments can increase money allocated to health. Lastly, health budgets can be increased by improving health research development and innovation through offering incentives (Garcia-Fontes, 2012). While this study was in the pharmaceutical sector, incentives can be offered in other sectors in the health research development and innovation space.

3.2 Investing in the youthful population

The youth is the future and investing in the youth ensures that there will be continuity. Investing in the youth can be through various ways. One of these ways would be through creating demand-driven jobs which can stimulate investment in training platforms, startup growth, and diagnostics, care, and logistics. Further, African governments can involve the youth in decision-making through initiatives such as including them in the agenda for sustainable development and giving them opportunities to innovate as advocated for by the UN Sustainable goals (Goals 9, 16 & 10) (United Nations, 2023). One of the challenges which cause for there to be a gap in health research development and innovation in Africa is a lack of funding for young researchers. This can be addressed by providing funding for young researchers through creating dedicated funding streams and grants for young researchers (Adebisi et al., 2024). Furthermore, young researchers face a challenge in that there are limited mentors available to groom them in research and to curb this, African governments can ensure that they create platforms for mentoring young researchers through connecting young researchers with established scientists (Mremi et al., 2023).

To retain talent and discourage researchers from leaving and seeking greener pastures in other countries, African governments can develop research career pathways to retain junior researchers in their home countries (Abouzeid et al., 2022). This will ensure that capacity for research is increased and that the research output for Africa is increased. There currently exists a gap in research from Africa, and this is in part due to researchers from other continents coming into Africa to do research without equitably engaging with African researchers and institutions. Although there have been some improvements in recent years, with African universities having student exchange programs with international institutions, more can still be done to improve the situation further and increase the health research output from Africa. Building equitable partnerships with international institutions which would encourage partnering for research collaboration and faculty development (Academy of Medical Sciences, 2012; Monette et al., 2021). There is also a need to enhance and sustain health research development and innovation capacity through continuous monitoring, evaluation, input, refinement, and maintenance (Cerf, 2023). Lastly, African governments can provide access to digital resources especially for the youth (Tan et al., 2024).

3.3 Advocating for political support and commitment

Africa imports for over 75% of pharmaceuticals and 98% of vaccines and this is unsustainable, and a health security risk. Whilst in the past there has been limited political advocacy for HRD&I, the recent occurrence of pandemics such as COVID-19, mpox, Marburg, have seen political support for HRD&I from regional entities including the African Union, Africa CDC, and AUDA-NEPAD. They have convened or have been part of several initiatives which constitute high-level political support and policy advocacy for HRD&I capacity building for the African continent, especially advocating for investment into HRD&I and urging African countries, private sector and donors to collaborate. As a result, there have been initiatives such as the Partnership for African Vaccine Manufacturing (PAVM) which was established by the African Union in 2021, under the Africa Centre for Disease Prevention and Control (CDC) to deliver on the goal of enabling the Africa vaccine manufacturing industry to increase its capacity to meet local demand from its current level of 1% to 60% by 2040. Another show of political support is the appointment by the African Union of President Cyril Ramaphosa of South Africa as a PPPR champion, and President William Ruto as a local manufacturing champion.

There are several platforms that are hosted by Africa CDC on an annual basis which are aimed at providing political support to HRD&I including the 2nd Edition of the Global Event on Harnessing Private Sector Engagement for Sustainable Vaccine and Pharmaceutical Manufacturing in Africa; 2nd Vaccine and Other Health Products Manufacturing Forum for African Union Member States, organised by Africa CDC, Gavi and RVMC, and hosted by the Egyptian United Procurement Authority (UPA), are some examples of how regional entities are strengthening the role of leveraging political will to convene relevant stakeholders to advance HRD&I (https://africacdc.org/news-item/new-dawn-for-health-security-and-sovereignty-in-africa-as-stakeholders-convene-at-manufacturing-forum/).

Support and commitment can be further demonstrated by African governments increasing their allocation of domestic resources to clinical research and further securing additional investments through donor base funding portfolios (CHReaD, 2024). Political leaders are best placed to lead partnerships with key stakeholders to build trust and accelerate research and encourage intra-African research collaborations and funding through leveraging and supporting platforms such as Science for Africa Foundation which encourages and promotes research in Africa. The 'Open Access Partnerships Key to Increasing the Global Impact of African Research' publication by Taylor & Francis, further highlights the importance of establishing partnerships (Taylor & Francis, 2024).

Biovac in South Africa, Biovax in Kenya and Institute Pasture Dakar in Senegal are other examples of government linked institutions that are advancing manufacturing and are working closely with country governments and regional institutions. Political support and commitment can be further demonstrated by developing national sustainability plans which would ensure diversification and increased government budget allocations for research and development (Wiegant, Dewulf & Van Zeben, 2024). Since research happens in communities at times, support and commitment can be demonstrated by ensuring that communities are fairly and transparently engaged in research and innovation. This is essential as investing in local research and development would help to build an environment where African scientists and innovators thrive (Science for Africa Foundation, 2023).

Currently, the gap in research output from Africa is caused by a lack of equitable partnerships with other researchers. One of the ways in which governments can demonstrate support and commitment would be by fair and transparent engagement through ensuring the inclusion and recognition of community researchers in dissemination (Marín-González et al., 2016). Furthermore, the World Health Organisation (WHO) has a Local Production & Assistance Unit (LPA) which was conceptualised in the 1970s to encourage local production and technology transfer by member states. The LPA provides support to member states for local production (WHO, 2024); therefore, African governments can use the support from the LPA to build a commercial sector that will help boost local production and improve universal health research coverage (Koohpayehzadeh et al., 2021). Political support and commitment can be further demonstrated by learning from other countries which make a significant contribution to health research development and innovation (Witter et al., 2019). Especially countries in Europe.

3.4 Fostering research collaborations

Whilst there is still a lot of room for fostering and improving collaborations on HRD&I initiatives in Africa, there are several initiatives that have been implemented over time and have shown promising results. Fostering research collaborations plays a crucial role in enhancing research capacity and addressing health challenges in Africa through innovative and coordinated approaches. While primarily a health agency, Africa Centres for Disease Control and Prevention (Africa CDC) collaborates with various research institutions and networks to promote health research and innovation across the continent. The Africa CDC has established various research collaborations to enhance public health research and innovation across the continent, partnering with regional and international organizations.

The **African Collaborative for Health Research and Development** (ACHRD) is a network which promotes collaborative health research among African researchers, organizations, and institutions, focusing on capacity building and addressing health challenges on the continent.

The **African Network for Drugs and Diagnostics Innovation** (ANDI) fosters partnerships among African researchers, pharmaceutical companies, and health organizations to develop new drugs and diagnostics tailored to diseases prevalent in Africa.

The **African Academy of Sciences** (AAS) supports and promotes collaborative health research across Africa, providing a platform for researchers to share knowledge and resources, and to address critical health issues.

Research collaborations mean that researchers can work together and thus learn from each other. Collaborations also ensure that there is depth in research. African governments can foster research collaborations through creating a conducive policy environment which would require harmonizing legal and regulatory frameworks to support innovation and collaboration (IFPMA, 2024). Further, these governments would need to strengthen intellectual property laws and regulations to protect local innovators and innovations (AUDA-NEPAD, 2023).

Collaborations can be fostered through investing in ensuring that the necessary research infrastructure is in place as well as ensuring institutional strengthening support for the research and development ecosystem (OECD, 2024). African governments can also attract private sector investment through encouraging private sector participation through incentives like tax breaks and startup support. Further, the private sector can also act as information brokers between innovators and industry (Cirera et al., 2020). There exists an opportunity for Africa to increase her research output and one of the ways to do this is by African governments and African institutions of higher learning partnering with international institutions for research collaboration and faculty development (UMN, 2024). The current clinical guidelines mean that Africa hosts clinical trials at stages 3 and 4, missing the opportunity to host these in the early stages. Collaborations would lead to creating clearer and stronger clinical guidelines (World Economic Forum, 2024) and this would ensure that there is increased participation from the continent.

3.5 Investing in infrastructure

Poor or inadequate infrastructure hinders health research development and innovation in Africa. African governments can invest in infrastructure by streamlining regulations to facilitate the discovery and access to safe therapies and vaccines as advocated for by Immunization Agenda 2030 (IA2030, 2024). There also exists an opportunity for African governments to provide incentives for private sector participation in clinical research, this is especially true for pharmaceutical firms (World Economic Forum, 2024). Furthermore, African governments can strengthen specialist innovation centres across Africa to support commercialization and tech transfer (Bolo, 2020). This would also happen through collective efforts to foster collaborations by African governments.

Currently, less than 2% of all venture capital funding is directed at women-led start-ups globally, this figure is even lower for startups that have women CEOs (COGENT, 2022). There exists therefore an opportunity for African governments to seek out and prioritize women-led health tech startups. Lastly, using innovative financing such as a mix of public financing, prepayment mechanisms, and innovative financing to increase investment in health research development and innovation (Nabyong-Orem, 2023) can ensure that African governments invest in infrastructure. Aneibo (2024) asserts that investing in large-scale research facilities with cutting-edge equipment, as well as digital research infrastructure and networks of technologies will help boost health and economic growth.

3.6 Establishing equitable international research partnerships

Equitable partnerships will require early and clear communication about goals and expectations of partnerships and redefining academic careers and priorities. Mentorship programmes and investment in Africa-based researchers and Africa-based development are also necessary for achieving equitable partnerships (Boum et al., 2018; Ng'oda et al., 2024). Ngongalah et al., (2020) conducted an empirical study between 2018 – 2020 in which the effects of mentoring African researchers were investigated. This empirical study supports the assertion that African governments need to invest in mentoring African researchers, including through small research projects. The challenge African researchers are facing is that they do not have the funds that will enable them to be principal researchers in publications. This therefore negatively impacts the research output for the continent (Ger, Lugossy & Petrucka, 2024). To mitigate this, African governments can invest in providing funding for career development, so African researchers can lead global health research. Interestingly, the last twenty years have seen female researchers increase from 29% to 41% and female senior researchers increase from 15% to 27% respectively in the United Kingdom.

This means that there have been strides in gender mainstreaming in the research space (Schemm, 2024). These figures support the assertion that African governments need to prioritize gender mainstreaming and ensure that female researchers can fully contribute to research. There is also an opportunity for African governments to build networks of African research talent, including identifying emerging leaders and incentivizing them to stay in Africa (Jackson et al., 2022).

The H3D Foundation was established to reduce barriers to health innovation and support African Researchers (H3D, 2021). According to the World Economic Forum (WEF), one of the ways to do this is through putting greater energy and resources into public health institutions (WEF, 2022). This supports the assertion that African governments and by extension health research development and innovation capacity would benefit from reducing barriers to health innovation and support African researchers. Lastly, pairing health institutions or medical schools from high-income countries with counterparts in Africa (Olapade-Olaopa et al., 2014; Tsinuel et al., 2016) would also grow health research development and innovation capacity in Africa.

3.7 Leveraging Digital Public Infrastructure and Artificial Intelligence

Africa stands at a critical juncture where the integration of digital public infrastructure and artificial intelligence (AI) can significantly enhance Health Research Development and Innovation (HRD&I) capacity. Here's This can be achieved through **Enhancing Access to Education and Training** with **Digital Learning Platforms**. The proliferation of online learning platforms provides widespread access to quality education and training resources, overcoming geographic and economic barriers.

Public and private sector have an opportunity to drive **Reskilling and Upskilling Initiatives**. As industries evolve with technology, digital public infrastructure can facilitate nationwide reskilling programs, equipping the workforce with the necessary skills for emerging sectors, such as IT, digital marketing, and data analysis.

Academic institutions have an opportunity to incorporate AI in Curricula. Integrating AI concepts into educational programs can prepare students for future job markets while fostering a culture of innovation.

By strategically leveraging digital public infrastructure and AI, Africa can significantly enhance its HRD&I capacity. This approach not only addresses current skills shortages and educational challenges but also positions the continent to thrive in an increasingly digital and interconnected global economy. Policymakers, educational institutions, and industry leaders must collaborate to create an enabling environment that fosters innovation, inclusivity, and sustainable growth in the HRD&I landscape.

4. THE STRENGTHS AND BEST PRACTICES THAT HAVE ENABLED SOME AFRICAN INSTITUTIONS TO EXCEL IN HRD&I

African institutions have demonstrated significant growth in health research, development, and innovation, driven by several key strengths and best practices. These have not only contributed to advancing healthcare on the continent but also positioned African institutions as important players in global health research. Here are some of the strengths and best practices that have enabled their success:

4.1 Strong Collaborative Networks

Through collaborations with international research organizations, universities, and non-governmental organisations, African institutions have seen increased access to funding, shared knowledge, and research resources (Boampong et al., 2024). Regional health networks, such as HIRSA, African Health Research Network (AHRN), and African Academy of Sciences, enable cross-border cooperation. These institutions specifically encourage the pooling resources and expertise to tackle health challenges that affect different countries such as malnutrition, maternal health, and infectious diseases (Mathauer et al., 2020). The Africa-CDC has been instrumental in driving some of these collaborations, especially for African Union (AU) member states, widening the impact.

4.2 Focus on Local Context and Relevance

African researchers are increasingly focusing on diseases that disproportionately affect the continent (Kasprowicz et al., 2020), such as malaria, tuberculosis, HIV/AIDS, and emerging diseases like Ebola and COVID-19. Tailoring research to local health issues ensures that the findings are relevant and directly impacts public health strategies. There has been an emphasis on community-engaged research (CEnR), where local populations are involved in the development of research agendas, implementation, and dissemination (Mthembu, Chimbri & Macherera, 2022). This ensures that research aligns with local health priorities and increases the likelihood of uptake and sustainability. This has been instrumental in raising awareness of and at times treatment for different diseases such as cervical cancer, HIV/AIDS, Ebola virus and the COVID-19 pandemic.

4.3 Capacity Building and Investment in Human Capital

Institutions have placed a strong emphasis on building local research capacity through training programs, PhD programs, and fellowships. Initiatives like the African Institute for Health Research, African Minds and Africa Research Excellence Fund, have contributed to developing a new generation of scientists and health professionals capable of leading high-impact research. By creating specialized research centres and institutes, such as the Kenya Medical Research Institute (KEMRI) or the South African Medical Research Council (SAMRC), and the University of Nairobi Implementation Science Fellowship (Osanjo et al., 2016), African institutions have been able to develop expertise in specific health research areas, including clinical trials (through the Clinical Trials Community Africa Network), epidemiology, and biotechnology.

4.4 Innovation in Health Technologies and Solutions

African institutions have increasingly developed and adopted innovative solutions suited to the region's unique health needs, such as affordable diagnostic tools, vaccines, and medical devices (AfDB, 2014; WEF, 2023). For example, mobile health technology (mHealth) has been used for disease surveillance, patient monitoring, and health education in resource-limited settings (Aboye et al., 2023). Many African countries have integrated indigenous knowledge and traditional medicine into research and healthcare systems. This has led to the discovery of novel therapeutic compounds and health practices rooted in local culture and biodiversity.

4.5 Robust Research Infrastructure

Increasing investments in research infrastructure, including modern laboratories, data management systems, and clinical trial facilities, have bolstered the capacity of African institutions to conduct high-quality research. For example, the African Centre for Disease Control and Prevention (CDC) has established key infrastructure for monitoring and responding to disease outbreaks. The African Development Bank (AfDB) invested $5 billion in health operations and health infrastructure between 1975 – 2020 and although the bank had scaled back on this funding, there were calls to increase it post the COVID-19 pandemic. This saw the bank develop the Strategy for Quality Health Infrastructure in Africa 2022 – 2030, which will guide the investments made in health infrastructure across the continent African (African Development Bank, 2022). The establishment of large health databases (i.e. African Index Medicus, Africa Data Hub and African Journals Online) and surveillance systems has improved the quality of epidemiological research. These systems are critical in tracking diseases, assessing health interventions, and informing public health decisions.

4.6 Policy Support and Government Commitment

Governments have increasingly recognized the importance of health research for achieving sustainable development goals (SDGs). Although many nations in Africa have made progress in implementing SDG No.3, which focusses on ensuring healthy lives and promoting wellbeing for all at all ages; fragmented health systems, frequent disasters and armed conflict threaten this progress (Relief Web, 2024). Policies and funding programs have been put in place to support health innovation and research capacity, such as the African Union's Science, Technology, and Innovation Strategy for Africa. Furthermore, strong ethical and regulatory frameworks, coupled with institutions like national ethics committees and regulatory agencies, ensure that health research is conducted with integrity and in line with international standards.

A study of 35 African countries established that 18 countries had legislation in place to regulate health research while this was lacking in 12 countries. Although some legislation was either grossly outdated or too limiting in scope and some countries had multiple laws; this could be attributed to overlapping mandates of institutions responsible for health research. Furthermore, the study established that health research policies and strategies were in place in 16 and 15 countries, respectively. Research priority lists were available in 25 countries. Ethical committees were present in most countries and these committees also performed scientific review. Research partnership frameworks were available to govern both in-country and north-south research collaboration (Nabyona-Orem, Asami & Makanga, 2021).

