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Building health research capacity in Africa: the Einstein-Rwanda research and capacity building program

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Abstract

The growing demand for healthcare services and the burden of diseases such as cancer in sub-Saharan Africa (SSA) requires locally-led and setting-relevant evidence that should be driven by local investigators. However, there is a huge gap in the health research capacity to generate such evidence in most of SSA, particularly in Rwanda. With a changing focus and the willingness of investigators and funders from high-income countries (HICs) to support investigators and research from SSA, it is important to build strong, successful, and sustained partnerships. In this perspective, we describe the Einstein-Rwanda Research and Capacity Building Program (ER-RCBP), which represents almost two decades of a fruitful and sustained partnership that has contributed to the development of research physical and human resources in Rwanda. We have established a broad range of health research infrastructure that involves human resources, including training three pathologists, leadership and administrative personnel and structures, clinical research operations, laboratory capacity, and data collection and management systems, and are implementing a long-term plan to transfer most of the leadership to local investigators and the local lead institution. Our experience demonstrates that collaborations between high- and low-income countries can be leveraged to strengthen research capacity in SSA but that such efforts require putting in place structures and systems to ensure success. Building strong partnerships and collaborations, good leadership, empowering local teams, and having buy-in from national governments are key to achieving sustainable research capacity in SSA.

Keywords Research capacity strengthening, Research collaboration and partnerships, Einstein, Rwanda and sub-Saharan Africa

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Background

Africa, especially sub-Saharan Africa (SSA), experiences the greatest burden of many diseases, including infectious diseases, some cancers (mostly those that are preventable), and emerging, re-emerging, and neglected diseases [1–3]. In the past, most of the evidence used for policy formulation to prevent and control these diseases in SSA was derived either from studies conducted in high-income countries (HICs) or from those conducted in SSA but led by investigators from HICs. This has implications both in terms of applicability and policy

makers in SSA being slow to adopt some recommendations from HICs [4].

Additionally, there is limited data/evidence utilization by policy makers to inform their decisions mainly because of not aligning research with national priorities as mentioned in the World Health Organization (WHO) report on Health Evidence Network Synthesis [5], which includes producing and using research among the four functions of strengthening health research systems. There is a growing trend and advocacy from different stakeholders to have locally derived data to inform local policy, and this has put a spotlight on the lack of research capacity in many SSA countries [6].

There is a huge gap in health research capacity in Rwanda and in SSA, resulting in multifaceted disparities in research output [7, 8]. This is further complicated by the lack of institutional support and local mentorship for most African investigators. Africa-based investigators conducting high-impact research are emerging, and there is increasing awareness among African governments and civil society about the need for locally-derived data for appropriate policy formulation. In addition, investigators from HICs and funding agencies, such as the United States (US) National Institutes of Health (NIH), are increasingly willing to support African investigators to strengthen their research capacity through training, mentorship, and funding.

For example, a 2009 report from the US National Academies of Sciences, Engineering, and Medicine highlighted the commitment of the US Government through the NIH and the Centers for Disease Control and Prevention (CDC) to strengthen the capacity of international partners in health research [9]. Specifically, the NIH's Fogarty International Center (FIC) has been running successful capacity-strengthening programs, including the Acquired Immunodeficiency Syndrome (AIDS) International Training and Research Program (AITRP) that brought scientists from low-and-middle-income countries (LMICs) to the US to train in multidisciplinary biomedical and behavioral research in human immunodeficiency virus (HIV)/AIDS and related comorbidities [10]. The FIC has also been funding training programs under the D71/D43 and G11 grant mechanisms, which aim to improve research capacity in LMICs [11].

The Einstein-Rwanda Research and Capacity Building Program (ER-RCBP) is one of several research collaborations between HICs and LMICs existing across SSA that deserve mentioning. Another example is the Academic Model Providing Access to Healthcare (AMPATH), a partnership between Indiana University in the US and Moi University in Kenya, which has mainly focused on academic and clinical exchanges with integrated research and educational opportunities via a consortium of multiple US academic institutions [12]. Another partnership of note is between the Fred Hutch Cancer Center-Uganda Cancer Institute [13] and the University of North Carolina (UNC) project in Malawi [14], which have contributed to capacity strengthening via NIH-funded research projects as well as educational opportunities.

It is critical to understand the key components of HIC-LMIC collaborations, particularly in developing local capacity and building sustainable, LMIC-driven research infrastructure. We therefore showcase the ER-RCBP, a collaboration between Rwandan and US institutions of almost two decades, and describe how partnerships have been built and sustained, human and infrastructural capacity strengthening approached, and its research leadership, coordination, clinical, laboratory, and data systems and structures. We also document the lessons learned, challenges, and best practices from this collaboration that may serve as a resource for other networks and institutions aiming to strengthen research capacity in SSA.

