Research into language-based equity in Africa health science research

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Note regarding final report
The official version of the final report of *Research into language-based equity in African health science research* is the English version. The final report has been translated into Arabic, French, Portuguese and Swahili to reach out to more health science researchers across the continent and to encourage youth and young researchers in Africa who speak these languages to pursue their health science research dreams. Only the English version includes the annexes. All versions (Arabic, English, French Portuguese and Swahili) of the final report and the 2-page policy brief are available at www.hppafrica.org.

Translators of Final Report
Madalena Lobo Antunes and José Bernardino – Portuguese
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Cover Photo
The photo is of the sculpture, Ending and Beginning, by David Hlongwane, winner of the University of the Western Cape (UWC) public sculpture competition in 1994. The photo was chosen to celebrate African art and change in South Africa. The sculpture features in Minty, Z., CHAPTER 6: PUBLIC ART PROJECTS IN POST-APARTHEID SOUTH AFRICA Visual culture, creative spaces and postcolonial geographies, in The Visual Century: South African Art in Context 1907 to 2007, G. Jantjes, et al., Editors. 2011, Wits University Press: Johannesburg, South Africa. The photo was provided by University of the Western Cape (South Africa).

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Annexes

List of Acronyms

AAAQ	Availability, Accessibility, Acceptability and Quality
AAS	African Academy of Sciences
AU	African Union
EARIMA	Eastern African Research and Innovations Management Association
IDRC	International Development Research Centre
KI	key informant
MENAWCA	Middle East and North Africa Writing Centres
SARIMA	Southern African Research and Innovation Management Association
WHO-AFR	World Health Organization African Region
WHO-EMR	World Health Organization Eastern Mediterranean Region
WHO	World Health Organization

Executive Summary

Wellcome commissioned this study to examine a critical barrier to developing a more inclusive pan-African research ecosystem, enabling a greater diversity of research talent to contribute knowledge and be heard. The overall objective of the project is to identify actual and perceived language and intersectional barriers (e.g. gender, institutional, individual, attitudinal, economic, financial) facing African health science researchers in the short- and longer-term that constrain cross-language understanding and participation in all aspects of the research endeavour.

This study has three specific objectives:
1. To examine whether the use of English, in the African context, is a barrier to the advancement and success of health science researchers either individually, nationally or internationally, and to the advancement of health science more widely in Africa.
2. To examine whether the use of English, in the African context, is contributing to wider structural inequalities within the general health science research ecosystem.
3. To recommend practical solutions to addressing concerns identified.

A mixed method approach, employing both qualitative and quantitative data collection, was used. Ninety-five articles, including peer-reviewed and grey literature, were systematically analysed. Sixty-four individuals – 48 Africans and 16 non-Africans – participated in the study by being interviewed as key informants (45) or by completing questionnaires (19). The participants came from 18 African countries and 6 non-African countries. The principal language of instruction of medical schools in the countries in which the key informants were based were: English, six; French, six: Portuguese, two; French/English, one; and English/Arabic, one. interviews were conducted in the language of choice of the interviewees. The qualitative data were analysed using a grounded theory approach. The findings were triangulated with the literature analysed.

The study has 15 findings. They are grouped by: i) language related findings; and ii) non-language related finding.

The key findings related to language include the following.
- There are a multitude of languages used for health science education, research and service delivery in Africa.
- Academic language is a language unto itself.
- English is currently the dominant language used within health science research.
- There are advantages and disadvantages of English being the dominant language of health science research. The main advantages of English being dominant are that there is a common language for science and it has extensive technical vocabulary in many disciplines. The main disadvantage is that English is a requirement for researchers to use for reading, writing and verbal communication in order to succeed internationally.