4.7 Private Sector and Philanthropic Contributions

Private sector involvement has been key in driving innovation and scaling up successful health interventions (Ebulue, Ebulue & Ekesiobi, 2024). Pharmaceutical companies, biotechnology firms, and technology startups have collaborated with African institutions on product development, clinical trials, and distribution.

These initiatives include the **Science for Africa Foundation, EU Africa Rise, Fondation Merieux** and **BioNTech**, among others. International philanthropic organizations, such as the **Bill & Melinda Gates Foundation** and **Wellcome Trust**, have provided funding for health research and innovations in Africa. These grants have enabled African institutions to undertake high-impact research, especially in infectious disease control.

4.8 Agile Response to Emerging Health Challenges

African institutions have demonstrated the ability to respond quickly and effectively to health crises, such as the Ebola outbreak, COVID-19 pandemic, and the resurgence of malaria (Nnaji et al., 2021). This has been mainly through the interventions of the Africa-CDC as well as implementing the Integrated Disease Surveillance and Response (IDSR) framework. The expertise in disease surveillance, rapid diagnostics, and contact tracing has contributed to managing these outbreaks effectively (Global Health Protection, 2023). This is attributed to interventions such as the Field Epidemiology Training Program (FETP) and strengthening lab diagnostic capacity in labs. African institutions, particularly in the field of infectious diseases, have been instrumental in vaccine development and clinical trials. An example of this is the development of the RTS, S malaria vaccine was a key milestone in African-led research (Ogieuhi et al., 2024).

4.9 Improved Access to Research Funding

Over the years, several African countries and organisations have established dedicated health research funding mechanisms. These include the African Research Excellence Fund (AREF) and the South African National Research Foundation (NRF) among others. It is through these funds that basic and applied health research have been supported (Karamagi et al., 2023). While research is still not equitable in the African context, there have been African researchers who have leveraged global funding opportunities from international donors and research bodies, allowing these to undertake cutting-edge research that aligns with international health priorities while also addressing regional needs (Olatunji et al., 2023).

4.10 Strong Leadership and Vision

The success of African institutions in health research is also attributed to visionary leadership within academic and research institutions. Research leaders in Africa are often described as having a strong sense of patriotism and a pursuit of community or public goals. They are also often described as having a communal focus and using transparency and accountability skills and knowledge (Jackson et al., 2022). Strong leaders who understand the importance of science and innovation for public health have been pivotal in driving growth and ensuring sustainability. Visionary leaders can ensure that institutions are structured to support research goals (University World News, 2024). Odugbose, Adegoke & Adeyemi (2024) state that visionary leaders can use partnerships, technology, and community engagement to improve health systems. Visionary leaders can help promote preventive healthcare and address health inequities. Institutions and leaders advocate for the importance of health research in addressing Africa's health challenges, thereby helping to secure funding, political support, and visibility on the international stage (Wellcome Trust, 2022).

In conclusion, a combination of collaborative networks, capacity building, government support, and innovation in research practices has enabled African institutions to excel in health research, development, and innovation. These strengths have empowered them to address both local and global health challenges effectively and are critical to continuing Africa's progress in health and innovation.

5. THE IMPORTANCE OF BUILDING CAPACITY FOR HRD&I IN AFRICA AS A KEY DRIVER FOR IMPROVING PUBLIC HEALTH OUTCOMES

Given the foregoing, building capacity for health research development and innovation can be a key driver for improving public health outcomes.

5.1 Address health challenges

Africa faces a range of health challenges, including infectious diseases (e.g., malaria, HIV/AIDS, tuberculosis), non-communicable diseases (e.g., diabetes, hypertension), and emerging health threats (e.g., Ebola, COVID-19). Strengthening health research development and innovation allows the continent to develop homegrown solutions that are specifically tailored to its context, including local epidemiological patterns, socio-economic conditions, and health systems. A well-developed research capacity can assist African countries to address endemic diseases. Furthermore, emerging diseases (such as respiratory diseases caused by climate change and air pollution) and health issues can also be easily identified and treated with medication developed within the continent. This would be possible with policy refinement and an improvement in the public health sector, which would be supported by research (Tran et al., 2023). There exists a real danger that Africa could over-rely on Global Health initiatives if the continent does not improve capacity for health research development and innovation. This is worrisome because the continent has its own unique health needs which may be different from that of the rest of the world. The COVID-19 pandemic has served to highlight the importance of having a sturdy, home-grown research capacity capable of promptly responding to emerging health crises (Adebisi et al., 2024). Health challenges can further be addressed through data sharing. This is because sharing climate and health data across borders and sectors can help inform data-driven decision-making and policy development (Climate & Health Evidence Bank; 2024). Health challenges would be easily addressed through the domestic application of research findings. This would mean that treatments and prevention can be tailored to everyone based on genetic make-up and health history (National Library of Medicine, 2009). Research can also lead to earlier diagnosis of illnesses thus resulting in better outcomes for patients (NHS England, 2021).

5.2 Improving Local Research Capacity

In 2008, African governments committed to investing 2% of their health budgets to health research. However, despite this commitment, an assessment conducted in 2018 revealed that only 2 of the 39 countries that participated in the assessment within the WHO African Region had met this target (Nabyonga-Orem, Asami & Makanga, 2021). This has resulted in health research in Africa being predominantly externally funded. This can limit the ability of African countries to drive solutions tailored to their needs. Building capacity for health research development and innovation helps to develop local expertise in both basic and applied health sciences. This fosters self-reliance, strengthens research infrastructure, and promotes a research culture within local universities, institutions, and health systems.

5.3 Promoting Innovation in Health Technologies

By investing in health research and innovation, African nations can advance the development of low-cost, sustainable health technologies and innovations (World Economic Forum, 2024; Adebisi et al., 2024). These can include diagnostics, vaccines, treatment protocols, and healthcare delivery systems that are more accessible and affordable in the African context. Innovations such as mobile health (mHealth), telemedicine, and locally developed medical devices can revolutionize healthcare delivery, especially in underserved areas. Having such innovations conceptualised and produced in Africa, would benefit the continent. Furthermore, the Investing in Innovation (i3) Africa initiative and HRISA are some of the platforms promoting investing in innovation in health in Africa.

5.4 Enhancing Disease Prevention and Control

Health research is critical for developing strategies to prevent and control diseases. In Africa, where health systems are often under-resourced, research into disease surveillance, early detection, and public health interventions can lead to more effective and cost-efficient health programs. Research-driven interventions such as vaccination campaigns or vector control strategies have already proven to reduce the burden of diseases like malaria and polio (Lubanga et al., 2024).

5.5 Reducing reliance on global health initiatives

A strong research infrastructure can help African countries avoid over-reliance on global health initiatives that may not align with their unique needs. Therefore, by investing in health research infrastructure and capacity building, African countries can generate evidence that is relevant to their local needs. This would result in improved health policies and improved healthcare delivery (Olatunji et al., 2023). Furthermore, research can lead to better health outcomes for African communities, as treatments would be localised. There would also be a reduction on over reliance on external donors and donor funding. This is because research is underfunded in Africa and this leads to over-reliance on external donors thus skewing research towards global rather than local needs (Adebisi et al., 2024).

6. OPPORTUNITIES FOR COLLABORATIONS AMONG THE RESEARCH INSTITUTIONS, ACADEMIC INSTITUTIONS, AND INDUSTRY STAKEHOLDERS TO ENHANCE TECHNICAL CAPABILITIES AND INNOVATION POTENTIAL

Collaboration among research institutions, academic institutions, and industry stakeholders in Africa offers tremendous opportunities to enhance the continent's technical capabilities and innovation potential. By leveraging diverse expertise, resources, and networks, these collaborations can lead to the development of locally relevant solutions that address Africa's unique health challenges while driving economic growth and fostering sustainable innovation ecosystems. Here are key opportunities for collaboration to enhance technical capabilities and innovation potential in Africa:

6.1 Joint Research and Development (R&D) Projects

Academic and research institutions can partner with industry stakeholders (e.g., pharmaceutical, biotech, and health tech companies) to address specific health challenges prevalent in Africa, such as infectious diseases (malaria, HIV/AIDS, tuberculosis), non-communicable diseases (NCDs), and maternal-child health. Mutapi, Banda and Woolhouse (2023) did a case study on the Tackling Infections to Benefit Africa (TIBA) initiative. This involves partnering with academic and research institutions based in Ghana, Sudan, Rwanda, Uganda, Kenya, Tanzania, Zimbabwe, Botswana South Africa and the United Kingdom. Furthermore, 15 other African countries have participated in TIBA activities. What makes TIBA very effective is that 77% of research publications from TIBA have Africa based first and/or last authors; postgraduate, postdoctoral and professional training; career progression for African researchers and health professionals with no net brain drain from participating countries and supporting African Institutions. TIBA is externally funded in the UK.

Collaborative research and development projects can focus on drug discovery, vaccine development, diagnostics, and treatment technologies tailored to the African context. The Pan-African Clinical Trials registry (PACTR) and the Clinical Trials Community Africa Network (CTCAN) are some examples of clinical trials collaborative research. Furthermore, the Coalition for Epidemic Preparedness Innovation (CEPI) is another initiative focusing on rapid vaccine development and deployment within 100 days of a pandemic threat.

The African Medicines Agency was established to harmonize regulatory standards and foster an environment conducive to high quality research in Africa (Ndembi et al, 2024). This indicates that collaborative networks for clinical trials, involving research institutions and pharmaceutical companies, can conduct localized studies on African populations. Moreover, many African communities possess valuable traditional knowledge related to medicinal plants, alternative therapies, and local health practices (Mutombo et al., 2023).

Collaborating with industry stakeholders can help validate, refine, and commercialize this knowledge through modern scientific methods, potentially leading to the development of novel therapies and treatments. This ensures that clinical trials are representative of the demographic and health profile of the continent, addressing gaps in global medical knowledge.

6.2 Industry-Academia Partnerships for Technology Transfer

The inception and management of Technology Transfer Offices (TTOs) is also an opportunity. The role of TTOs is to bridge the gap between academic research and commercial application. Their primary role is to manage Intellectual property (IP) generated within universities and facilitate its commercialisation (Dell Technology, 2024). Universities and research institutions in Africa can establish or enhance technology transfer offices to facilitate the commercialization of research outcomes. The Southern African Research & Innovation Management Association (SARIMA) is an organisation that helps commercialise innovations. Further, universities have TTOs in-house, and these are governed under the South African Technology Transfer Offices at the national level.

Other African countries can benefit from establishing and managing National Intellectual Property Management Offices (NIPMOs) to manage technology transfer. This would involve leveraging on the science and technology parks that some African countries have. Through partnerships with industry stakeholders, TTOs can help translate academic research into practical products, services, and technologies, such as medical devices, diagnostic tools, and health software solutions. The establishments of joint innovation hubs and incubators is also an opportunity. These hubs are also available at some business schools (such as Wits Business School and UCT in South Africa). This means that other African countries can participate in creating collaborative innovation hubs, accelerators, and incubators, where researchers, academics, and entrepreneurs collaborate to incubate new health-related technologies. These hubs can provide access to resources like funding, mentorship, and technical expertise, as well as foster partnerships with venture capitalists, angel investors, and industry partners to scale innovative ideas as is the case with South African Universities.

Lastly, joint training programs between academic institutions and industry leaders can build the capacity of researchers and entrepreneurs to better understand the commercialization process. This includes intellectual property (IP) management, patenting, regulatory approval processes, and market access. The World intellectual Property Organisation (WIPO) offers the Masters in Intellectual Property through Africa University to capacitate Africans on Intellectual Property (WIPO, 2024).

6.3 Public-Private Partnerships (PPPs) for Innovation and Scaling

Industry stakeholders, including pharmaceutical and biotechnology companies, can collaborate with African universities and research institutions to develop affordable, locally relevant health products, such as vaccines, diagnostics, and treatments (G7 Italia, 2024). Public Private Partnerships (PPPs) can facilitate the translation of research into tangible products while ensuring affordability and accessibility for local populations (Ebulue, Ebulue & Ekesiobi, 2024). Furthermore, collaborative investments in infrastructure are essential to support the commercialization of health innovations.

Research institutions and industry partners can pool resources to build modern labs, clinical trial centres, and technology parks, creating an ecosystem conducive to health innovation and scaling. Industry stakeholders can help guide research institutions and universities by providing insights into market needs, ensuring that health innovations are aligned with demand and can be scaled effectively within African markets. This collaboration can help move products from the research phase to market adoption faster.

6.4 Joint Capacity Building and Training Programs

Industry and academic institutions can create joint training programs to build technical skills among the next generation of African scientists, healthcare professionals, and entrepreneurs. These programs could focus on emerging technologies like AI, machine learning, data analytics, bioinformatics, and medical device manufacturing. By partnering with universities and research institutions, industry stakeholders can offer fellowships and scholarships for postgraduate studies, PhD programs, and postdoctoral research. This can help build specialized expertise in areas like clinical trials, regulatory science, and public health management, with a focus on innovation in Africa's health sector.

Currently, the HJF Medical Research international (HJFMRI) offers laboratory accreditation, disease-specific training, and mentoring to help partner sites improve quality and performance. The Africa One Health University network (AFROHUN) is a network that focuses on strengthening the One Health workforce in Africa. AMARI-II is a consortium of six African universities that provide fellowships to mental health scholars to build excellence in leadership, training, and science. The Royal Society-FCDO Capacity Building Initiative provides funding for PhD studentships, research expenses, travel, training, and equipment. The Global Health EDCTP3 Joint undertaking funds collaborative research innovation projects to tackle infectious diseases and support research capacity building in Africa. The Africa Academy for Public Health (AAPH) is a learning organisation that seeks out best practices and applies them to design cost-effective interventions to address public health challenges in Sub-Saharan Africa. The Specialised Programme for Research and Training in Tropical Disease Research (TDR) supports research capacity strengthening activities in the African Region.

Collaborative workshops and conferences can be organized to foster exchange of ideas, best practices, and cutting-edge research between academia, industry, and other stakeholders. Examples of these are the Creative Imagination Workshops (CIWs) between Kenya, Nigeria, and South Africa (Kibuchi, Ogungbe & Ekesiobi, 2024). The Deep Learning Indaba hosted in Dakar, Senegal in 2024 and the Education Collaborative June Convening that allows stakeholders in African higher education to share innovations and strategies to improve educational outcomes (The Education Collaborative, 2024). These platforms allow professionals to stay updated on emerging trends in health research and innovation.

6.5 Public Health and Disease Control Collaborations

Joint research on epidemiology, disease surveillance, and public health systems can help strengthen Africa's ability to respond to health crises. Partnerships among academic researchers, governments, and industry players can lead to the development of data-driven strategies, tools, and technologies for disease prevention and control. Collaborative initiatives can address systemic challenges in African health systems. Industry stakeholders can provide resources, expertise, and innovative solutions for improving healthcare delivery, especially in resource-limited settings. Research institutions can play a key role in evaluating and optimizing these solutions for better health outcomes. Collaboration between academic institutions, health technology companies, and governments can lead to the development of digital health platforms (*e.g., telemedicine, mobile health apps, e-health records*). These solutions can improve access to healthcare, especially in rural and underserved areas, and enhance disease prevention and health education.

6.6 Access to Funding and Investment

Industry and academic institutions can work together to secure funding for joint research initiatives through competitive grants and funding programs. This can include government, international, and philanthropic funding sources aimed at addressing health issues unique to Africa. By fostering partnerships with private investors and venture capitalists, academic institutions and researchers can attract funding to commercialize promising innovations. The Research and innovation Systems for Africa (RISA) Fund recently hosted a maiden summit dubbed the Africa Research and Innovation Commercialisation Summit (ARICS). The theme for the summit was 'From Labs to Markets: Creating Viable and Inclusive Value Chains and Innovation Markets for Sustainable Socio-economic Development'.

Industry stakeholders can invest in or co-invest with universities in early-stage startups focused on health technologies and innovations. Future Africa connects investors with startups working in challenges in Africa, including healthcare. Timbuktoo Pan-African HealthTech Hub is a hub that supports startups developing medical technologies such as diagnostic tools, telemedicine platforms, and AI-driven healthcare solutions. Startups receive access to a network of industry leaders, health experts, and potential investors. Boost Africa is an investment program from the European Investment bank that supports the creation of innovative startups in health, education, and other sectors. Power Africa is a public charity that provides early-stage financial investment in the healthcare sector in India and East Africa. Kepple Africa Ventures is a venture capital company that connects startups with investors and strategic corporate partners.

Furthermore, research institutions in Africa can collaborate with international organizations, development agencies, and donor bodies to access funding and resources that support local innovation. For example, partnerships with organizations such as the Gates Foundation, the World Bank, and the WHO can provide critical funding for African-led research initiatives.