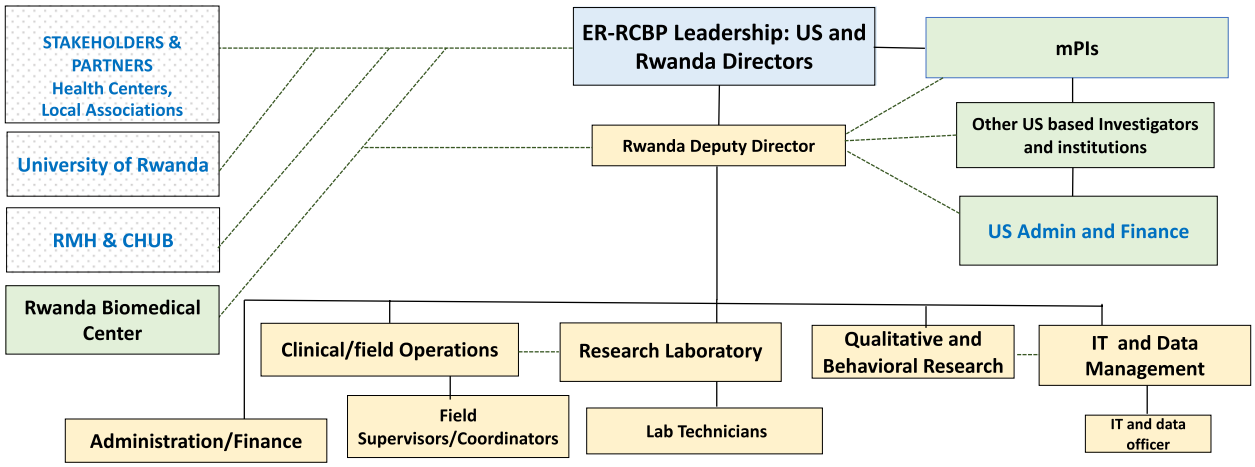
Development and accomplishments of the ER-RCBP

Partnerships and collaborations

The ER-RCBP, which has operated as a partnership with various institutions in Rwanda since 2004, has primary partners, including the Albert Einstein College of Medicine (Einstein) and Research for Development (RD Rwanda). The ER-RCBP also has an operational partnership with the Rwanda Military Referral and Teaching Hospital (RMRTH) and collaborates with other institutions, including the Rwanda Biomedical Center (RBC), the University of Rwanda, and the NIH's National Cancer Institute (NCI); there is also a proposed expansion to the University Teaching Hospital of Butare (CHUB). Nearly all funding for the ER-RCBP comes from the US NIH, mostly from the NCI and the National Institute of Allergy and Infectious Diseases (NIAID).

Currently, the ER-RCBP has a clear vision and structure (Fig. 1) that has been spearheaded by local investigators with support and guidance from senior US investigators. This highlights the role of local researchers in the success of any collaborative initiatives. While support from HICs may be crucial to strengthening capacity in SSA, local investigators and partners must play an integral and eventually leading role in setting the research agenda and running projects on the ground, providing commitment and extra effort to acquire the much-needed knowledge and skills required to nurture partnerships through smooth communication, transparency, and innovation.

The ER-RCBP has achieved several milestones that are key to strengthening health research capacity in Rwanda, including establishing a well-coordinated team and locally led scientific productivity, especially in the past few years [15–32]. In order to build sustainable research capacity, resources should be allocated to several levels of



CHUB: University Teaching Hospital of Butare; ER-RCBP: Einstein-Rwanda Research and Capacity Building Program; IT: Information and Technology; mPI: Multi-Principal Investigator; RMH: Rwanda Military Hospital; US :United States of America

Fig. 1 The Einstein-Rwanda research and capacity building program organizational structure

infrastructure development to achieve the ultimate goal of sustaining generational capacity to conduct research that informs policy and practice in any setting. These include human resource capacity strengthening, leadership, coordination and administrative structures, clinical and field research operations capacity, laboratory infrastructure (if required), and data collection and management systems.

Human resource capacity strengthening

The ER-RCBP has contributed to training a diverse group of Rwandan medical doctors, nurses, and allied health professionals. Through mostly US NIH and Einstein institutional funding, at least 30 individuals, including 12 medical doctors, 11 nurses, three laboratory scientists, and five allied health professionals, have been fully or partially supported to obtain advanced degrees (master's and/or PhD), with some individuals, mainly diploma-level nurses, supported to obtain their Bachelor's degrees (Table 1). Driven by the funding source, most of the training has focused on HIV and cancer-related fields for clinical training, research-based training, or a combination of both. Over 90% of the trained individuals are currently working in Rwanda or participate in Rwanda-related work as health leaders, researchers, medical specialists, health technical experts, and civil society leaders.