6.7 Collaborations on Policy Advocacy and Regulatory Alignment

Industry and academic institutions can collaborate to build regulatory capacity within African countries, ensuring that local regulatory bodies are equipped to assess and approve new health technologies. This can be done through sharing resources wherein higher-income institutions can provide African partners with access to resources like online libraries, statistical expertise, and database development (Chu et al., 2014). Creating partnerships that can help local manufacturers meet Africa's needs for Personal Protective Equipment (PPE), vaccines, and diagnostics (Mohammed, 2023). This collaboration can also be through developing global partnerships and formal platforms for communication. It is important to set clear expectations for collaborations and these should focus on deliverables. Furthermore, institutions should be provided with the tools they need to drive industry collaboration.

Other initiatives that can build regulatory capacity in Africa include the African Medicines Agency (AMA) which was ratified in November 2021 to regulate and approve medical products. The African Pharmaceutical Technology Foundation was established to develop technologies for manufacturing products in the continent (Wale et al., 2023). The African Medicines Regulatory Harmonisation (AMRH) Initiative has played a key role in facilitating clinical trial oversight and the joint review of COVID-19 vaccines. The African Medical Devices Forum (AMDF) provides regulatory guidance to AU member states on the marketing authorisation, procurement, and management of medical devices. The AU is further developing the Partnerships for African Vaccines Manufacturing (PAVM) Framework.

These partnerships can facilitate the adoption of global best practices while aligning them with the specific needs of African health systems. Collaborative efforts can be made to conduct policy research that shapes government strategies for health innovation. Academic institutions can provide evidence-based insights, while industry stakeholders can offer real-world data on the feasibility of innovations in the marketplace.

6.8 Knowledge Sharing and Global Networks

African academic and research institutions can join global research networks and collaborate with international partners on large-scale, multi-country health studies. These partnerships help African institutions access cutting-edge research, global best practices, and technical expertise, all while ensuring that African priorities and challenges are addressed in global research agendas. Collaborative participation in innovation expos and trade fairs can help African institutions and companies showcase their health innovations, attract global partners, and engage with potential investors.

7. GENDER DISPARITIES IN HRD&I CAPACITY, PARTICULARLY IN LEADERSHIP ROLES, RESEARCH OUTPUT, AND ACCESS TO FUNDING, AND PROPOSE STRATEGIES FOR GENDER EQUITY IN HRD&I ACROSS AFRICAN COUNTRIES

Gender disparities in HRD&I capacity across African countries are multifaceted and stem from both structural and cultural challenges. Addressing these disparities requires a comprehensive approach that targets leadership, research output, funding access, and societal attitudes. By implementing gender-inclusive policies, providing mentorship and capacity-building opportunities, ensuring equal access to funding, and promoting family-friendly work environments, African countries can foster a more equitable and innovative HRD&I ecosystem. Achieving gender equity in HRD&I will not only empower women but also enhance the continent's capacity to address its diverse health challenges and unlock the full potential of its human capital.

7.1 Leadership Roles

Women are significantly underrepresented in leadership positions in health research institutions, universities, and innovation-driven sectors across Africa. The Times Higher Education (THE) World University Rankings 2023 revealed that only 24% of the top 200 Universities in the world had a female leader (THE, 2023). This gender gap is more pronounced in Africa. A study done by Diab et al., (2024) established that of the 16 universities studied, only 13% had female Vice Chancellors, half the universities had fewer than 50% women in their executive teams and half had fewer 30% female Deans. UNESCO carried out a study in 2019 that established that only 24% of academic staff at universities in Southern Africa were female (UNESCO, 2019).

Gender biases, cultural barriers, and a lack of mentorship or networking opportunities often limit women's advancement. Women often have limited participation in decision-making processes within research organizations and health policy-making bodies, affecting how research priorities are set and how innovation is shaped. This imbalance leads to a narrow representation of ideas and health solutions.

7.2 Research Output

Studies have shown that women researchers, particularly in science, technology, engineering, and medicine (STEM), tend to have lower publication rates and fewer citations than their male counterparts. A study by UNESCO (2019) revealed that only 30% of researchers in sub-Saharan Africa were women. Furthermore, women were also paid less and got published less often than their male counterparts. Although there has been an increase in women researchers across South Africa, Egypt, Morocco, Senegal, Nigeria, Rwanda, Cameroon and Ethiopia, women researchers are in junior positions and there are limited leadership opportunities. Women also do not progress as far in their careers compared to their male counterparts (SpeakUpAfrica, 2021).

Based on regional analyses, the greatest magnitude of authorship inequity is in papers from sub-Saharan Africa where men comprised 61% of first authors, 65% of last authors and 66% of single authors. Whereas women from South Africa and Nigeria had greater success in publishing with 20% of last authors in 25 sub-Saharan African countries surveyed and these publications were in journals that had prominence in Sub-Saharan Africa (Baobeid, 2022).

This is often due to systemic biases, fewer resources, and limited access to mentorship or academic networks. According to Bosch and Pondayi (2022), women are less likely to be included in high-profile collaborative research projects, particularly those that attract international attention or significant funding. This exclusion affects the visibility of their work and limits their opportunities for career advancement. In many African countries, the health research agenda is often shaped by male-dominated leadership and priorities (Abouzeid, 2022), which can neglect issues specifically impacting women's health, such as maternal health, gender-based violence, or reproductive health.

7.3 Access to Funding

Research grants and funding opportunities are often disproportionately awarded to male researchers or male-led research teams. In a study done in 15 countries in Africa, men received 62.8% of research awards and often received larger grants than women (Jackson et al., 2022). This was despite having policies committing science-granting councils to advance women in science. Few of these councils had implemented programmes to turn the policies into practice or to help women researchers overcome barriers. The study team focused on 15 members of the Science Granting Councils Initiative (a five-year initiative funded by the governments of the United Kingdom, Canada and South Africa to strengthen science funding bodies on the continent). This group covers: Botswana, Malawi, Mozambique, Namibia, Zambia and Zimbabwe in Southern Africa; Ethiopia, Kenya, Rwanda, Tanzania and Uganda in East Africa; and Burkina Faso, Côte d'Ivoire, Ghana and Senegal in West Africa (Jackson et al., 2022).

Women may face challenges in accessing grants due to institutional biases, a lack of access to influential networks, or perceptions that their research is less impactful or groundbreaking. Even when women receive funding, it may be less than what male counterparts receive for similar research projects. This disparity in resource allocation affects their ability to conduct high-quality research and hampers their potential for innovation. In innovation sectors, women entrepreneurs and innovators in the health field face difficulties in securing venture capital or other investment forms compared to their male counterparts, which limits their ability to scale health innovations.

7.4 Strategies for Gender Equity in HRD&I Across African Countries

7.4.1 Promote Gender-Inclusive Leadership

Develop mentorship programs where senior women and men in HRD&I can guide and sponsor younger women researchers, helping them navigate academic and leadership pathways. There are numerous mentorship programs that can help women in health research development and innovation grow. The million Women Mentors is a movement that uses online platforms, events, and partnerships to support women and girls in STEM. While it is available in other regions, there exists the opportunity to add Africa as a member through volunteer programs and joining as mentees (MWM, 2024). One must sign up for membership. The American Society for Microbiology (ASM)'s Future Leaders Mentorship Fellowship is a formal mentoring program offered by the Society (ASM, 2024).

The Developing Research Innovation, Localisation and Leadership (DRILL) programme is a program that uses mentorship to develop early career health scientists (Brysiewicz, Nadesan-Reddy & Suleman, 2020). The Royal Society SUSTAIN mentoring and training programme is a program that supports female researchers' leadership and career potential (The Royal Society, 2024). The Mwele Malecela Mentorship (MMM) Programme for Women in Neglected Tropical Diseases (NTDs) is a program that supports mid-career African women to become leaders in NTD elimination (WHO-AFRO, 2024). The Mentoring Network for African Women in Academia (MTAWA) is a mentorship network for African women in academia (MTAWA, 2024). The African Academy of Sciences Mentorship Scheme is a mentorship scheme that includes steps like identifying mentoring strengths and needs, enrolling as a mentor or mentee, and attending an annual mentorship retreat (AAS, 2024).

These programs can offer advice on career progression, grant applications, and leadership skills. Furthermore, there exists an opportunity to create leadership development programs that specifically target women in health research, innovation, and academia. Such programs as the Women in Global Health Leadership Fellowship Program (WGHLF) which is a 12-month program that aims to improve leadership skills for African women who want to promote gender equity in global health systems. The program uses lecturers, case studies, role plays, workshops, discussion forums, reflective exercises, and mentorship (Africa Health Collaborative, 2024).

The Canadian Institute for Advanced Research (CIFAR) Women in Research Leadership Development Symposium is a symposium that aims to strengthen leadership skills for early career researchers from sub-Saharan Africa. The program includes facilitated training, networking, and mentorship from established female research leaders (CIFAR, 2024). The 2025 East Africa Signature Leadership Journey is a program that aims to create a mindset shift to solve complex challenges in global public health. The program provides tools and frameworks to address challenges that women leaders face (Women Lift Health, 2024). The African Women in Agricultural Research and Development (AWARD) Leadership Program for Emerging African Women in Science is a program for young African women in science under the age of 35. The program includes training sessions on leadership, mentoring, proposal writing, and communication skills (AWARD, 2024).

These programs should focus on building strategic thinking, public speaking, and networking skills to increase women's presence in decision-making roles. There exists an opportunity to implement policies that promote gender balance in leadership roles within health research institutions and universities. For example, setting targets for female representation in senior positions or establishing quotas for leadership roles in key research projects.

7.4.2 Increase Research Opportunities and Visibility for Women

Ensure that health research agendas reflect the diverse needs of women and men. Encourage research topics that address gender-specific health challenges, such as maternal health, sexual and reproductive health, and gender-based violence, ensuring that these issues receive adequate attention and funding. Promote inclusive collaboration between male and female researchers, ensuring that women have equal access to high-impact, multi-institutional, and international research projects. Gender-sensitive recruitment policies should be put in place to ensure women's equal representation in collaborative teams. Institutions can adopt policies that actively encourage and support the publication of research by female scientists. This could include providing support for writing, peer review, and ensuring that female researchers are recognized for their contributions to publications.

7.4.3 Enhance Access to Funding for Women Researchers

Establish funding programs specifically designed to support female researchers and entrepreneurs in health research and innovation. These programs can offer preferential access to grants, seed funding, or startup capital, ensuring that women have the resources they need to conduct impactful research or scale their innovations. Provide targeted training on grant writing and funding application processes for women researchers. This training can help women navigate the complexities of funding applications and increase their chances of securing grants. Create or support women-focused research networks, where female researchers can collaborate, share resources, and increase their visibility in the global research community. Such networks can facilitate funding opportunities and improve the professional standing of women in HRD&I.

7.4.4 Address Cultural and Societal Barriers

Promote policies within academic and research institutions that address implicit biases and ensure fair treatment for female researchers. Training programs for faculty and administrators on recognizing and eliminating gender bias are crucial. Implement family-friendly policies in academic and research settings, such as parental leave, flexible working hours, and childcare facilities, to help women balance their professional and personal responsibilities. Conduct public awareness campaigns to challenge societal norms and biases that discourage women from pursuing careers in Science, Technology, Engineering, and Mathematics (STEM) fields. These campaigns can highlight female role models in HRD&I and showcase their contributions to health innovation.

7.4.5 Strengthen Legal and Policy Frameworks

African governments and institutions should adopt and enforce gender-equitable policies that mandate equal opportunities for women in health research and innovation. These policies could include gender quotas for research leadership, scholarships for female researchers, and the establishment of dedicated gender units within research organizations. Advocacy efforts should focus on ensuring that gender equity is integrated into national health policies, research agendas, and innovation strategies. This involves engaging policymakers, academics, and industry leaders to commit to and implement gender-inclusive policies.

7.4.6 Foster Cross-Sector Partnerships for Gender Equity

African governments, research institutions, and industry leaders should collaborate with international organizations, such as UNESCO, WHO, and the African Union, to develop regional and global initiatives that support gender equity in health research and innovation. Foster partnerships between the public and private sectors that prioritize gender equity in their research and innovation initiatives. This includes setting targets for female participation in research teams, product development, and leadership roles within health innovation firms.

8. LITERATURE REVIEW ON CAPACITY TO CONDUCT HEALTH RESEARCH DEVELOPMENT AND INNOVATION (HRD&I) IN AFRICA

8.1 Health Research and Development in Africa: Overview of programs

There currently exist different programs to support HRD&I across Africa. These are continental and regional with the WHO providing expertise and policies and continental bodies such as Africa CDC, the African Union Development Agency-New Partnership for Africa's Development (AUDA-NEPAD), African Medicines Agency, in collaboration with governments, academia, private sector and different stakeholders driving the HRD&I initiatives. While some initiatives are funded by governments in each country, most are funded by international donors and function in collaboration with international partners and institutions.

One of the most significant barriers to HRD&I in Africa is the inadequate funding and resources for research activities. African countries have historically spent a small percentage of their GDP on research and development (R&D). A study by the African Union (2016) notes that many African countries allocate less than 1% of their GDP to R&D, far below the recommended 2-3% set by international bodies like the United Nations Educational, Scientific and Cultural Organization (UNESCO). This scarcity of financial support limits the ability to conduct large-scale, high-impact health research projects.

HRD&I in Africa is also hindered by the lack of modern research facilities, laboratories, and technological infrastructure. According to the World Health Organization (WHO), many African research institutions still rely on outdated technologies, which restricts the scope and quality of research (WHO, 2017). Furthermore, a significant gap exists in the availability of data management systems, clinical research tools, and other essential equipment, impeding the ability to undertake cutting-edge research.

The lack of sufficient career development opportunities and research funding has led to a significant "brain drain" from African countries. Many talented researchers migrate to developed countries in search of better opportunities. A report by the African Academy of Sciences (AAS) (2020) revealed that over 30% of African-trained scientists leave the continent for better opportunities abroad, further reducing the capacity for homegrown research and innovation.

A lack of strong governance frameworks and clear health research policies hinders the development of health RDI in many African countries. According to Okeke et al. (2015), weak regulatory environments and lack of coordination among government agencies, universities, and private sector players often lead to fragmented research efforts and ineffective use of available resources. This absence of clear policy direction also affects the prioritization of health issues and the allocation of research funds.

8.1.1 Clinical and Operational Research Alliance (CORAL)

This is a partnership between Alliance for International Medical Action (ALIMA), Inserm 1219, Global Health in the Global South (GHiGS), and Franco-Ivorian Research Program (PACCI) to develop innovative solutions to health threats in Africa. CORAL was created in 2016 after the partners collaborated in response to the Ebola Virus Disease epidemic in Guinea (ALIMA, 2024). The platform has two research poles: mother and child health and emerging infectious diseases.

8.1.2 Health Research and Innovation Strategy for Africa (HRISA) 2018 – 2030

Launched in December 2018, the Health Research and Innovation Strategy for Africa (HRISA) is comprehensive framework developed by the African Union to guide and strengthen health research and innovation across the continent. Its primary goal is to improve the health and well-being of African populations through the advancement of scientific research and innovation. This strategy envisions an Africa where African-led Research and innovation drives health and wellbeing. Its mission is to facilitate coordinated, sustainable and responsive Health research and innovation that will provide effective interventions for health in Africa. The HRISA requires collaboration between member states, international organizations, the private sector, and regional economic communities (AUDA-NEPAD, 2022). The strategy's goals are to:

- Facilitate coordinated, sustainable, and responsive health research and innovation.
- Provide effective interventions for health in Africa.
- Advocate for the adoption of emerging technologies and supporting platforms to improve health.
- Strengthen and harmonize regulatory, ethics, and intellectual property systems.

The strategy outlines key objectives, which include:

- **Promoting Research Excellence:** Enhancing the capacity of African institutions to conduct high-quality health research and innovation, focusing on areas that address the continent's specific health challenges.
- **Strengthening Partnerships:** Encouraging collaboration between African countries, international organizations, and the private sector to foster innovation and create solutions tailored to Africa's unique health needs.
- **Fostering Innovation and Technology Transfer:** Supporting the development of innovative solutions, including vaccines, treatments, and health technologies, and ensuring these innovations are accessible and adaptable to the African context.
- **Capacity Building:** Increasing the number of skilled health researchers, scientists, and innovators through education, training, and professional development.
- **Research Funding and Resource Mobilization:** Expanding funding sources for health research and innovation, both from African governments and international partners, to ensure the sustainability and growth of health research initiatives.
- **Ensuring Equity:** Promoting inclusive health research that considers the diverse health needs of different regions and populations across Africa.
- **Developing Policy and Governance Frameworks:** Strengthening governance structures to ensure that health research and innovation policies are effectively implemented and aligned with national and continental priorities.

HRISA is aimed at achieving sustainable health outcomes, addressing public health challenges like infectious diseases, maternal and child health, non-communicable diseases, and other emerging health threats. By aligning research and innovation with Africa's health priorities, HRISA aspires to improve healthcare systems and promote health equity across the continent.

8.1.3 Africa Health Strategy 2016-2030

The Africa Health Strategy 2016-2030 is a comprehensive plan developed by the AU to guide and improve the health systems and outcomes across the continent. The strategy aims to enhance health and well-being for all Africans through stronger health systems, improved healthcare access, and more efficient policies. The Africa Health Strategy 2016-2030 envisions an integrated, inclusive, and prosperous Africa, free from diseases. To achieve this, the African Union (AU) prioritises a robust, African-driven response to health challenges. The Africa Health Strategy (AHS) 2016-2030 is a framework to improve health outcomes in Africa (Yapor, 2023). The strategy was developed by the African Union Commission (AUC) in collaboration with the World Health Organization (WHO) and other partners and is set to run over a 15-year period.

Key objectives of the Africa Health Strategy 2016-2030

The strategy is based on the principles of equity, sustainability, and human rights, and it emphasizes the need to strengthen health systems, improve health governance, and prioritize investments in health. The strategy has six strategic objectives, which are as follows:

- **Strengthen health systems:** This objective focuses on strengthening health systems in Africa by enhancing access to health services, improving health infrastructure, and strengthening health workforce capacity.
- **Address determinants of health:** This objective focuses on addressing the social, economic, and environmental determinants of health in Africa. This includes promoting healthy lifestyles, addressing social and economic inequalities, and improving environmental health.
- **Improve health outcomes:** This objective focuses on improving health outcomes for all Africans by reducing maternal and child mortality, improving access to essential medicines and technologies, and reducing the burden of communicable and non-communicable diseases.
- **Promote health research and innovation:** This objective focuses on promoting health research and innovation in Africa by strengthening health research capacity, promoting innovation in health technologies, and promoting collaboration between researchers and other stakeholders.
- **Enhance health partnerships:** This objective focuses on enhancing partnerships between African countries, regional and international organizations, and other stakeholders to promote health and sustainable development in Africa.
- **Strengthen health governance:** This objective focuses on strengthening health governance in Africa by improving health policy and regulatory frameworks, promoting transparency and accountability, and strengthening health information systems.

To achieve these strategic objectives, the Africa Health Strategy 2016-2030 outlines several key actions that need to be taken at national, regional, and continental levels. These include:

- **Strengthening health systems:** To achieve this objective, the strategy calls for the development and implementation of national health plans, the strengthening of health workforce capacity, the improvement of health infrastructure and equipment, and the strengthening of health financing systems.
- **Addressing determinants of health:** The strategy recommends that countries prioritize investments in social and economic development, promote healthy lifestyles, and improve environmental health through measures such as reducing air and water pollution.
- **Improving health outcomes:** The strategy calls for the implementation of evidence-based interventions to improve maternal and child health, the promotion of universal health coverage, the scaling up of HIV, TB, and malaria interventions, and the strengthening of health systems to address non-communicable diseases.
- **Promoting health research and innovation:** The strategy recommends that countries invest in health research and innovation, promote the development of health technologies, and strengthen collaboration between researchers and other stakeholders.
- **Enhancing health partnerships:** The strategy calls for the strengthening of partnerships between African countries, regional and international organizations, and other stakeholders to promote health and sustainable development in Africa.
- **Strengthening health governance:** The strategy recommends that countries strengthen health governance by improving health policy and regulatory frameworks, promoting transparency and accountability, and strengthening health information systems (AUDA-NEPAD, 2019).

To support the implementation of the Africa Health Strategy 2016-2030, the AUC and its partners have committed to providing technical and financial support to African countries. This includes providing technical assistance to develop national health plans, strengthening health systems, and building capacity in health research and innovation (HRISA, 2019). The Africa Health Strategy 2016-2030 provides a comprehensive framework for improving the health outcomes of people in Africa. The strategy addresses the key challenges facing African health systems, and it outlines a range of actions that can be taken to improve health outcomes. The successful implementation of the strategy will require the commitment and collaboration of all stakeholders, and it has the potential to make a significant contribution to achieving the Sustainable Development Goals and improving the lives of people in Africa.

8.1 4 African Union's Science, Technology, and Innovation Strategy (STISA-2024)

The African Union's Science, Technology, and Innovation Strategy (STISA-2024) is a framework designed to drive Africa's socio-economic development by harnessing science, technology, and innovation (STI) to address the continent's challenges and opportunities. The strategy, which was adopted in 2014, provides a roadmap for integrating STI into development plans and fostering sustainable growth across Africa.

Key objectives and focus areas of STISA-2024 include:

- **Enhancing Research and Development (R&D):** Strengthening research capacities in Africa by increasing investment in R&D, improving collaboration between research institutions, and supporting innovation ecosystems.
- **Industrialization and Technological Transformation:** Promoting the use of STI to support Africa's industrialization, focusing on sectors like manufacturing, agriculture, energy, and infrastructure. This includes fostering technology transfer, innovation in industries, and improving access to advanced technologies.
- **Human Capital Development:** Building and expanding Africa's pool of skilled scientists, engineers, and innovators through education, training, and capacity-building programs, with an emphasis on youth involvement in STI.
- **Innovation and Entrepreneurship:** Creating an environment conducive to entrepreneurship and innovation by supporting startups, encouraging private sector investment, and facilitating the commercialization of research outputs.
- **Digital Transformation:** Advancing Africa's digital economy by promoting information and communication technology (ICT) as enablers of development, including in sectors like education, healthcare, and agriculture.
- **Strengthening Partnerships and Networks:** Promoting regional and international cooperation in STI, fostering partnerships between African countries, and collaborating with global partners to enhance technology transfer and innovation capacity.
- **Sustainable Development and Green Technologies:** Utilizing STI to achieve sustainable development, focusing on environmental conservation, clean energy, and addressing climate change through innovation.
- **Policy and Governance:** Strengthening governance structures to ensure effective implementation of STI policies and strategies, creating enabling environments for science, technology, and innovation to thrive.

Overall, STISA-2024 aims to leverage science, technology, and innovation to transform Africa's economies, improve quality of life, and enhance Africa's global competitiveness. The strategy aligns with the African Union's Agenda 2063, which envisions an integrated, prosperous, and peaceful Africa driven by its own citizens and resourceful economies.

8.1.5 The African Network for Drugs and Diagnostics Innovation (ANDI)

ANDI is an initiative designed to strengthen Africa's capacity for drug discovery and diagnostics development. This network brings together researchers, industry players, and policymakers from across the continent to collaborate on the development of new health technologies tailored to Africa's unique disease burden. By fostering partnerships and promoting local expertise, ANDI aims to create sustainable health research capacity and innovation on the continent (Marrone et al., 2013).

ANDI's primary objective is to promote and support health product R&D led by African institutions for diseases that disproportionately affect the continent. The expected outcome is the discovery, development and delivery of affordable new health tools including those based on traditional medicine, as well as the development of capacity and establishment of centres of research excellence.

8.1.6 The Grand Challenges Africa Initiative

Grand Challenges Africa is a funding initiative aimed at supporting innovative solutions to pressing health and development issues across the African continent. Launched by the African Academy of Sciences (AAS) in collaboration with the Bill & Melinda Gates Foundation, the program encourages African researchers to develop scalable, high-impact solutions that address key challenges in health, agriculture, and development.

The Grand Challenges Africa (GC Africa) initiative seeks to promote Africa-led scientific innovations to help countries better achieve the Sustainable Development Goals by awarding seed and scale-up grants to the continent's most impressive solutions. GC Africa supports big, bold impactful innovative ideas that have a potential for impact, scale and sustainability.

The focus for GC Africa is not new academic research but impactful robust solutions and products from scientific research. GC Africa builds on the previous successes of local Grand Challenges initiatives and a strong base of African Grand Challenges grantees.

GC Africa is part of the Grand Challenges family of initiatives, which seeks to engage innovators from around the world to solve science, technology and innovation, health and developmental challenges. Grand Challenges initiatives are united by their focus on fostering innovation, directing research to where it will have the most impact, and serving those most in need. The first phase of the GC Africa, started in 2017, was implemented at the African Academy of Sciences with the support of funding partners.

In Africa, the Science for Africa Foundation's GC Africa Initiative has quickly become an example of an effective tool to unlock government funding to address widespread development challenges. With its focus on facilitating inclusive multi-stakeholder collaboration within Africa's research and innovation ecosystem, the Grand Challenges Africa model is enabling a highly coordinated, well-funded and innovative R&D ecosystem by 'connecting the dots' to link innovators to funding, technical resources and other factors that sustain a robust R&D ecosystem.

GC Africa also promotes Africa-led scientific innovations to help African nations achieve the United Nations (UN) Sustainable Development Goals (SDGs). In Africa, the Grand Challenges family includes Botswana, Ethiopia, Senegal and South Africa, with Rwanda and Malawi having joined most recently in May and August 2023. Key aspects of GC Africa include:

- **Focus on Innovation:** The initiative encourages the development of innovative technologies, interventions, and approaches that can address the unique health and development challenges faced by African countries.
- **Research and Development:** By funding research projects, GC Africa aims to accelerate scientific discoveries and technological advancements that can improve public health, education, agriculture, and other sectors.
- **Collaboration and Networking:** The program fosters collaboration between African researchers, institutions, and global partners to share knowledge, expertise, and resources to scale innovations.
- **Health Priorities:** It addresses key health challenges, such as infectious diseases (***e.g., malaria, HIV/AIDS, tuberculosis***), maternal and child health, and non-communicable diseases (***e.g., cancer, diabetes***), aiming for scalable solutions that improve healthcare outcomes across the continent.
- **Supporting Entrepreneurs:** GC Africa also supports African innovators and entrepreneurs by funding early-stage projects and providing mentorship, with the goal of turning innovative ideas into impactful solutions.
- **Capacity Building:** The initiative focuses on building local capacity for conducting high-quality research, developing new technologies, and ensuring the sustainability of solutions in Africa.

Unlocking Funding Through Grand Challenges Africa

These seven Grand Challenges country initiatives have adopted this model to invest in science and innovation, particularly because of the attraction of providing complementary support from partners to innovations that address high-priority national development needs from pan-African and global funders. These needs are determined through landscaping exercises with the direct engagement of communities and subject experts. GC Africa's complementary funds provide an incentive to African governments to increase R&D funding by complementing investments to national innovators, money often leveraged by additional funders, such as the Science for Africa Foundation (SFA). In 2023, for example, the Rwandan government provided $1 million to match the SFA Foundation and other partner funding for Grand Challenges Rwanda to support country-based priorities.

Overall, Grand Challenges Africa is an important program for driving African-led innovation, addressing critical issues in health and development, and promoting sustainable solutions that can improve the well-being of African populations.

8.1.7 The African Academy of Sciences (AAS)

The AAS is a pan-African organization that promotes the development of science, technology, and innovation across the African continent. Founded in 1985, its mission is to advance scientific excellence, foster collaboration, and support the use of science and technology to address Africa's development challenges.

Key aspects of the AAS include:

- **Promoting Scientific Excellence:** The AAS brings together leading African scientists to advance scientific research, foster innovation, and ensure that science plays a central role in solving Africa's development challenges.
- **Research and Innovation:** The academy supports research in various fields, including health, agriculture, engineering, and environmental sciences. It provides funding for innovative research initiatives that address the continent's unique needs.
- **Capacity Building:** A major focus of the AAS is to strengthen scientific and technological capacities in Africa by providing training, mentorship, and resources to young scientists, researchers, and institutions across the continent.
- **Policy Influence:** The AAS works closely with African governments, international organizations, and other stakeholders to promote evidence-based policymaking. It advocates for policies that support the advancement of science and technology to drive sustainable development.
- **Collaboration and Networking:** The academy fosters partnerships among African scientists and global research networks. It encourages collaborative research, knowledge sharing, and the exchange of ideas to strengthen Africa's scientific community.
- **Supporting Innovation Ecosystems:** The AAS also supports innovation and entrepreneurship, helping to turn scientific discoveries into practical solutions for Africa's development, particularly in areas like health, agriculture, and technology.

Overall, the African Academy of Sciences is a key organization driving the scientific and technological transformation of Africa, helping to shape a future where science and innovation contribute to solving the continent's most pressing challenges and improving the quality of life for its people.

8.1.8 Science for Africa Foundation (SFAF)

The SFAF is a non-profit organization dedicated to advancing science and innovation across Africa. Its primary mission is to foster scientific excellence and promote the use of science, technology, and innovation (STI) to address the continent's socio-economic challenges. SFAF works to build strong scientific networks, support research initiatives, and create an environment conducive to scientific advancement in Africa.

Key elements of the SFAF include:

- **Supporting African Scientists:** SFAF focuses on empowering African researchers and scientists by providing funding, training, and resources to help them address local challenges in areas such as health, agriculture, and the environment.
- **Research and Innovation:** The foundation encourages the development of innovative solutions to Africa's most pressing problems. It funds and supports research in various fields to drive sustainable development and improve the quality of life across the continent.
- **Capacity Building:** SFAF emphasizes the importance of building scientific and technological capacity by offering programs that train young scientists, researchers, and innovators. This helps to strengthen Africa's research infrastructure and create a new generation of science leaders.
- **Collaboration and Networking:** The foundation fosters partnerships and collaboration between African researchers, institutions, governments, and international organizations. It seeks to build a network of scientists and stakeholders to share knowledge and promote collective problem-solving.
- **Science Advocacy and Policy:** SFAF advocates for science-based policies and decisions to be incorporated into the continent's development plans. It works to raise awareness about the importance of science and technology in achieving sustainable economic growth and addressing key challenges like health crises, climate change, and food security.
- **Promoting Innovation:** The foundation also focuses on supporting African innovation and entrepreneurship, encouraging the commercialization of research and creating an ecosystem that nurtures scientific ideas into impactful solutions.

Overall, the Science for Africa Foundation plays a vital role in strengthening Africa's science and innovation landscape, aiming to enhance the continent's capacity to address its development needs through the application of research, technology, and knowledge.

8.1.9 Holistic Drug Discovery and Development (H3D)

The H3D, Africa's first and only integrated drug discovery and development centre, aims to translate scientific discoveries into potentially life-saving medicines in areas such as tuberculosis, malaria, and anti-microbial resistance (Technology Innovation Agency, 2024). A partnership between H3D, an international group of scientists, and Chemical Process Technologies (CPT) Pharma to develop a new approach to medicine manufacturing in South Africa (H3D Foundation, 2022).

The H3D Centre aims to:

- Discover and develop innovative, life-saving medicines for infectious diseases.
- Build Africa-specific models to contribute to improving treatment outcomes in African patients.
- Develop drug discovery platform technologies.
- Train African scientists in drug discovery-related sciences.

The H3D Foundation was established to complement the work of the H3D Drug Discovery and Development Centre, specifically in relation to capacity development that enables and unlocks the potential for sustainable drug discovery and development activities across Africa. H3D is the first and only centre of its kind on the African continent. It is a place where African scientists can utilize their scientific skills and education to improve the health of African patients and to educate the next generation of African pharmaceutical scientists (European Union, 2024).

H3D is uniquely positioned to seed the establishment of an innovative pharmaceutical industry in Africa. One of the key strengths of the Centre is its neutral positioning, which allows for strong partnerships with governments, philanthropies, industry, and academic partners, forming a bridge between academic and translational science. H3D has four drug discovery portfolios (***Malaria, TB, Antimicrobial Resistance - AMR, and COVID-19***) that are largely funded through research grants with a programmatic focus. H3D relies on an extensive international network of partners and collaborators to bring in relevant expertise and capacities to assist with sustaining the portfolio pipelines and delivering preclinical candidates (Global Health Progress, 2024). Product development and industry partners are particularly positioned to take any preclinical candidates emerging from the Centre through development.

The H3D Centre has an infectious disease drug discovery portfolio with about 20 active projects and a global network with just over 30 active research partners. To date, the Centre has progressed 5 programs to selection phase and delivered 2 preclinical candidates (H3D-UCT, 2024).

8.1.10 Global Strategy on Human Resources for Health: Workforce 2030 (GSHRH)

This strategy aims to ensure equitable access to qualified health workers. The Global Strategy on Human Resources for Health: Workforce 2030 called for a greater focus on the preparation of the entire health workforce for emergencies, such as their involvement in preparedness and response, training, and planning for staffing requirements and surge capacity (World Health Organisation: 2020).

8.1.11 National Health Research Systems (NHRS)

A NHRS has been defined as the people, institutions, and activities whose primary purpose is to generate scientific knowledge and promote its utilization to improve health and health equity. It consists of the four functions of governance, creating and sustaining resources, producing, and using research, and financing. The capacity for governments to perform research for health can be assessed by the NHRS barometer developed by the World Health Organization Regional Office for Africa— WHO-AFRO (EDCPT-WHO, 2018).

According to Kirigia (2016) the NHRS barometer is informed by 17 indicators listed under four core functions of the health system:

- **Governance:** including national policy and strategic plan, law governing research, and a national ethics review committee.
- **Developing and sustaining resources:** including availability of universities conducting health sciences research, numbers of researchers, a national research institute, a health research programme within the ministry of health, and research being conducted within NGOs.
- **Producing and using research:** including numbers of peer-reviewed publications and systems for knowledge translation.
- **Financing:** a budget line in the health budget for research, with the aim of progressing towards allocation of two per cent of the national health budget on research for health.