Table 1 List of Rwandans trained in various fields and their current status

Field of training	Number of trainees	Degree	Location	Duration	Completion date	Training grant
Clinical research training	12 total, 8 MDs, 4 allied health professionals or academics	Epidemiology, statistics, and research ethics	Rwanda	1 month	Jan 29, 2010	D43
Pathology	3 MDs	MMed in Pathology	USA, Kenya, and Tanzania	1–3 years	2013, 2014, 2015, 2023	D43 and institutional funds
Clinical research methods	2 MDs	MS	USA	2 years	2013, 2014	D43
Epidemiology and biostatics	4 MDs	MS	South Africa	2 years	2013	D43
Public health	10 total, 2 MDs, 5 nurses, and 3 allied health professionals	MPH	Rwanda	2 years	2018–2023	Institutional funds
PhD	8 total, 3 MDs, 1 nurse, and 4 allied health professionals	PhD	Australia, Rwanda, and Switzerland	3–5 years	2018–2025	Institutional funds

D43, US National Institutes of Health International Research Training Grant, *MD* Medical Doctor, *MPH* Master of Public Health

This represents an extremely high retention rate and provides an example of scientific workforce development without the subsequent migration of research personnel out of the country, i.e., "brain drain." Factors contributing to this high retention include the Government of Rwanda's (GoR) commitment to human resource development (manifested through retention contracts signed between the GoR and trainees) and the ER-RCBP's supporting reintegration of trainees into the Rwandan system when they return by providing projects for them to participate in and competitive salaries upon their return.

D43, US National Institutes of Health International Research Training Grant; *MD*, Medical Doctor; *MPH*, Master of Public Health.

In addition to the formal training that yields an academic degree, most of the trained individuals receive mentorship to further develop their research skills through conducting pilot studies, leading analyses, writing abstracts and/or manuscripts and ultimately grant applications, and via field study implementation and research leadership. This is coupled with active and planned mentorship programs, ranging from monthly research club meetings on various research topics to the NIH-funded Fogarty-IeDEA mentorship program (FIMP) [33], which have yielded significant results in terms of acquiring skills and scientific productivity. In addition, the ER-RCBP offers short training and courses for team members and partners in various areas, including clinical and laboratory procedures, summer courses on cancer prevention, and research training including qualitative research.

These longitudinal activities highlight the need to go beyond supporting an advanced degree, which is not an end but a first step in developing a research career. It is also important to note that the time it takes to become an independent researcher in SSA is longer than in HICs, given the individual, institutional, and systemic barriers and challenges encountered in SSA. These activities have expanded beyond the research team members to support in-country clinicians to have protected time to be involved in research in order to develop their research skills. This leverages the investment in developing the funded research team to strengthen further capacity in-country.

In addition to developing Rwandan research capacity, the ER-RCBP has served as a basis for regional capacity-strengthening efforts. These include supporting similar models in other countries in the region such as Cameroon and the Democratic Republic of Congo (DRC), utilizing the infrastructure of the Central Africa International Epidemiology Databases to Evaluate AIDS (CA-IeDEA) [34], as well as the Einstein-Rwanda/DRC HIV-Associated Malignancies Research Center (HAMRC), both funded by the NIH. These efforts involve strengthening research capacity for both local research teams as well as staff from local partner institutions through regular research meetings and South-South collaborations, leveraging other resources including government and other non-NIH partners. In addition, a population-based research training program was launched in January 2023 to train individuals from the five countries participating in the CA-IeDEA program on basic epidemiology, biostatistics, computer programming, and data management. The program was designed to have virtual and in-person practical components where participants attended up to 10 scientific sessions virtually (online via Zoom) and a 2-week in-person practical training in Kigali, Rwanda, in September 2023.

Leadership, coordination, and administrative structures

Over nearly two decades, the ER-RCBP has put in place solid leadership, coordination, and administrative structures that have ultimately allowed RD-Rwanda (the main Rwanda partner institution) to successfully apply for (in 2022) and receive (in 2023) its first NIH grant with a Rwandan contact principal investigator. This achievement has required years of engagement with the local team members, mentorship, and training. Currently, the ER-RCBP is led by a team that includes a Rwandan director who oversees all scientific and administrative aspects of the program, a US director (given the multinational nature of the collaboration), a Rwandan deputy director, and other senior Rwandan and US investigators who support specific projects.

Under the directors is a secondary level of coordinators and managers who are responsible for specific aspects of studies, projects, and units (Fig. 1). Directors as well as coordinators and managers form the management team that meets monthly to discuss progress and identify challenges. Rwandan directors then meet the US director to provide updates and make decisions. Further discussions and engagement are made within various committee meetings depending on the project or activity. This is coupled with a monthly activity plan and weekly activity reports communicated to all partners.

This leadership and coordination structure makes it possible to keep all team members fully informed, and it serves as a capacity strengthening framework for the local team. Study coordinators and managers feel empowered and valued by being part of the decision-making process which signifies inclusive leadership. The structure also allows for the empowering of various study and project team members because they feel represented at the highest level of the structure. This engagement is reinforced through less formal opportunities for interaction between the field/data entry staff, study

coordinators, and senior investigators, as the leadership team participates in some clinical procedures/field operations and study coordinators are mostly nurses who also do clinical work.