A national health research policy document should include a situation analysis, a long-term vision, guiding principles, policy objectives, and an implementation framework. The roadmap for the National Health Research Systems (NHRS) in Africa includes:

- **Strengthening regional collaboration:** Agree on ways to strengthen regional collaboration and networking through the Regional Economic Communities (REC) and EDCTP Regional Networks of Excellence platforms.
- **Generating NHRS data:** Agree on a strategy to generate NHRS data through the Africa Health Observatory web platform of WHO-AFRO.
- **Conducting web-based surveys:** Agree on a roadmap to conduct web-based NHRS surveys in all member states in 2020.
- **Establishing knowledge translation platforms:** Establish, sustain, and use knowledge translation platforms to increase evidence-informed health decision-making.
- **Providing adequate funding:** Provide adequate domestic funding for research for health.
- **Promoting research interventions:** Promote mechanisms for addressing priority research interventions.
- **Committing to research capacity-building:** Research capacity-strengthening and development assistance agencies should commit at least 5% of health project aid to essential national health research and research capacity-building (Kirigia et al., 2015).

Conclusion

The above sections were a literature exposition of HRD&I within the African continent, the following section will zoom in to the regions and discuss the countries identified in the objectives. This means that the Southern African Region (South Africa and Zambia), the East African Region (Kenya and Tanzania), the West African Region (Nigeria and Senegal) and the North African Region (Egypt) will be elaborated upon.

9. SOUTHERN AFRICA

9.1 South Africa

South Africa is regarded to be amongst leading countries in the continent on HRD&I. South Africa invests approximately 0.8% to 1% of its GDP in research and development (R&D) (National Research Foundation, 2024). This is below the global target of 2-3% of GDP for countries to achieve significant innovation and economic growth through research.

While South Africa's investment in R&D is one of the higher rates in sub-Saharan Africa, it still falls short of the recommended levels set by global organizations like the UNESCO and other international bodies. Increasing this percentage is seen as essential for boosting technological innovation, advancing scientific research, and addressing socio-economic challenges such as health, education, and infrastructure development.

9.1.1 Department of Science and Innovation (DSI)

The DSI is the government department responsible for creating and implementing policies to promote science, technology, and innovation in South Africa. DSI supports research and development in various sectors, such as biotechnology, information technology, and energy, and provides funding for innovation initiatives. DSI plays a key role in capacity building, creating funding mechanisms for skills development and research through initiatives such as the South African Medical Research Council (SAMRC), Council for Scientific and Industrial Research (CSIR), National Research Foundation (NRF) and Technology Innovation Agency (TIA), which focus on enhancing HRD&I in the science and technology fields.

9.1.2 SAMRC

The SAMRC was founded in 1969 with the aim to improve South Africa's health, and to provide data and analysis for health-related policy changes and practice notes. The organization is the largest national funder of health research, medical diagnostics, medical devices, and therapeutics. The SAMRC additionally has a strong capacity development element with several funding programmes focusses on developing research capacity nationally and on the African continents such as the early career (scientist) research grant, self, initiated research grants, mid-career scientists' programs and the CSSF African scientists' development grant.

SAMRC plays a critical role in advancing Health Research Development and Innovation (HRD&I) in South Africa, particularly in the health sector. Through initiatives such as the Career Development Awards, Postdoctoral Research Fellowships, and the Health Innovation Partnership, SAMRC is contributing to the development of highly skilled researchers, fostering innovation, and addressing health challenges in South Africa. These programs not only build local capacity but also position South Africa as a leader in health research on the African continent.

SAMRC also has strategic collaboration with organisations such as PATH on the Global Health Innovation Accelerator (GHIA) which is a partnership between the SAMRC and PATH aimed at driving global health innovation and capacity building. Specifically, GHIA supports the local development and implementation of a portfolio of health-focused technologies as well as broader health innovation ecosystem development.

The grant from the Bill and Melinda Gates Foundation (BMGF) has been the primary catalyst for GHIA's growth, evolution and activities over the past 8 years from November 2016 to November 2024 and has been critical to GHIA's success.

The grant has also been instrumental in attracting other funding and additional partners to support and expand GHIA's activities. It has been used to support the GHIA team and consultants, the participation of PATH in the partnership and core GHIA activities and projects.

The Global Health Innovation Accelerator was established in 2014 with the objective of combining the appropriate mix of SAMRC and PATH resources, capacity and expertise to support the local development and commercialization in South Africa of a portfolio of health-focused technologies. For SAMRC the partnership represents an opportunity to learn from experts how to manage product development projects and get them to market in low- and middle-income countries (LMICs) and to tap into PATH's networks, while for PATH, GHIA is an embodiment of their Impact Lab concept for South Africa. The grant from the Foundation was targeted at establishing and validating a working model for GHIA, progressing technologies as evidence of the partnership's capacity and success and attracting future funding and additional partners to continue and expand GHIA's product development and commercialization activities, including elsewhere in Africa. The charitable purpose of the grant was to build the capacity of GHIA to drive growth in the local health innovation ecosystem and actively commercialize locally transformative health technologies to address the primary healthcare needs of South Africa and the African continent.

9.1.3 The South African Health Products Regulatory Authority (SAHPRA)

The SAHPRA is an entity of the National Department of Health, created by the South African government to ensure that the health and well-being of human and animal health are at its core. It is a WHO Maturity Level 3 (ML3) regulatory authority for vaccine production. SAHPRA is tasked with regulating (monitoring, evaluating, investigating, inspecting and registering) all health products. This includes clinical trials, complementary medicines, medical devices and In Vitro Diagnostics (IVDs). Furthermore, SAHPRA has the added responsibility of overseeing radiation control in South Africa. SAHPRA's mandate is outlined in the Medicines and Related Substances Act (Act No 101 of 1965 as amended) as well as the Hazardous Substances Act (Act No 15 of 1973).

SAHPRA is a Schedule 3A public entity that is responsible for: the regulation of health products intended for human and animal use; the licensing of manufacturers, wholesalers, and distributors of medicines and medical devices; radiation emitting devices and radioactive nuclides; the conduct of clinical trials in a manner that is compatible with the national medicines policy.

In 2023, SAHPRA signed a Memorandum of Understanding (MOU) with the Egyptian Drug Authority (EDA). The MOU between SAHPRA and EDA allows for crucial collaboration and engagement on mutual reliance for pharmaceuticals, biological products, and medical devices.

9.1.4 Council for Scientific and Industrial Research (CSIR)

The CSIR is one of South Africa's primary research and technology organizations. It focuses on scientific and industrial research in various sectors, including health, energy, and the environment. It is instrumental in driving innovation and research development, including human resource development in the sciences and engineering. It also supports the government and industries in building local technological capacity.

The CSIR runs several programs aimed at developing skills in science and technology, such as internships, postgraduate support, and collaborations with universities to foster innovation.

9.1.5 National Research Foundation

The National research Fund has a strong focus on supporting, promoting and advancing research and human capacity development in South Africa. This is advanced mainly through the provision of critical infrastructure and bursaries the development of high-end Human Capacity that foster the creation of knowledge, innovation and development in all fields of science and technology. The goal of the organisation is to create innovative funding instruments, advance research career development, increase public science engagement and to establish leading-edge research platforms that will transform the scientific landscape and inspire a representative research community to aspire to global competitiveness.

9.1.6 Technology Innovation Agency

The Technology Innovation Agency serves to bridge the gap that exists between research coming out of Higher Education Institutions, Science Councils, Public and Private Sector entities. One of the primary goals of the organisation is to stimulate and intensify a culture of Innovation amongst south Africans. While the organisation funds several sectors, with regards to health, they have been instrumental in setting up cutting-edge technological capabilities such as the:

- Centre for Proteomic and Genomic Research
- Biosafety Platform
- KwaZulu-Natal Research Innovation and Sequencing Platform
- African Medicines Innovation Technology Development Platform
- National Metabolomics Platform
- Holistic Drug Discovery and Development
- Cape Universities Body Imaging Centre
- TIA Bioprocessing Platform

9.1.7 Biovac

Biovac is a bio-pharmaceutical company based in Cape Town that is the result of a partnership formed with the South African government in 2003 to establish local vaccine manufacturing capability for the provision of vaccines for national health management and security. Biovac's solid partnerships with international vaccine R&D and manufacturing organisations have allowed the institution brings innovative technologies to the continent. Through steep investment in local infrastructure building and the development of vaccine development and manufacturing skills, the Biovac has secured high profile technology transfers from international pharmaceutical companies for the manufacturing of paediatric vaccines. These partnerships have enabled Biovac to be a frontrunner in establishing the South African vaccine industry, through local infrastructure building, the transfer of sophisticated technology and the building of scarce aseptic manufacturing skills.

Strengthening Health Research Governance

The establishment of the National Health Research Ethics Council established a mandate that gives direction of issues relating to health and additionally provides guidelines for health research ethics as mandated by section 72 of the National Health Act 51 0f 2003. This includes but is not limited to providing guiding principles of ethics that ensure that health research in South Africa is conducted responsibly and ethically.

These guidelines strengthen the health research governance by broadly ensuring that all research that involve humans undergo independent ethics review before research commences and ensuring that all protocols undergo both scientific and ethical scrutiny and there is minimal to limited harm to research participants. such as informed consent, confidentiality, human dignity and autonomy. One of the most significant outputs from this council is the establishment of research councils at all higher education's institutions and science councils that conduct research.

Enhancing Financial Stability for Health Research

The gross domestic expenditure on research and development 2021/22 in South Africa was 27, 757 billion ZAR which is a 6.9% increase from 2020/21. This represents a 0.62% of GDP, which was two basis points higher than figures reported in 20202/21. The main sources of R&D funding in South Africa are government (52,5%), the business sectors (29%) and foreign funded R&D (14.5%). Social (18.4%), medical and health science (22%) remaining the strongest research areas. The largest fraction of these funds went towards Applied Research (81.3%) and 17.9 % went towards basic research while 10.8% was for experimental development research.

Improving Access to Essential Information

South Africa developed the National Digital Health Strategy 2019 – 2024 to strengthen digital health governance, structures, create integrated platforms for development of information systems and ensure broadband network infrastructure in conjunction with other government departments. This strategy was meant to benefit healthcare workers to provide better services and to empower citizens to navigate their personal health journeys using digital technologies. The priorities for the strategy were as follows:

- Development of a complete health electronic record which will improve patient management
- Digitisation of health systems business processes. That will include digitisation of various health systems to improve efficiency and quality at an institutional level such as human resource, medicine access etc.
- Establishment of an integrated platform and architecture for health sector information system which will also ensure interoperability and linkage of existing patient-based information system.
- Scaling up high impact mHealth for community-based interventions. Within the context of the NHI, it will expand health promotion coverage to the vulnerable groups such as the children, the elderly, women and others who are prioritized
- Development of digital health knowledge workers working to support digital health as well as economic development.

Preliminary indications (report not yet published); different regions have adopted various electronic records per province, which are not inter-operable. The same challenges have been observed with m-health solutions, with systems working per province and not linked to the national database. Additionally, healthcare workers still need to receive training on digital health as well as the integration and interpretation of the following acts that have an impact on digital health for privacy and confidentiality of communications, health records, retention and security protocols of health records.

- Protection of Personal Information Act
- Electronic Communications Act
- The National Archives of South Africa Act

Including Health Research in Alignment and Harmonisation Processes

Due to its peculiar history, most of the policies in South Africa will have a focus on transformation. One such policy in the health sector is the white paper on the transformation of the health systems in South Africa which largely dealt with the transformation to reduce the level of social inequality in health and ensure that the country shits towards free access to comprehensive health care and to reduce the disproportionate level of preventable diseases and premature deaths in certain segments of the population. To this end the National Health Insurance Act (NHI) was assented in 2024. While the country awaits the enactment and eventual implementation of the NHI, three organizations established through Acts of Parliament were identified as key in the alignment and harmonization process of health research development, innovation and capacity development in South Africa:

9.2 Zambia

The primary custodian of clinical and public health data collected from routine and research-based activities in Zambia, is the Ministry of Health. However, the country additionally has non-government institutions and platforms that contribute to health and sustainable development.

9.2.1 The Southern Africa Regional Collaborating Centre (RCC)

The Africa CDC Southern Africa Hub, also referred to as the Southern African RCC, is in Zambia and is based at the Zambia National Public Health Institute, situated in Lusaka, Zambia; effectively making the National Public Health Institute in Zambia the host institution for the Southern Africa Hub of the Africa CDC. Its function is to coordinate public health initiatives and emergency response activities across the Southern African region, focusing Disease surveillance, preparedness, emergency response, and collaboration with member states in the region.

Strengthening Health Research Governance

Zambia uses an Interoperability Architectural Framework to support data governance, this includes but is not limited to updating software, infrastructure and ensuring that there is interoperability.

Enhancing Financial Stability for Health Research

The Gross Domestic Expenditure on Research and Development (GERD) 2021/22 in for Zambia was at 0.28% and has been the same since 2020. No historical GERD information is available.

Improving Access to Essential Information

The country has 5 levels of data access: community level, facility, district, provincial and the national level. The different levels focus on several stages of the data life-cycle management tool that they use. I.e. at the community level, only 2 data life-cycle stages, take place, generation and collection, whereas the other levels will include storage, management, analysis and interpretation of the data. The country additionally has a health information system which will be implemented on 2 levels, through existing systems and future systems (information updated in 2024), all contributing towards a digital health strategy (2022 – 2026) which is yet to be deployed.

Existing health information systems have feeder systems that collect, generate and store data captured at the point of service delivery, as well as core registries and Health Management Information Systems as well as the national reports presentations – which are centralized databases that contain patient, health facility and population information within several districts, digital platforms for the collection, management, analysis and dissemination of the information across the healthcare system as all as report generation at a national level.

The country further developed the Data Protection Act No. 3 of 2021 which provides for general management of data. For health data, the framework is meant to support the process and procedure for data collection, storage, sharing of data in line with the Data Protection Act, which will consider the protection of information of patients as well the transparency related to the data governance i.e. patient information will by anonymized to anyone that is nor a health care provider.

9.2.2 National Health Research Authority (NHRA)

The NHRA in Zambia was established under the health research act and is mandated to promote a regulatory framework for the development, regulation, financing and coordination of Health research to ensure constant health standards and guidelines for ethical health research in the country. The organisation also has a capacity development mandate and facilitates the development of health researchers, institutions and ethics communities that ensures a responsive state that can address both the health and research demands of the country. As part of the capacity development programme the agency offers a fate to policy mentorship programme, where mentees are equipped with analytical skills and quantitative methods to inform policy.

9.2.3 Zambia Forum for Health Research (ZAMFOHR)

ZAMFOHR is a platform whose role is to strengthen the capacity to undertake and utilise research evidence in health policy and practice. The organisation additionally has a database that contains researchers and health research.

9.2.4 National Science and Technology Council (NSTC)

The NSTC in Zambia is mandated to promote science and technology to improve the quality of life of the citizens. This is done through the provision of policy advice, promotion, regulation, coordination and resource mobilisation. This organisation additionally provides access to STI information and funding for both strategic research and youth innovation, which covers basic and applied research as well as funding for innovation.

9.2.5 Health Data Collaborative

Health Data collaborative is a network of over 400 partner organisations that provide collaborative platforms that align technical, financial and political resources per country where they operate to improve health outcomes. They work in 6 countries including Tanzania and Kenya.

10. EAST AFRICA

10.1 Kenya

10.1.1 Biovax

Kenya Biovax Institute is a state-owned organization that was incorporated in 2021 to manufacture, package and commercialize vaccines and other health products and technologies. This was informed by a feasibility study that was conducted in 2020 which sought to understand if the country could manufacture its own vaccines to fill the gap when it exits the support of Global Alliance on Vaccines and Immunization (GAVI) in 2027. Based on this study, the Government of Kenya committed to build its own capacity to produce human vaccines to ensure long-term sufficiency in its immunization agenda. Additionally, this project was catalysed by the lessons learned from the COVID-19 pandemic whereby African governments could not provide adequate vaccines for their populations as developed countries prioritized the vaccination of their own citizens bringing into light the vaccine inequity that exists especially in LMICs.

BioVax focuses on the research and development of vaccines tailored to local health challenges, such as infectious diseases prevalent in Kenya and the broader East African region. This targeted approach helps address specific public health needs.

Biovax collaborates with local and international research institutions, universities, and government agencies. These partnerships facilitate knowledge exchange, resource sharing, and joint research initiatives, enhancing the capacity for health innovation.

The company also invests in training and developing local talent in biotechnology and vaccine development. This includes educational programs, workshops, and internships that equip researchers and healthcare professionals with essential skills and knowledge. By establishing state-of-the-art laboratories and research facilities, BioVax helps create an environment conducive to high-quality research, attracting both local and international researchers.

BioVax, as part of its public-private partnerships strategy, engages in partnerships with government entities and NGOs allows BioVax to contribute to national health strategies, ensuring that research and innovations align with public health priorities.