Efforts have been made to build the administration team to allow the division of labor required for financial accountability with significant team expansion over the years. The administrative core has been empowered further by leadership from the deputy program director given the importance of the administrative structures and capacity required to apply for and administer NIH grants. Over the years, multiple members of the administrative team have been trained in NIH policy and fiscal procedures and practices, and the program, through the host institution, is currently well suited and positioned to serve as an NIH prime award recipient. That has led to the Rwanda team applying for its first NIH grant as the pass-through entity (PTE) as noted above, and more projects, grant applications, and team building initiatives are in the pipeline. This administrative capacity reflects the amount of institutional capacity strengthening for RD Rwanda that could serve as a national or regional resource. This institutional capacity is already being used to support research administration at other local partner institutions such as RBC.

Clinical and field research operations

Over the years, the ER-RCBP has built enormous capacity in clinical and field research operations, and we currently have structures in place to implement diverse, multi-site, and complex studies that require extensive field operations. Our team members have the capacity to be involved in multiple studies over a certain period given study needs. For example, we have longitudinal studies for which we complete enrollment of all participants within 3 months, with a need for follow-up visits 12 months after enrollment. Thus, there is a sufficient period between completing the baseline and initiating the 12-month follow-up visits. In this case, staff will be working on other studies during that period, having been trained on multiple study protocols and procedures. These complex field operations require intricate planning that requires consideration of study timelines and deliverables, staff availability (annual/maternal/sick leave), and participant recruitment, enrollment, and flow for the over 15 currently active protocols.

Because we have developed a robust research capacity, the ER-RCBP has successfully implemented a number of complex clinical procedures that were previously unavailable in Rwanda, such as cervical and anal cancer screening as well as other measurements such as substance and alcohol use and genetic testing in studies of HIV comorbidities. Over nearly two decades, we have trained Rwandan nurses and doctors on visual inspection with acetic acid (VIA), specimen collection for human papillomavirus (HPV) testing (both dry swabs and in PreservCyt- Hologic, Bedford, MA, USA), colposcopy, high-resolution anoscopy (HRA), cryotherapy, thermal ablation, loop electrosurgical excision procedure (LEEP) and digital imaging of the cervix and anal canal with a mobile phone and/or camera adapted colposcope. We have also introduced multi-drug panel substance point-of-care (POC) testing and long-term specimen collection and storage on dried blood spot (DBS) cards (Table 2). This diverse capacity has positioned our team to be competitive for expansion of both North–South and/or South-South collaborations, further strengthening the team's capacity.

Laboratory development and capacity

In the early days of the ER-RCBP, most laboratory (lab) testing was performed outside of Rwanda given the complexity of setting up a research lab plus the high cost, not forgetting the sustainability of the lab after the project it supported was phased out. However, when the right opportunity arose with growing research lab needs, the program leadership established a full-fledged research lab in Rwanda in partnership with RMRTH beginning in 2016. The following techniques have been implemented over the past few years:

1. HPV DNA testing using the GeneXpert (Xpert) platform (Cepheid, Sunnyvale, California, USA). The Xpert HPV assay is a qualitative, real-time polymerase chain reaction (PCR) assay for the detection of 14 high-risk (hr) HPV types detected in five fluorescent channels: (i) HPV16; (ii) HPV18 and hrHPV 45 (HPV18/45); (iii) HPV31, 33, 35, 52, and 58; (iv) HPV51 and HPV59; and (v) HPV39, 56, 66, and 68.
2. The E6/E7 Oncoproteins test (Arbovita Corporation, CA, USA). The E6/E7 oncoprotein test uses three lateral flow strips to detect eight hrHPV types.
3. A specimen biorepository (biobank) using a lab information system, Freezerworks. We currently have tens of thousands of specimens and/or aliquots stored in freezers at various temperatures, and we are currently setting up electronic temperature monitoring and a shipping module to allow easy shipping out of specimens or aliquots.
4. The AmpFire HPV genotyping assay (Atila Biosystems Inc., Mountain View, CA, USA) which is an isothermal nucleic acid amplification-based, real-time fluorescence detection of 15 HPV genotypes (16, 18, 31, 33, 35, 39, 45, 51,52, 53, 56, 58, 59, 66, and 68) individually.

Table 2 List of previous and current studies conducted by the ER-RCBP

ER-RCBP major studies' recruitment, retention, and relevant activities and skills						
Study	**Years**	**Recruitment period**	***N***	**Follow-up period**	**Annual retention**	**Relevant activities and skills**
Cervical cancer screening studies						
RWISA	2005–2010	6 months	970	Q6m for 5 years	93%	Cytology, HPV testing, colpo, LEEP, biorepository
HPV demonstration project with CareHPV study (CxCa see and Treat, clinic- and community-based)	2009–2010	1 year	3100	Not applicable	NA	HPV, VIA, Cryotherapy, biorepository, CHW
Optimal methods for CxCa prevention among WWH	2015–2020	2 years	5061	2 years f/u of screen + WWH	89–91%	Xpert HPV, E6/7, p16, Ki67, image capture for AVE, colposcopy, thermal ablation, LEEP, biorepository, CHW
Anal high-risk human papillomavirus (hrHPV) and ASIL in Rwandan WWH with cervical HPV (pilot)	2019	1 month	50	NA	NA	Anal pap, HRA, anal/cervical HPV by Ampfire, biorepository
Other studies in people living with HIV						
Prevalence and incidence of HPV, HIV, and anal disease in Rwandan MSM	2016–now	1 year	350	Q6m × 8	91%	ACASI, anal, penile specimens, HRA, Ampfire, biorepository, anal cytology
CA-IeDEA Sentinel Research Network	2020–now	9 months	600	6 months, 12 months, 24 months	99%	POC testing, fibroscan, ACASI, REDCap, biorepository
Reducing time to spaced-out appointments for newly diagnosed people living with HIV (pilot)	2020–2022	6 months	90	6 months, 12 months	97%	Clinical trial (pilot), REDCap
Cancer Registration	2010–now	Ongoing	19,906	NA	NA	Senior cancer registrars/trainer, transferred to RBC 2018; registry match with HIV; access to data
CA-IeDEA	2011–now	Ongoing	35,000	Ongoing	94%	Secondary data extracted from EMR

ASIL Anal squamous intraepithelial lesions, *ACASI* Audio computer-assisted self-interview, *AVE* Automated visual evaluation, *CA-IeDEA* Central Africa International epidemiology Databases to Evaluate AIDS, *CxCa* Cervical cancer, *colpo*, colposcopy, *ER-RCBP* Einstein-Rwanda Research and Capacity Building Program, *EMR* Electronic Medical Record (OpenMRS), *E6/E7*, E6 and E7 HPV oncoproteins, *HRA* high-resolution anoscopy, *MSM* Men who have sex with men, *NA* Not applicable, *POC* Point of care, *p16*, p16 expression marker, *Q6m*, every 6 months, *REDCap* Research Electronic Data Capture, *RBC* Rwanda Biomedical Center (Ministry of Health), *RWISA* Rwanda Women's Interassociation and Assessment, VIA Visual inspection with acetic acid, *WWH* Women living with HIV

5. Next Generation Sequencing (NGS) using the MiniSeq (Illumina, USA).
6. HPV antibody titers serology testing using Enzyme-linked immunosorbent assay (ELISA).

All these techniques and infrastructure have required extensive training, quality control, and enormous effort by the local lab scientists to be able to achieve the current standards, although more needs to be done. With this infrastructure, we have managed to perform testing under South-South collaborations, and we have other requests in the pipeline. This is in line with our vision of becoming a regional hub for HPV research, and we plan to continue building on the current infrastructure both to apply for more funding for additional research and to set up higher capacity and throughput machines.

Data collection and management systems

Our team has used and has been adopting multiple data collection tools over the past years, ranging from paper-based data collection, offline electronic databases (Microsoft Access/Excel), and online real-time data entry tools such as Research Electronic Data Capture (REDCap). However, REDCap requires servers that are not readily available in Rwanda, and we thus still rely on servers in the US. This raises some issues around data security, study participant privacy, and confidentiality. Specifically for Rwanda, the Rwanda National Ethics Committee

(RNEC) does not allow data containing participant identifiers to leave the country in any form, and this has led us to put in place systems that prevent that from happening. This has involved setting up local, offline databases that contain participant identifying information and that can be linked (locally) to the online database if required. We are also studying the feasibility of hosting a REDCap server in Rwanda in order to have the Rwanda team take full control of the database in addition to the recent training on developing REDCap questionnaires.

In addition, we have used other tools such as audio computer-assisted self-interviewing (ACASI) which allows participants to self-interview using a tablet while reading and listening to the questions. This is especially important when asking sensitive questions such as those about sexual behavior, traumatizing events, and substance or alcohol use. ACASI is also popular with young participants who are familiar with and like using electronic tools, hence making participating in studies more enjoyable. Nevertheless, ACASI has been difficult to merge with or link to some other databases such as REDCap; however, our data management team has been able to develop protocols for database linkage.

Lessons learned, challenges, and best practices

Given the limited resources in SSA, strengthening research capacity and conducting research in the region typically requires funding from HICs and partnership/collaboration with investigators from those countries [35]. It is therefore important for SSA-based investigators to seek and sustain successful partnerships and collaborations to achieve research capacity and mentorship. This should be coupled with well-coordinated initiatives to avoid duplication and waste of the limited resources [36] as well as evaluation of these initiatives to assess impact at individual, institutional, and societal levels [37]; the ER-RCBP has achieved some aspects of these levels.

One of the biggest challenges in Africa is training and retaining a competent workforce that would bring about societal change over time. There has been slow but steady human resource development in SSA in spite of the continued exodus of African scientists and scholars to HICs [38]. To retain SSA scientists, national governments must both invest in training and create conditions for professional development [39]. The latter is more challenging than the former because in addition to training, it is important both to motivate the workforce and to create satisfactory working conditions that make it conducive for the trained individuals to grow in all aspects and stay in their home countries to contribute their skill and knowledge to local development. The support provided to trained cadres under the ER-RCBP could serve as a model for other partnerships and institutions to improve the retention of the highly needed and valuable human resources supported by international collaborations.