10.1.2 The Kenya Food and Drugs Administration (FDA)

The Kenya Food and Drugs Administration (FDA), often referred to as the Pharmacy and Poisons Board (PPB), is the regulatory authority responsible for overseeing the safety, efficacy, and quality of food, drugs, and other health products in Kenya. The Drug Regulatory Authority established under the Pharmacy and Poisons Act, Chapter 244 of the Laws of Kenya. The Board regulates the Practice of Pharmacy and the Manufacture and Trade in drugs and poisons. The Board aims to implement the appropriate regulatory measures to achieve the highest standards of safety, efficacy and quality for all drugs, chemical substances and medical devices, locally manufactured, imported, exported, distributed, sold, or used, to ensure the protection of the consumer as envisaged by the laws regulating drugs in force in Kenya.

Strengthening Health Research Governance

Additional recommendations included increased cross-sector and inter-regional partnerships. Kenya has the following legislation that covers science, technology and innovation as well as health research:

- 2008 STI Policy
- Health Act of 2017
- 2019 Health Research Policy

» Ministry of Education (*Directorate of Research Management and Development*)
» National Commission for Science, Technology and Innovation (NACOSTI)
» Ministry of Health, Research and Innovation Division, Health Research Office,
» National Health Research Committee

Ethical review Systems:

Kenya has 27 Institutional Review Boards (IRBs) accredited by the National Bioethics committee, Kenya Medical Research Institute (KEMRI), Amref Health Africa and IRBs in some hospitals and universities.

Enhancing Financial Stability for Health Research

The gross domestic expenditure on research and development 2021/22 in Kenya was 0.81% which is lower than what was committed by the Science, Technology and Innovation Act at 2% (PATH, 2020). In this aspect, Kenya is considered a leader in health research and development. Additionally, the Health Act of 2017 mandated a 30% allocation to funding Health R&D, however almost 25 was invested in health R&D between 2013 and 2018 (PATH, 2020). Furthermore, it was noted that the majority of health research initiative were either donor or self-funded, further consolidating donor's determining research priorities and that only 60% of these funds were utilised for research and development, while the bulk was designated to providing elementary training to medical students (PATH, 2020).

Additional recommendations made by PATH were that the NRF should ensure that research funding is disbursed on time to ensure that researchers do not attempt to find funding alternatives when their research funding is delayed.

Including Health Research in Alignment and Harmonisation Processes

The following institutions make up the main health research institutions in Kenya (Juma et.al, 2022):

- Academic Model Providing Access to Healthcare (AMPATH)
- Alupe Leprosy and Other Skin Diseases Research Centre
- The Centre for HIV and AIDS Prevention and Research (CHIVPR)
- East African Kidney Institute (EAKI)
- University of Nairobi Institute of Tropical and Infectious Diseases (UNITID)
- Kenya Institute for Public Policy Research and Analysis (KIP-PRA)
- KEMRI
- Kenya Trypanosomiasis Research Centre
- University of Nairobi, College of Health Sciences.

10.2 Tanzania

The Council on Health Research for Development (COHRED) collaborated with the Tanzania National Institute for Medical Research (TNIMR) to conduct an 'Assessment of the Health Research System' in Tanzania. Although the report is from 2009, there were identified within the health research system in the country. The document identifies four key challenges in the Tanzanian health research system:

Strengthening Health Research Governance

Although national development strategies and policies addressed the health sector, they only peripherally considered health research. This resulted in the country not having a specific health research policy seeing as the National Science and Technology Policy did not explicitly reference health research at the time. Therefore, there was a need to have a priority-setting process for the health research system which would be based on broader sectoral involvement and increased national visibility and adherence.

Enhancing Financial Stability for Health Research

There was no specific budget line for health research in the government budget at the time. Research institutions had also experienced a decrease in public research funding in the last two years leading up to the publication of the report in 2009. Furthermore, while there had been a commitment made by the government to increase public research funding to 1% of GDP, this had not been implemented.

Improving Access to Essential Information

There is a challenge in accessing essential information for managing the research system. This situation had been worsened by the fact that official requirements for researchers to report on their research outputs and outcomes were not strictly followed, leading to a lack of systematic data collection. There was difficulty in accessing financial data and information on research projects, and the relevance of these projects to national priorities and their outputs.

Including Health Research in Alignment and Harmonisation Processes

While there had been an aid alignment and harmonisation process in the country, health research had not received sufficient attention. Due to this lack of attention, and other factors, basket funds in the health sector had negatively impacted the availability of resources for health research. Furthermore, there was no specific group of donors for health research, and coordination among development agencies was lacking. There was a need for better alignment of external resources as these influence research priorities and thus needed to be aligned with national health research priorities.

At the time of publishing the report, there was a proposal on how the country could address the above challenges. This involved developing a more explicit health research policy, ensuring financial stability, improving information access, and better integrating health research into alignment and harmonisation processes. Furthermore, to support the use of research outputs, COSTECH was developing a research information system at the time, comprising of all the essential information needed to manage S&T – including health research, in the country.

The Tanzanian research information system would be operated through Health Research Web, an electronic platform made available by COHRED. Such research information system would:

- Facilitate essential research management tasks, such as: decisions on which research areas need additional funding or human resources (i.e. the neglected priority areas); decisions on decentralisation of funding, for research to be carried out in the geographical regions where research is most needed; review of national priority areas; review of national human resource strategies.
- Improve research financial management: by providing information on research grants, on their sources (public or private, national, or international agencies), on their delivery channels (direct or through research institutions based in other countries). To help facilitate negotiations with national and international funding bodies regarding how best to invest the available resources, to obtain highest return for health and development in Tanzania.
- Enhance networking opportunities among all research actors.

However, in a follow up study done by Kengia et al., (2023), some of the barriers found to be in existence in 2009 were still hindering health research development and innovation capacity in Tanzania. Although the authors specifically focused on the public health system and surveyed public healthcare employees from 45 facilities, the same challenges were identified. These workers were surveyed using five categories:

- **Healthcare workers research capacity.** Respondents reported low experience and confidence in quantitative and qualitative research methods.
- **Research engagement.** Less than half of healthcare workers engaged in research. Engagement in research was positively associated with working at a District Hospital or above, having a university degree or more and previous research experience; it was negatively associated with females.
- **Barriers, motivators, and facilitators.** Barriers to conducting research included lack of research funding, time, skills, opportunities to practice, and research infrastructure.
- **Interest in conducting research.** Motivators and facilitators included a desire to address health problems, professional development, and local and international collaborations.
- **Institutional research capacity.** Almost all healthcare workers (92%) indicated interest in building their research capacity.

This means, therefore, that in 2023 (***14 years after the publication of the COHRED study)***; individual and institutional research capacity and engagement among healthcare workers in Tanzania is low, despite high interest for capacity building. Kengia et al., (2023) propose that a fourfold pathway for building research capacity in Tanzania:

- High-quality research training and mentorship.
- Strengthening research infrastructure, funding, and coordination.
- Implementing policies and strategies that stimulate engagement.
- Strengthening local and international collaborations.

11. WEST AFRICA

11.1 Senegal

Strengthening Health Research Governance

The Ministry of Health and Social Action is responsible for drafting and implementation of the prevention, health and social action that is defined by the Head of State. The responsibility of this ministry is to ensure that health care is accessible to all citizens in the rural, per-urban and urban regions of Senegal. The Ministry encourages the training of healthcare workers such as doctors, nurses and midwives as well as other medical personnel and ensures supply of drugs for the nation. The Ministry is also responsible for the oversight of public health bodies and their staffing with specialized personal and technical platforms and additionally enforces laws and regulations related to pharmaceutical, medical and paramedical fields. There are specific programmes focused in both communicable and non-communicable disease such as AIDS, diabetes and malaria that the ministry facilitates in addition to actively fighting against maternal and infant mortality. There are social programmes aligned to this ministry that aid chronically ill and vulnerable patient groups and protection of women, children, elderly and disabled people's health.

The country additional has a National Development Plan- NDP (2019 – 2028) that aims to provide / achieve universal coverage in the country and has 3 Focus areas; sector governance and financing, health and social services; and social protection. The goal of this plan includes capacity development to monitor both the activities and sustainability of the NDP, building capacities of health structures as well as improving the quality, and community participation of basic health care, this speaks to making health care accessible at lower-level facilities.

Enhancing Financial Stability for Health Research

The gross domestic expenditure on research and development 2021/22 in Senegal was 0.6% (figure last updated in 2015). Senegal is considered a leader in terms of the progress the country has made with regards to the universal health coverage as it continues to reform and innovate its health systems. The country has set a target to expand the financial protection of the health insurance from 23 to 75% of the population by 2026 through a USAID Building a Resilient Health system project in the country.

Including Health Research in Alignment and Harmonization Processes

USAID Senegal designed a health Program (2016 – 2021) to support the Ministry of Health and Social action in its efforts to combat maternal, neonatal and child mortality which was reviewed in 2019. The review concluded that there is an impact on healthcare based on the level of support received from government, in regions where more support was received, the data indicated improvement in the maternal, neonatal and child mortality rates. The study further indicated that good or increased collaboration between health programs in the country led to various synergy plans that supported the joint implementation of health activities.

These activities led to increased partnerships for the provision of training in Southern regions of Senegal. However, there was criticism that a systemic approach could lead to better outcomes such as support for health insurance schemes, activities for community involvement, engagement with stakeholders and local and community radio stations. Interventions such as mentoring by older women were also recognized as a key intervention that could be improved if better coordinated. Another challenge that was identified in the harmonisation of health research and process was the lack of coordination between key stakeholders and it was found that the establishment of regional offices led to a formal integration of activities between the two health regions. It additionally appears that the provision of financial access to services is one of the weakest links of this Programme.

11.2 Nigeria

Strengthening Health Research Governance

Uneke et.al (2013) stated that there was Nigeria, there is no rational process in place to set health research priorities, especially at national and local government levels, and that this often happened by chance and not by choice and were disease driven rather than having an integrated systems-level perspective. It was further found that the patterns for research funding were largely driven by the interests of the research funders, a topic, echoed by the Minister of Science, Innovation and Technology for South Africa in 2024. A need to strengthen procurement practices, quality assurance and storage systems for health products and technology was identified. Additional research should focus on effective health service delivery and disease prevention in responding to emergency health situations (*i.e. a framework should be out in place for national state(s) of disaster*). There is also consensus that to strengthen health research governance, efforts should also be directed towards the supply of healthcare workers and reducing the professional labour crisis in the Nigerian Health sector. In terms of leadership and governance, there should be increased research on addressing the issues of governance in the health sector management in Nigeria.

11.2.1 National Health Research Council, Nigeria (NHRC)

The NHRC in Nigeria was set up to promote the highest Ethical and Scientific Standards for Health Research in Nigeria. The organization also focusses on health research ethics capacity building in the country as well as the provision of a registry of all clinical trials taking place in the country.

11.2.2 The Tertiary Education Trust Fund

This agency was set up to provide supplementary support to all levels of public tertiary institutions for the management of the rehabilitation, restoration and consolidation of all Tertiary Education in Nigeria. The distribution of funds is on a 2:1:1 ration between Universities, Colleges of Education and Polytechnics.

Enhancing Financial Stability for Health Research

The GERD 2021/22 in Nigeria was at 0.13% of the GDP (Comstech, 2022). No historical data was found for the country's GERD. Nigeria, however, does have an education tax paid from accessible profit of companies that are registered in the country, and this was set at 2% and revised to 2.5% and this does provide support for education institutions to provide and maintain infrastructure for teaching and learning, capacity development of staff as well as research and publications. This 2% is managed by an organisation the Tertiary Trust Fund which is established by an act of parliament.

Improving Access to Essential Information

Nigeria published the Nigerian Freedom of Information Act (FOIA) in 1993 and assented 12 years later, while this act relates to the handling of government information, it does not appear to cover the protection of personal information for example in relation to health data and or records (Osawe, 2022). The act does however cover, all public bodies, private institutions that utilise public funds and or perform public services. It appears this act was assented to overcome the culture of secrecy of the Nigerian public service, but there are no specific terms of the level of secrecy and to what extent is extend to i.e. Policy and practice notes in the health sector and or research sector. The act however does cover the provision of appropriate training of public officials on the public's rights to access information and records and to the maintenance of all this information held by the government.

The Nigerian Implementation Science Alliance (NISA) in contrary aims to utilise innovative platforms that catalyse collaboration, enhance communication and promote the update of evidence-based interventions in improving healthcare delivery). This entity is a collaboration between US PEPFAR supported implementation partners (50+) such as universities and policy makers.

Including Health Research in Alignment and Harmonisation Processes

Nigeria developed the Basic Health Services Scheme (BHSS) as far back as 1982 (E. Lambo) which was an implementation tool for the National Comprehensive Health care Scheme. The basic health services scheme had 3 objectives set out as follows:

- The provision of adequate and effective primary health care for the entire population, with 100% coverage by 2000.
- The correction of imbalances among preventive programmes such as immunization, health education, maternal and child health, family planning, environmental health ser vices, nutrition, and communicable diseases control.
- To use the Local Government Area as the basic implementation unit and the Federal Ministry of Health as the central coordinating agency.

To ensure successful implementation of this scheme, several innovative training programmes were set to be introduced, including elements related to capacity development such as on-the-job training, in-service training as well as reducing the length of formal training for healthcare workers. It was observed in that the BHSS did not yield the desired results due to poor leadership, lack of human and financial capital as all as discontinuity of policy implementation (Nigeria has had 4 national development plans (all which had a health component to correct shortfalls in health services since 1960) due to political instability, low literacy levels and corrupt practices). Consequences of poor leadership include inadequate funding to the healthcare manifesting in shortage of drugs, equipment and irregular payment of salaries, leading to strikes, that impact the provision of services (Tayo, 2006). The poor governance additionally leads to the lack of financial capital to remunerate healthcare workers leading to emigration to countries such as Saudi Arabia and dilapidated infrastructure.

Nigeria largely practices an informal mentoring system (Musa et al, 2022). In the same study published, it was found that challenges to mentorship were the lack of understanding of the mentorship Programme, the lack of both the capacity to mentor and freedom of expression as well as the predominant culture of individualism or selfishness the lack of formal relationships. These challenges are experience in the health academic as well as research institutions. It was recommended that systemic approaches should be utilised to fund mentorship programmes and context specific solutions to ensure increased mentorship to develop HRDI Capacity.

12. NORTH AFRICA

12.1 Egypt

Enhancing Financial Stability for Health Research

Research and development expenditure (% of GDP) in Egypt was reported at 1.0197 % in 2022, according to the World Bank collection of development indicators, compiled from officially recognized sources.

Egypt has made significant strides in strengthening its health research strategy and investments to address key public health challenges and improve healthcare outcomes. The country's approach is focused on promoting scientific innovation, enhancing healthcare delivery, and addressing both communicable and non-communicable diseases.

The Egyptian government has implemented several programs aimed at capacity building in health research, development, and innovation to address public health challenges and foster scientific advancements. These programs focus on strengthening human resources, improving infrastructure, and promoting scientific innovation to achieve better health outcomes.

13.1.1 The National Research Centre (NRC)

- **Research and Training Programs:** The NRC plays a central role in health research and innovation in Egypt. It conducts various training programs and workshops for scientists, researchers, and healthcare professionals to enhance their skills in biomedical research, clinical trials, and laboratory techniques.
- **Postgraduate Training:** NRC collaborates with universities to offer specialized postgraduate programs in health research, biotechnology, and public health to build a highly skilled workforce.

13.1.2 Egyptian National Strategy for Health Research (2020-2025)

- **Focus Areas:** This strategy outlines several programs aimed at strengthening health research capacities. It prioritizes areas such as infectious diseases (e.g., Hepatitis C), non-communicable diseases (e.g., cancer, diabetes), and maternal and child health.
- **Human Resource Development:** The strategy includes initiatives to train researchers, build leadership in the health sector, and enhance the research skills of healthcare professionals to drive innovation in health.
- **Infrastructure Development:** Investments are directed toward upgrading research facilities and equipping them with modern technology to support health-related research.

13.2.3 The Science, Technology, and Innovation (STI) Strategy 2030

- **Capacity Building in STI:** Part of Egypt's broader national development strategy, the STI 2030 framework aims to improve the country's innovation capacity, with a particular focus on health-related research and development (R&D).
- **Health Research Focus:** This strategy includes initiatives to promote collaboration between academic institutions, government bodies, and the private sector, aimed at building a robust ecosystem for health R&D.
- **Support for Startups and Innovation:** It provides funding, mentorship, and resources to health technology startups, encouraging innovation and entrepreneurship in the health sector.

13.2.4 The Ministry of Higher Education and Scientific Research Programs

- **Research Grants and Fellowships:** The Ministry of Higher Education provides grants and fellowships to support research in health and related fields. These programs are aimed at encouraging young researchers and scientists to pursue careers in health innovation and development.
- **Capacity Building in Research Institutions:** The ministry works to enhance the capacity of universities and research institutions by providing funding for research infrastructure and offering specialized training for researchers.