Leadership is a critical component of any enterprise's success and creates enormous potential for growth, mobilization of resources, and deliverables. Good leadership makes teams perform better through fostering a sense of mission, ensuring inclusiveness, engaging team members, and communicating clearly and appropriately delegating tasks. One of the major challenges for conducting research in SSA is the lack of research administrative support which is necessary for investigators to achieve their full potential. Most research institutions in Africa lack the necessary administrative structures to support investigators to apply for funding, manage awards, and work with research teams to provide all the required field and logistical support.

It is therefore crucial to put in place strong local leadership and administrative structures to allow investigators to continue to grow. This should be coupled with efficient clinical and field research operations which are key to successful research performance. This requires research teams to be trained in all the necessary steps to implement a study, from developing a study protocol to enrollment. This requires making sure that everyone to be involved is included in the process at a very early stage. Over time, this becomes easy to manage since all team members are familiar with the process.

Clinical research studies also often require lab infrastructure, which necessitates technology transfer of lab techniques that have already been set up elsewhere or de novo ones. Set-up of any of those techniques in SSA can be challenging given the required operational expertise and lack of trained individuals, especially for molecular lab techniques; this was even more challenging before the COVID-19 pandemic when the use of molecular lab technologies was rare or even unheard of in Rwanda and SSA. Molecular lab techniques require a rigorous working environment and very close supervision and quality control to achieve the necessary standards. In addition, training lab scientists in these techniques may take long and certain skills are acquired over time rather than from a single training event. Our experience indicates that laboratory knowledge and tech transfer are possible in Rwanda and potentially in SSA, and empowering local lab technicians is key to achieving sustainable resources.

The ultimate goal of any biomedical research enterprise is to collect high-quality data to understand what is happening in the studied population for a given disease and, using that information, to have a substantial positive impact on related health outcomes. It is therefore critical to put in place data collection and management systems for a successful research enterprise. All these activities and initiatives under the ER-RCBP could serve

as a model for other North–South collaborations in order to contribute to strengthening research capacity in SSA with potential for South-South knowledge and technology transfer. For example, the ER-RCBP has supported developing data management system capacity in the DRC, and our data manager has been training the Congolese team on ACASI.

Similar initiatives, coupled with the mobilization of and collaboration with local academic and public institutions, would stimulate local innovation where SSA investigators design and lead research studies in their home countries. This would ideally shed light on the need for publicly- or locally-funded research in those countries which, if achieved, would ultimately make both research capacity strengthening and the sustainable conduct of research in SSA possible in line with the WHO's four functions for health research systems strengthening [5, 40].

Regardless of these achievements, the program has faced several challenges, especially at the beginning of major projects, that warrant mention with the inclusion of some solutions and best practices. Cultural and contextual differences have led to miscommunication and mistakes from both sides of the partnership. This led to perceived slowness of the local system that sometimes meant delays and potential project failures. Understanding the cultural and contextual differences to avoid miscommunication and ignorant mistakes is key to building sustainable partnerships.

In addition, partnerships should be built on mutual benefit and trust, and good local leadership is key to success. In addition, the lack of integration mechanisms for sponsored research in local institutions, especially public ones, is a major challenge. This has led to change in partnerships over time to reach the current arrangement. Although every setting has its own "modus operandi" which should be carefully studied for adaptation and integration, systems should be put in place to make sure the partnerships are sustainable by ensuring continuity by local team members.

Furthermore, the scarcity of local senior scientists and mentors has impacted the speed at which capacity strengthening could be achieved especially for lab procedures and qualitative research. Although local scientists and mentors are scarce, it is important to identify and invest in local talent and to have long-term mentorship plans for successful capacity strengthening. Additionally, some "trivial" processes such as procurement can be very challenging due to inadequate integration of research processes in local procedures and could negatively impact research projects given the tight timelines that require quick procurement of equipment and supplies to ensure research success. This could be overcome by allowing local research administrative teams the autonomy and capacity to manage these procedures. Finally, other processes such as waste management still require optimization and strengthening, and local capacity to manage those processes is key to sustainability.

Future directions and conclusions

Although more work needs to be done, the ER-RCBP is currently a balanced partnership with the capacity to potentially sustain research funding and serve as a capacity-strengthening resource for Rwanda and the region. Some potential areas of future capacity strengthening include implementation science research and clinical trials capacity in order to diversify resources and partnerships.

In conclusion, North–South collaborations can be leveraged to strengthen research capacity in Rwanda and potentially in SSA. This requires putting in place structures and systems to ensure success. Building strong partnerships and collaborations, good leadership, empowering local teams, and having buy-in by national governments which should build on these international partnerships are key to achieving sustainable research capacity in SSA.