13.2.5 The Egyptian Academy of Scientific Research and Technology (ASRT)

- **Research and Development (R&D) Projects:** ASRT supports health-related R&D projects by providing funding and technical assistance, with a particular focus on public health challenges like communicable diseases and chronic conditions.
- **Training and Development Programs:** ASRT organizes training courses and workshops to build the capacity of healthcare professionals and researchers, including programs on data analysis, clinical research, and public health policy.
- **International Collaboration:** ASRT fosters partnerships with global research institutions, enhancing the international exchange of knowledge and best practices in health research.

13.2.6 Egypt's Health Innovation and Entrepreneurship

- **Health Innovation Hubs:** Programs such as the Health Innovation Lab are designed to foster innovation by providing support to healthcare entrepreneurs and innovators in developing solutions to health problems. These hubs offer resources like mentorship, funding, and access to research facilities.
- **Support for Startups:** Through public-private partnerships and incubators, the government supports health-related startups that work on developing innovative solutions, such as digital health technologies, diagnostics, and healthcare delivery models.

13.2.7 The National Cancer Institute (NCI)

- **Capacity Building in Cancer Research:** The NCI provides training for researchers and healthcare professionals in oncology, focusing on cutting-edge research methods and therapies. These programs include workshops, seminars, and fellowships for developing expertise in cancer research and treatment.
- **International Collaboration:** NCI collaborates with international organizations to exchange knowledge and provide opportunities for Egyptian researchers to gain exposure to global best practices in cancer research.

13.2.8 WHO Collaborations

- **Health Research Capacity Building:** Through its partnerships with WHO, Egypt has been involved in capacity-building initiatives to enhance its research capabilities, particularly in the areas of infectious disease control, public health policy, and epidemiological research.
- **Training and Certification Programs:** WHO collaborates with Egyptian institutions to provide training in various health research areas, including surveillance systems, health system strengthening, and data management.

13.2.9 The Egyptian Biomedical Research and Innovation Network (EBRIN)

- **Network for Health Innovation:** EBRIN is an initiative that connects various research institutions, universities, and healthcare providers to promote collaborative research in health and biotechnology.
- **Training and Mentorship:** EBRIN offers capacity-building programs for young scientists and researchers in health innovation and biomedical sciences, focusing on skill development and fostering a culture of innovation.

INTERVIEW REPORT

13.1 Data analysis

To complement the desktop review and enrich the report, 11 interviews were conducted with public health professionals involved in the health research, development and innovation ecosystem. People interviewed were government officials, manufacturers, donors, NGO, regional agencies. The countries represented by the sample are outlined below:

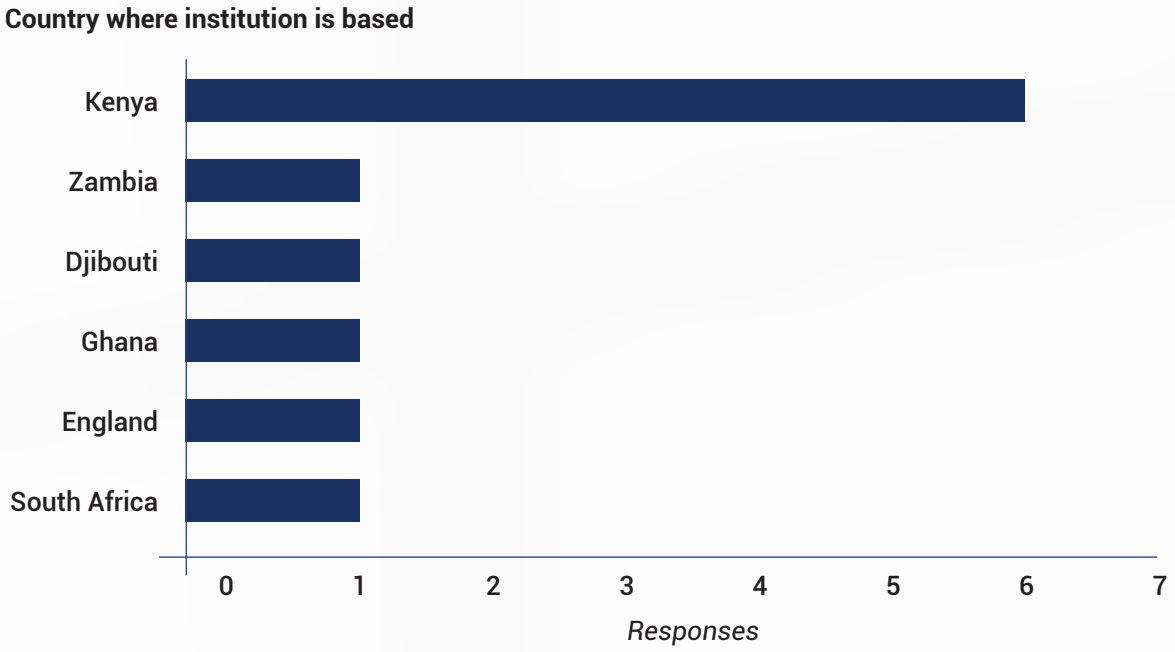


Figure 1: Country where institution is based.

What are the main gaps or challenges your institution faces in building HRD&I capacity? **(***Select all that apply***).**

As depicted in Table 16.2, respondents stated that 'Lack of Funding' was the biggest challenge. This confirms the assertion by the World Health Organisation that African Governments need to invest 2% of their GDP to health research and development (WHO, 2022). Further it confirms the findings of the World Economic Forum (2024) and the Africa CDC (2023) that there was a lack of funding in HRD&I in Africa. Gender disparities, insufficient human resources and skills were also identified as challenges. Despite the African Development Bank investing $5 Billion in health research infrastructure between 1975 – 2020 (WHO, 2017), there is still inadequate infrastructure as identified by one respondent. However, the AfDB (2022) Strategy for quality Health Infrastructure in Africa 2022 – 2030 might play a big role in addressing this gap.

As posited by Aiyede and Muganda (2023), policy makers do not rely on research to inform policies. This therefore means that there is a lack of political will or government support for HRD&I in Africa. This is further confirmed by the fact that African governments are not investing enough in HRD&I.

What are the main gaps or challenges your institution faces in building HRD&I capacity

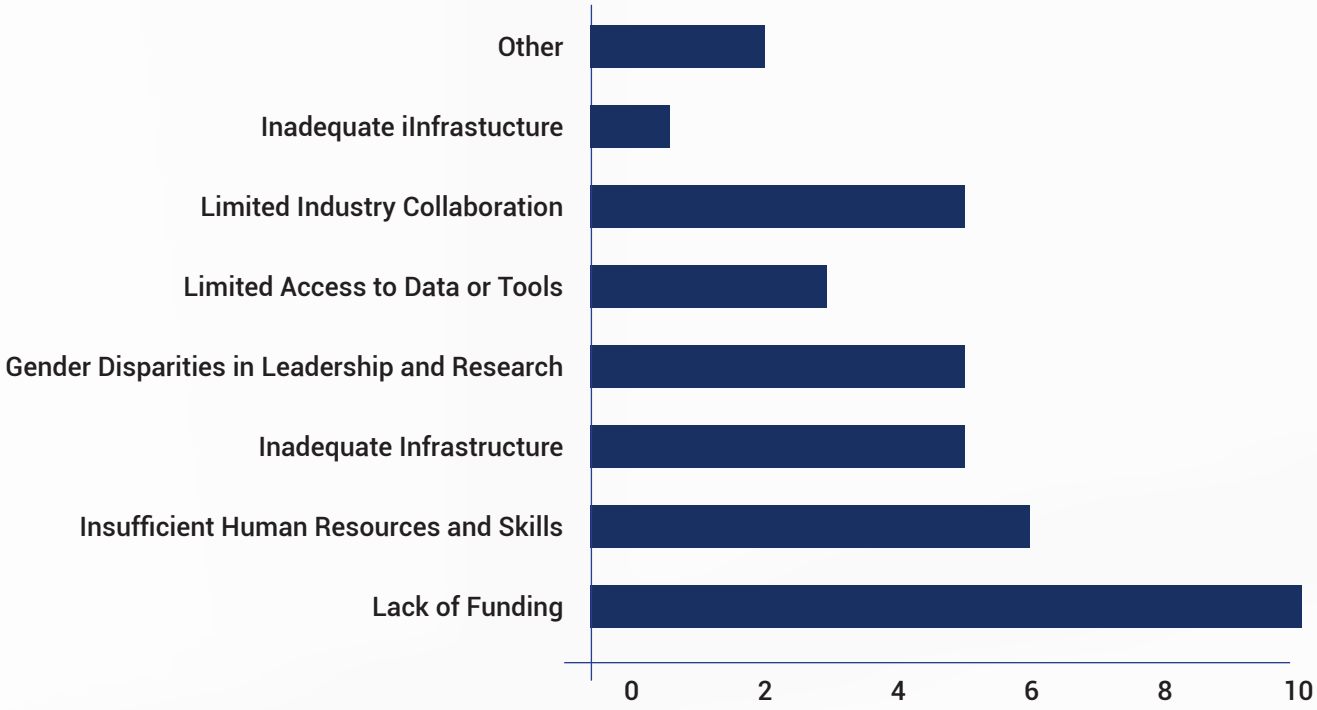


Figure 2: Gaps or Challenges in building HRD&I Capacity.

If '**Other**' please specify:

- Lack of political will or government support.
- Lack of coordination at continental, regional and member state levels.
- Lack of clear product targets leading to procurement.
- Fragmented and underdeveloped health systems.

In your opinion, what specific challenges do you/your organization face in addressing these challenges? 10 responses

In your opinion, what specific challenges do you/ your organisation face in addressing these challenges

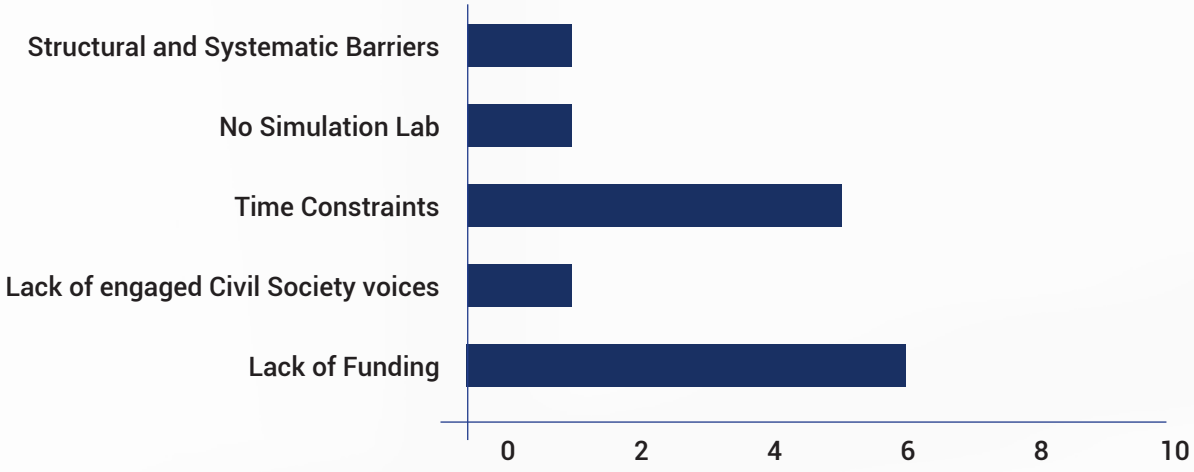


Figure 3: Specific challenges in overcoming hurdles.

The respondents were further asked to identify challenges that were specific to their organisations. From the responses, a lack of funding is a challenge across organisations, followed by noting that external funding leads to distortion of priorities as pointed out by Adebisi et al., (2024). Limited capacity and insufficient human capital were also a challenge. This alludes to the finding by the African Academy of Sciences (2020) which notes that 30% of Africa trained scientists leave the continent for better opportunities abroad and because of a lack of research capacity in Africa.

Section 3: **Strengths and Best Practices**

In your opinion, what do you consider to be the key strengths or best practices in HRD&I in Africa? (*10 responses****)***

Respondents were further asked to identify best practices or key strengths in HRD&I in Africa. These were the responses:

- There are some pockets of best practices in collaboration between researchers and research institutions.
- The adoption of a multi sectoral approach involving key stakeholders with a focus on the local context.
- Local adaptation & development/ Capacity Building/ Promotion of innovation and new knowledge.
- Research institutions and networks, experts.
- Gap for access to qualified teachers in Upstream and R&D.
- Increasing local manufacturing and innovations
- Collaboration between industry and academia/research entities.
- Leadership and enabling role of Africa CDC.
- The challenge remains with the implementation as often not all contextual factors had been accounted for in the development of that product/intervention.

Can you provide examples of the best practices in HRD&I that have emerged from your organization/region? (*9 responses****)***

- Grand Challenges Africa.
- African Stars Fellowship for Young African Scientists.
- African Institute of Biomedical Science and Technology.
- Evidence Based Research (EBR).
- Medical Research Council South Africa.
- 100 Days Mission Implementation Report.
- BioNTech and MRNA South Africa.
- Noguchi Memorial Institute of Medicine (Ghana).
- West African Cell and Biological Lab.

Section 4: **Strategic Investments**

What strategic investments do you believe are necessary for developing and sustaining HRD&I in Africa? (*11 responses****)***

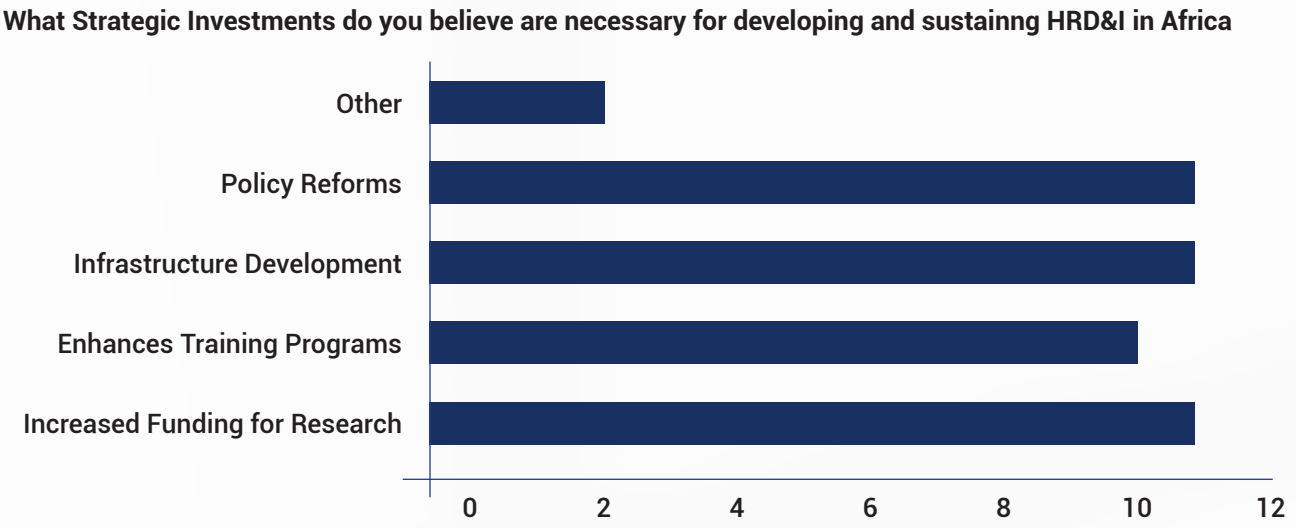


Figure.4: Strategic investments.

The respondents were further asked about possible strategic investments that would develop and sustain HRD&I in Africa. All eleven respondents indicated that Policy reforms, Infrastructure development and increased funding for research were the possible investments. With the introduction of enhanced training programs following closely. This confirmed the suggestion by the World Health organisation, Africa CDC and the World Economic Forum. One respondent reiterated the importance of collaboration through PPPs. Another suggestion was to have vaccines manufactured in Africa, sourced from Africa and only considering other continents if there was no availability within the continent (what Biovac is currently doing in South Africa).

Section 5: **Opportunities for Collaboration**

In your opinion, what opportunities do you think exist for collaboration among research institutions in Africa? (*11 responses****)***

- Capacity building and mentorship.
- Africa CDC coordination hubs.
- Africa Partners Forum.
- Lusaka Agenda.
- Leverage private sector to explore sustainable partnership arrangements.
- Establish regionally based network-building initiatives.
- Focus on indigenous and local knowledge sharing by Community Based Organisations (CBOs).
- Establish new institutional partnerships.
- African governments can utilise research collaboration as a policy instrument.
- African Union Countries (AUC).
- Sharing infrastructure and training course Intellectual Property.
- Regional networks within continental networks.
- Potential for South-South collaboration among African institutions.

In your opinion, are there any existing partnerships that you find particularly effective? Please elaborate: (*9 responses****)***

- The Centres for Research in Emerging Infectious Diseases (CREID) network.
- Resilience Action Network Africa.
- AU-EU Innovation Agenda.
- Horizon Europe's Africa Initiative.
- 20 joint Clusters of Research Excellence (COREs).
- The Guild of European Research-Intensive Universities.
- South African Medical Research Council.
- East African Community (EAC).
- Partnerships between industry and universities.
- Cross pharmacy capacity development.
- Research and Innovation strategy.
- Partnership with Council for Scientific and Industrial Research (CSIR).
- The International Vaccine Institute (IVI).

Section 6: **Attracting, absorbing and retaining talent.**

In your opinion, what strategies do you believe are necessary to attract talent to HRD&I in Africa?11 responses

The responses suggested that there was a need to increase clinical trials in the continent. According to the World Economic Forum (2024), only 4% of the total clinical trials were held in Africa in 2023, with the continent producing 2% of the genomic data from these trials. Furthermore, the continent hosts clinical trials at stages 3 & 4, and there is an opportunity to host these in the early stages. There was a suggestion to collaborate with the private sector and to further strengthen STEM education. Currently, women are underrepresented in STEM (UNESCO, 2019) and funding women would help strengthen STEM education.

The findings also indicated that there was a need for more collaboration with the private sector and clear technology transfer. Offering a conducive work environment with competitive remuneration was also identified. The findings also confirmed the finding by Abubakar et al., (2022) who stated that research budgets needed to be reinforced and removed from political influence. The findings stated that this could be done through formulating policies that would encourage increased investment in Research and Development. The findings further stated that there was a need to increase spending on R&D in Africa, create a clear knowledge mechanism and have incentives for young researchers as suggested by Adebisi et al., (2024).

Furthermore, the findings indicated that there was a need to leverage digital and AI driven research and culture of innovation and entrepreneurship. The findings confirmed that defining career pathways for young researchers and scientists was important to retain them, as stated by Abouzeid et al., (2022).

In your opinion, how can institutions improve their capacity to absorb and retain skilled professionals in HRD&I in Africa? (*11 responses****)***

The findings indicate that institutions can absorb and retain talent by having a broader pipeline of products and projects, building adequate infrastructure, having initiatives to engage scientists and providing adequate funding for fair remuneration. Furthermore, supporting research professional ecosystems as suggested by the Organisation for Economic and Cooperation and Development (2022). Investing in the implementation of New Generation of Academics Programme in universities was also suggested in the findings, along with the need to define career pathways for job stability and growth. Strengthening capacity of research management and support systems, technical assistance and strengthening leadership and institutional governance was also in the findings as well as increasing access to funding and grants.

In your opinion, what role do mentorship and training play in talent retention within your organization?11 responses

Figure 5: Role of mentorship and training.

The findings indicate that the participants credit hands-on training with helping students get jobs quicker. Furthermore, mentorship helped in skills transfer. Mentorship was also credited as being the key to retaining historical organisational culture and to building Africa's research capacity. However, worth noting is that mentorship requires the full support of all actors.

Section 7: **Additional Comments**

Please provide any additional comments or insights regarding Health Research, Development and Innovation in Africa. (*8 responses****)***

The respondents gave the following comments/insights regarding HRD&I in Africa.

- There is urgent need to build compelling narrative to shift the current disincentivizing narratives that see HR&DI as expenditure rather than investment.
- Areas required to support the pathway for successful capacity building in Africa: 1. Directly empowering African-based researchers, 2. Offering quality training to large numbers of junior African scientists and support staff, and 3. Effective information exchange and collaboration.
- Community practices and documentation of best practices.
- Research should not be based on availability of funds for research, rather research should be done on need base.
- Engage all key stakeholders, from regulatory to ethics, from animal science to pre-clinical and clinical studies, from policy makers to funding partners. Thought leadership is needed to bring these critical aspects together.
- Decolonise global health research, strengthen local research practices, leverage endogenous knowledge systems, leverage digital and AI innovations.
- So many surveys and studies have been done on this field but for some reason no lasting solution has resulted for Africa. Without a shift that facilitates large investments in early-stage research and development for health products, we will continue to be recipients of others' innovation, consequently limiting Africa's ability to direct that innovation along the product development pathways which ideally should lead to a product being manufactured here or closer to home.

Conclusion from Interviews:

The responses highlight a complex landscape of challenges and opportunities in health research, development, and innovation in Africa. Addressing these issues requires a multifaceted approach involving increased funding, enhanced training, collaborative partnerships, and strategic policy reforms, all aimed at building a robust and sustainable research ecosystem on the continent.

ROADMAP

The following section highlights the recommendations, best practices, and strategies to address the limitations in Africa's health research, development, and innovation (HRD&I) capacity:

1. Strengthening Research Infrastructure and Pooled Procurement

Recommendations:

- Invest in modern laboratories, research centres, and digital health technology infrastructure.
- Establish regional Centres of Excellence for specialized health research. Explore the possibility of building on proposed research hubs such as Afrigen, Institute Pasture Dakar to strengthen vaccine manufacturing.
- Have more manufacturing facilities that are linked to governments and work on systematically identifying products that should be manufactured in regional economic hubs. Africa CDC and AUC agencies need to lead operationalization of the Africa Pooled Procurement Mechanism.
- Promote shared research facilities to optimize resources across institutions and countries.

Best Practices:

- The **African Centre for Disease Control** (Africa CDC**)** has successfully established regional collaborative health hubs.
- The **African Development Bank** (AfDB)'s $5 billion investment in health infrastructure is a model for scaling research capacity and Mastercard's support for the African STARS Fellowship Program for Young African Scientists are examples of best practices on strengthening research infrastructure

Strategies:

- Governments should allocate **at least 2% of GDP** to R&D per WHO recommendations.
- Leverage **public-private partnerships (PPPs)** for infrastructure development.
- Use **digital platforms and leverage artificial intelligence** for clinical trials and telemedicine and research collaboration.

2. Sustainable Funding and Coordination of HRD&I

Recommendations:

- Increase national funding for health R&D to reduce dependence on external donors.
- Create dedicated health research funds supported by African governments, the private sector, and international donors.
- Develop incentive programs for private investors to support research initiatives.

Best Practices:

- **Accelerating Human Development** (HDX) supports facilitates investment in infrastructure and enables a better environment for health systems, as well as improved manufacturing capacities for health products and technologies.

- **Grand Challenges Africa** promotes Africa-led scientific innovations to help countries better achieve the Sustainable Development Goals by awarding seed and scale-up grants to the continent's most impressive solutions.
- **Sub-Saharan Funders Forum** brings together health research funders in African to promote collaboration and funding coordination to address a broad range of public health priorities.
- **South Africa's National Research Foundation** (NRF) provides structured funding for research projects – an example of government support towards HRD&I.
- **Nigeria's Tertiary Education Trust Fund** (TETFund) supports university-based research.
- **European and Developing Countries Clinical Trials Partnership** (EDCTP).
- **Funders Forum**

Strategies:

- Strengthen policies, platforms and an enabling for coordinating funding and implementation of HRD&I initiatives
- Implement **legally ring-fenced research budgets** to ensure consistent funding and strengthen public-private-partnerships.
- Utilize innovative financing methods like **health bonds and sin taxes** (e.g., tobacco/alcohol tax) to fund research.
- Set up **regional funding consortia** such as the Funders Forum to pool resources across multiple countries and research projects and to help avoid duplication of efforts in HRD&I funding.

3. Developing and Retaining a Skilled Health Research Workforce

Recommendations:

- Expand postgraduate training programs for researchers, focusing on emerging health challenges.
- Strengthen mentorship programs for young African researchers.
- Offer competitive salaries and career growth opportunities to curb brain drain.

Best Practices:

- **African STARS Fellowship Program for Young African Scientists** is an initiative aimed at building the capacity of the next generation African scientists in areas such as genomics and vaccine manufacturing.
- **H3Africa Consortium** trains African researchers in genomics and biomedical sciences.
- The **African Academy of Sciences** (AAS) provides fellowships for young researchers.

Strategies:

- Governments should establish **research career pathways** with clear progression routes.
- Universities should collaborate with manufacturers, governments, funders, global institutions to build the capacity of the next generation of scientists and link them to institutions that will provide them with the right exposure and experience.
- Introduce **remote research opportunities** and digital education to reach wider audiences.

4. Promoting Gender Equity in Health Research

Recommendations:

- Implement gender-sensitive research policies and funding schemes for women researchers.
- Establish mentorship and leadership programs specifically for female scientists.
- Introduce gender quotas for leadership roles in research institutions.

Best Practices:

- The **Royal Society SUSTAIN program** supports women in science and leadership.
- The **Mwele Malecela Mentorship (MMM) program** empowers African women researchers.

Strategies:

- Provide **scholarships and research grants** exclusively for women scientists.
- Create **family-friendly policies** (*e.g., flexible working hours, childcare support*).
- Promote **gender-balanced research teams** for equitable decision-making.

5. Reforming Regulatory Frameworks for Research

Recommendations:

- Strengthen Regional and National Regulatory authorities so that they are capable of supporting HRD&I initiatives including clinical trials and manufacturing initiatives.
- Promote the collaboration of NRAs across the different Regional Economic Communities
- Harmonize research approval processes across African nations to facilitate collaboration.
- Strengthen ethics committees and improve compliance with international research standards.
- Streamline patenting and intellectual property laws to protect African innovations.

Best Practices:

- The **African Medicines Agency** (AMA) was established to harmonize drug regulation across Africa.
- The **African Medicines Regulatory Harmonization** (AMRH) initiative works to standardize clinical trial oversight.
- **SAHPRA's collaboration with Egypt Drug Authority** is an example of how NRAs could collaborate as AMA is being operationalised.

Strategies:

- Implement fast-track approval mechanisms for research proposals.
- Develop a continental regulatory database for research standards.
- Provide regulatory training for health researchers and policymakers.

6. Encouraging Intra-African and Global Research Collaborations

Recommendations:

- Strengthen Africa CDC/AUDA-NEPAD Clinical Trials Ecosystem project to link coordinate and develop clinical trials ecosystem in Africa.
- Strengthen African research networks to promote knowledge sharing.
- Establish collaboration incentives between African institutions, academia, governments and global partners.

Best Practices:

- The **Grand Challenges Africa Initiative** fosters African-led health research collaborations.
- The **Science for Africa Foundation** (SFAF) supports collaborative research initiatives.
- **Africa CDC/AUDA-NEPAD Clinical Trials Ecosystem** to support the coordination of clinical trials and capacity building for researchers and establishment of more clinical trial sites.

Strategies:

- Create **continental research consortia** for large-scale studies.
- Offer **joint PhD and postdoctoral research programs** across African universities.
- Develop **African-led peer-reviewed journals** to boost global recognition.

7. Strengthening Public-Private Partnerships (PPPs)

Recommendations:

- Foster stronger collaboration between universities, industry, and government.
- Provide tax incentives for private-sector investment in health innovation.
- Establish innovation hubs for startups focusing on health technology.

Best Practices:

- The **Global Health Innovation Accelerator** (GHIA) is a partnership between the South African Medical Research Council an NGO and funders aimed at driving global health innovation and capacity building. Specifically, GHIA works with local innovators to support the local development and implementation of a portfolio of health-focused technologies as well as broader health innovation and helps with access to markets.
- The **Timbuktoo Pan-African HealthTech Hub** supports African health startups.
- **Boost Africa** provides venture capital for innovative African health startups.

Strategies:

- Offer **incubator grants** for health research startups.
- Encourage pharmaceutical companies to invest in **local vaccine manufacturing**.
- **Launch innovation challenges** and hackathons to stimulate health tech development.

8. Improving Ethical and Governance Standards in Research

Recommendations:

- Strengthen institutional ethics review boards for greater transparency.
- Enhance community engagement to ensure ethical research participation.
- Develop policies for fair benefit-sharing of research findings.

Best Practices:

- The **National Health Research Ethics Council** (NHREC) in South Africa sets national ethical guidelines.
- The WHO's **Local Production & Assistance Unit** (LPA) supports ethical production of health technologies.

Strategies:

- Standardize **informed consent processes** across Africa.
- Establish **research integrity offices** in major institutions.
- Encourage **ethical training programs** for researchers and policymakers.

These **recommendations and strategies** can be **implemented** by following the proposed **Action Plan for Strengthening Health Research, Development, and Innovation (HRD&I) Capacity in Africa**.

Table 1: Roadmap Action Plan.

Activity	Short Term (1 – 3 Years)	Medium Term (4 – 6 Years)	Long Term (7 – 10 Years)	Milestones & Responsible Persons
1. **Funding:** Securing Sustainable HRDR&I Funding.	• Establish dedicated research funds. • Implement innovative financing strategies.	• Diversify funding sources. • Reduce donor dependency.	Achieve financial sustainability for HRDR&I.	• **Milestone:** Monitor funding allocation and sustainability impact. • **Responsible:** Governments, Policymakers, NGOs.
2. **Developing and Retaining a Skilled Research Workforce.**	• Implement mentorship initiatives. • Strengthen postgraduate/ postdoc opportunities.	• Establish career pathways for researchers. • Improve research compensation.	Reduce brain drain by 50%.	• **Milestone:** Increase researcher retention rates. • **Responsible:** Universities, Ministries of Education, Industry, Scholarship Bodies.
3. **Promoting Gender Equity in HRD&I.**	• Launch mentorship programs for women. • Introduce leadership quotas.	• Improve gender representation in research leadership. • Expand women-focused grants.	Achieve a 50/50 gender balance in HRDR&I.	• **Milestone:** Track gender representation and leadership diversity. • **Responsible:** Governments, academic institutions, industry leaders.
4. **Reforming Regulatory Frameworks for Research.**	• Establish regulatory task forces. • Streamline research approval processes.	• Strengthen intellectual property laws. • Implement harmonized policies across regions.	Achieve seamless research approvals continent-wide.	• **Milestone:** Standardize and accelerate research approvals. • **Responsible:** AU, CDC, National Intellectual Property Offices, Tech Transfer Offices.

Activity	Short Term (1 – 3 Years)	Medium Term (4 – 6 Years)	Long Term (7 – 10 Years)	Milestones & Responsible Persons
5. Encouraging Intra-African and Global Research Collaborations.	• Develop policies for intra-African research. • Strengthen regional research networks.	• Implement visa reforms for research mobility. • Expand joint PhD programs.	Increase African-led global research publications.	• **Milestone:** Track cross-border research partnerships. • **Responsible:** Universities, African governments.
6.Strengthening Public-Private Partnerships (PPPs).	• Identify key private-sector partners. • Promote industry-academia collaborations.	• Implement tax incentives for R&D investments. • Develop innovation hubs.	Establish self-sustaining research & innovation ecosystems.	• **Milestone:** Increase private-sector investment in R&D. • **Responsible:** Industry, Ministries of Commerce, Universities.
7.Improving Ethical and Governance Standards in Research.	• Establish ethics training programs. • Strengthen ethics review boards.	Standardize informed consent & ethical review processes.	Ensure full compliance with international ethical standards.	• **Milestone:** Achieve uniform ethical research standards across Africa. • **Responsible:** Research Ethics Boards, Government, Industry.

This action plan provides a **structured roadmap** to enhance HRD&I capacity in Africa by addressing key challenges and implementing **best practices**. With strong commitment from governments, research institutions, industry partners, and international donors, Africa can build a **robust and sustainable** health research ecosystem that contributes to global health security and innovation. It also provides information on best practices in the continent.

CONCLUSION

The report highlights a complex landscape of challenges and opportunities in health research, development, and innovation in Africa. It also shows some best practices that need to be scaled. Addressing the complex issues requires a multifaceted approach involving increased funding, enhanced training, collaborative partnerships, and strategic policy reforms, all aimed at building a robust and sustainable research ecosystem on the continent.

The importance of leadership from a continental and regional economic hub levels is a consistent theme that provides opportunities for improved collaboration and coordination. The coordination of resources aimed at capacity building for HRD&I cannot be over emphasised. It helps with alignment on research priorities and ensures that optimal benefit is derived from HRD&I investments.

The research also highlights pockets of excellence in HRD&I implementation and collaboration.

RECOMMENDATIONS

Given the foregoing, the study proposes the following recommendations.

1. There is a need to establish what roadblocks would impede6 the implementation of the recommendations within the roadmap. This would include establishing how continental leaders can improve coordination of HRD&I efforts and thus ensure long-term commitment to HRD&I initiatives.
2. There is also a need to establish how incentives can be structured to attract more private-sector involvement.
3. There is a need to establish how African governments can legally ring-fence budgets for sustainability of HRD&I funding. This would also include looking into what innovative strategies can be introduced to ensure funding sustainability and thus reduce dependency on donor funding.
4. There is a need to establish how African nations can create a unified regulatory framework for HRD&I.
5. There is a need to establish data-sharing policies across the continent. This would include establishing a database to store data as and when it is collected by countries to enable prediction, identification and tracking of viruses/ diseases and pandemics before they break out or very early on.
6. There is a need to do an extensive analysis of regional HRD&I best practices across the continent to establish how these can be successfully replicated in other regions within the continent.
7. There is a need to do a longitudinal study to monitor the impact of HRD&I initiatives on health outcomes. This would provide evidence of HRD&I on improved health outcomes and thus provide motivation for future investments into the sector.

These recommendations leverage the insights gained from the desktop review and the action plan. By addressing these recommendations there is an opportunity to contribute significantly to building a sustainable and effective health research ecosystem, ultimately leading to improved health outcomes and innovation across the continent.

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