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Authors' contributions

KA has sought most of the funding for the program, GM drafted the initial text, GM, GK and KA currently lead the program, PC and KA edited and structured the initial text, GK, FR, AB, ER, JR, TH, AA, SN, MY, JP, LM, PC and KA all edited the text and are key collaborators in the program. All authors read and approved the final manuscript.

Authors' information

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

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Competing interests
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References

1. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. CA Cancer J Clin. 2021;71(3):209–49.
2. Ngwa W, Addai BW, Adewole I, Ainsworth V, Alaro J, Alatise OI, et al. Cancer in sub-Saharan Africa: a Lancet Oncology Commission. Lancet Oncol. 2022;23:e251–312.
3. UNAIDS. UNAIDS Data 2023. 2023; https://www.unaids.org/en/resources/documents/2023/2023_unaids_data.
4. Kasprowicz VO, Chopera D, Waddilove KD, Brockman MA, Gilmour J, Hunter E, et al. African-led health research and capacity building- is it working?, vol. 20. BioMed Central: BMC Public Health; 2020.
5. Hanney S, Lucy, Subhash Pokhrel K, Jones T, Boaz A. What is the evidence on policies, interventions and tools for establishing and/or strengthening national health research systems and their effectiveness? Health Evid Netw Synth Rep. 69. https://pubmed.ncbi.nlm.nih.gov/32598113/.
6. Condo J, Kateera B, Mutimura E, Birungi F, Ndagijimana A, Jansen S, et al. Building clinical trial priorities at the University of Rwanda. Trials. 2014;15:467.
7. Mutebi M, Lewison G, Aggarwal A, Alatise OI, Booth C, Cira M, et al. Cancer research across Africa: a comparative bibliometric analysis. BMJ Glob Health. 2022;7(11):1–13.
8. Hornstein P, Tuyishime H, Mutebi M, Surg Mm, Lasebikan N, Rubagumya F, et al. Authorship Equity and Gender Representation in Global Oncology Publications. 2022; Available from: https://ascopubs.org/go/authors/open-access
9. Institute of Medicine (U.S.). Committee on the U.S. Commitment to Global Health. The U.S. commitment to global health : recommendations for the public and private sectors. National Academies Press; 2009. 278 p.
10. Kupfer L, Hofman K, Jarawan R, Mcdermott J, Bridbord K. Strategies to discourage brain drain. Vol. 82, Bulletin of the World Health Organization. 2004. https://pubmed.ncbi.nlm.nih.gov/15375452/.
11. FIC/NIH. Fogarty Funding Opportunities. 2023. https://www.fic.nih.gov/Funding.
12. Turissini M, Mercer T, Baenziger J, Atwoli L, Einterz R, Gardner A, et al. Developing ethical and sustainable global health educational exchanges for clinical trainees: Implementation and lessons learned from the 30-year academic model providing access to healthcare (ampath) partnership. Ann Glob Health. 2020;86(1):1–9.
13. UCI-Fred Hutch Collaboration. 2024. https://research.fredhutch.org/uci-fred-hutch-collaboration/en.html.
14. UC Project Malawi. 2024. https://globalhealth.unc.edu/malawi/about-2/.
15. Musiime S, Muhairwe F, Rutagengwa A, Mutimura E, Anastos K, Hoover DR, et al. Adherence to highly active antiretroviral treatment in HIV-infected Rwandan women. PLoS One. 2011;6(11):1–6.
16. Munyazesa E, Emile I, Mutimura E, Hoover DR, Shi Q, Mcginn AP, et al. Assessment of haematological parameters in HIV-infected and uninfected Rwandan women: a cross-sectional study. BMJ Open. 2012;2. Available from: https://doi.org/10.1136/bmjopen-2012-001600
17. Tumusiime DK, et al. Over-reported peripheral neuropathy symptoms in a cohort of HIV infected and uninfected Rwandan women: the need for validated locally appropriate questionnaires. Afr Health Sci. 2014;14(2):460–7.
18. Jean d'Amour Sinayobye et al. Prevalence of shingles and its association with PTSD among HIV-infected women in Rwanda. BMJ Open. 2014;4(11):1–6.
19. Mutimura E, Anastos K, Lin Z, Cohen M, Binagwaho A, Kotler DP. Effect of HIV infection on body composition and fat distribution in rwandan women. J Int Assoc Physicians AIDS Care. 2010May;9(3):173–8.
20. Dusingize JC, Hoover DR, Shi Q, Mutimura E, Kiefer E, Anastos K. Associations of HIV infection with insulin and glucose levels in antiretroviral-naïve Rwandan women: a cross-sectional analysis. Available from: http://bmjopen.bmj.com/
21. Dusingize JC, Hoover DR, Shi Q, Mutimura E, Kiefer E, Cohen M, et al. Association of serum albumin with markers of nutritional status among HIV-infected and uninfected rwandan women. PLoS One. 2012;7(4):1–7.
22. Mutimura E, Hoover DR, Shi Q, Dusingize JC, Sinayobye JDA, Cohen M, et al. Insulin resistance change and antiretroviral therapy exposure in HIV-infected and uninfected Rwandan women: A longitudinal analysis. PLoS One. 2015;10(4):1–12.
23. Dusingize JC, Hoover DR, Shi Q, Mutimura E, Rudakemwa E, Ndacyayisenga V, et al. Association of Abnormal Liver Function Parameters with HIV Serostatus and CD4 Count in Antiretroviral-Naive Rwandan Women. AIDS Res Hum Retroviruses. 2015Jul 1;31(7):723–30.
24. Sinayobye JDA, Sklar M, Hoover DR, Shi Q, Dusingize JC, Cohen M, et al. Prevalence and risk factors for High-Risk Human Papillomavirus (hrHPV) infection among HIV-infected and Uninfected Rwandan women: Implications for hrHPV-based screening in Rwanda. Infect Agent Cancer. 2014;9(1):1–11.
25. Sinayobye J d'Amour, Sklar M, Hoover DR, Shi Q, Dusingize JC, Cohen M, et al. Prevalence and risk factors for High-Risk Human Papillomavirus (hrHPV) infection among HIV-infected and Uninfected Rwandan women: implications for hrHPV-based screening in Rwanda. Infect Agent Cancer. 2014;9(1):40. Available from: https://doi.org/10.1186/1750-9378-9-40
26. Murenzi G, Dusingize JC, Rurangwa T, Sinayobye JD, Munyaneza A, Murangwa A, et al. Protocol for the study of cervical cancer screening technologies in HIV-infected women living in Rwanda. BMJ Open. 2018;8(8):e020432. Available from: https://doi.org/10.1136/bmjopen-2017-020432.
27. Murenzi G, Kim HY, Munyaneza A, Tuyisenge P, Zawadi TM, Buteera AM, et al. Anogenital Human Papillomavirus and HIV Infection in Rwandan Men Who Have Sex With Men. 2020. Available from: www.jaids.com
28. Murenzi G, Kanyabwisha F, Murangwa A, Kubwimana G, Mutesa L, Burk RD, et al. Twelve-year trend in the prevalence of high-risk human papillomavirus infection among rwandan women living with HIV. J Infect Dis. 2020;222(1):74–81.
29. Murenzi G, Tuyisenge P, Kanyabwisha F, Munyaneza A, Muhoza B, Kubwimana G, et al. Type-specific persistence, clearance and incidence of high-risk HPV among screen-positive Rwandan women living with HIV. Infect Agent Cancer. 2021;16(1):1–9.
30. Munyaneza A, Adedimeji A, Kim HY, Shi Q, Hoover DR, Ross J, et al. Awareness and Willingness to Use HIV Pre-exposure Prophylaxis among Men Who Have Sex with Men in Rwanda: A Cross-Sectional Descriptive Survey. J Assoc Nurses AIDS Care. 2021Nov 1;32(6):693–700.
31. Murenzi G, Shumbusho F, Hansen N, Munyaneza A, Gage JC, Muhoza B, et al. Long-term human papillomavirus vaccination effectiveness and immunity in Rwandan women living with and without HIV: A study protocol. BMJ Open. 2022;12(8):1–12.
32. Murangwa A, Desai KT, Gage JC, Murenzi G, Tuyisenge P, Kanyabwisha F, et al. Agreement between Xpert and AmpFire tests for high-risk human papillomavirus among HIV-positive women in Rwanda. Afr J Lab Med. 2022;11(1):1–5.
33. IeDEA. Fogarty-IeDEA mentorship program (FIMP). 2024. https://www.fic.nih.gov/Programs/Pages/hiv-aids-research-training-mentorship.aspx.
34. CA-IeDEA. Central Africa International epidemiology Databases to Evaluate AIDS (CA-IeDEA). 2021. Available from: https://ca-iedea.org/
35. Chu KM, Jayaraman S, Kyamanywa P, Ntakiyiruta G. Building Research Capacity in Africa: Equity and Global Health Collaborations. PLoS Med. 2014;11(3):1–4.
36. Special Programme for Research and Training in Tropical Diseases. Essence on health research. 2024. https://tdr.who.int/.
37. Khisa AM, Gitau E, Pulford J, Bates I. A Framework and Indicators to Improve Research Capacity Strengthening Evaluation Practice. 2019.
38. Toyin-Thomas P, Ikhurionan P, Omoyibo EE, Iwegim C, Ukueku AO, Okpere J, et al. Drivers of health workers' migration, intention to migrate and non-migration from low/middle-income countries, 1970–2022: A systematic review. BMJ Glob Health. 2023;8(5):1–12.
39. Garbern SC, et al. Building and Sustaining Partnerships in Health Workforce and Research Capacity in Rwanda. R I Med J. 2019;102(7):32–5.
40. Hanney SR, Kanya L, Pokhrel S, Jones TH, Boaz A. How to strengthen a health research system: WHO's review, whose literature and who is providing leadership? Vol. 18, Health Research Policy and Systems. BioMed Central Ltd; 2020.

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