Findings concerning the intersection of non-language barriers with language include the following:
- Gender may intersect with language and other individual characteristics to multiply/compound vulnerabilities, especially for women.
- Access to interventions that aim to address language barriers is gendered.
- There was consensus among participants that financial barriers significantly impede both advancement for researchers at the individual level, as well as for broader scientific advancement in health science research institutions within Africa. Moreover, non-English[1] speaking researchers were reported to face the greatest financial challenges because the majority of grant applications are perceived to be in English.
- Limited institutional resources dedicated to research is a barrier for many African academic institutions research and underdeveloped research support systems are a barrier to research. Some institutions

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1. The terms "English-speaking", "French-speaking", etc. are used throughout this report instead of Anglophone, Francophone, etc., because the terminologies "Anglophone", "Francophone" in some African countries have cultural connotation more than an academic one. In Cameroon for instance," Anglophone" stands for someone originating from the two regions, North-west and South-west, that were under British administration after the First World War for some 40 years. A "Francophone" is considered someone originating from the eight other regions that were under French administration after the First World War until independence. It does not take into consideration if the person can actually speak, read or write English or French. The terms English-speaking or French-speaking persons are often use to describe a literate person who can use English or French languages to communicate.

do not yet have strong research support officers or automated systems. This intersects with language as the strongest research management networks appear to be the Southern African Research and Innovation Management Association (SARIMA) followed by the Eastern African Research and Innovations Management Association (EARIMA), both predominately English-speaking regions, although there are two Portuguese-speaking countries in southern Africa.

- Regulatory issues, particularly bureaucratic procedures to obtain research permits and obtain approval for research, pose a barrier to research in some countries. There is some evidence that this is related to low levels of English competency in some cases.
- The national education systems at the primary and secondary school levels were stated not to be robust enough to develop critical thinking in students in some countries resulting in the lack of needed skills to be successful researchers once in university and later in life.
- The notion or role of research in some countries and on the continent, generally, was reported to be insufficiently established or esteemed. As a result, there is not a general understanding of the value of health science research. This contributes to the lack of understanding about science and Academic Language.
- There were limited numbers of South-South networks, particularly those that foster collaboration between English-speaking and non-English speaking countries.
- Numerous key informants (KIs) stated that vestiges of colonialism and the colonial legacy remain both in terms of Africans often valuing non-African input and approaches more than those from Africa and non-Africans not recognising existing capacities on the continent. Decolonialism, or concerns about neo-colonialism, is an important issue in some countries. Funders should ensure that African researchers are engaged in leadership positions on research and education projects and programmes they fund on the continent. Non-African partners should ensure African trainees and early career researchers are directly involved. Three of the four primary languages of higher education in Africa - English, French and Portuguese - were first the languages of European colonial powers. Language intersects with the legacy of colonialism.

The study findings suggest 42 practical solutions to address the challenges faced. They have been grouped by actions, activities or initiatives that can be taken at five levels: ia) individuals – trainees, early career researchers and other researchers; ib) individuals - research leaders / principal investigators; ii) institutional; iii) national; iv) regional; and v) global (collaborations, journals, conferences, funders).

Five key recommendations to address language-based equity in African health science research are:
1. African universities are advised to institutionalise intensive academic writing and communicating science courses and writing support services.
2. Funders are advised to support virtual and in-person learning exchanges between writing support personnel.
3. Universities can increase research projects within the undergraduate curricula thereby allowing students to obtain more hands-on experience in research methods and the use of Academic Language regardless of the teaching language(s) of the institution.
4. Funders are advised to support direct interactions between non-English-speaking early-career researchers and English-speaking researchers.
5. Leading institutions and funders need to address their own policies and procedures that contribute to language and intersecting barriers.

1. Introduction

A priority area for Wellcome is `Research Ecosystems in Africa and Asia'. Wellcome seeks to support self-sustaining research ecosystems that generate knowledge and improve health for a defined population or area. Promoting independent research leadership in Africa is an important component of these efforts. Wellcome commissioned this study to examine a critical barrier to establishing self-sustaining health research ecosystems within Africa: the potential impact of English being one of the dominant global languages of science on researchers in Africa.

The overall objective of this research is to identify actual and perceived language and intersectional (e.g. gender, institutional, individual, attitudinal, economic, financial) barriers facing African health science research in the short- and long-term that constrain cross-language understanding, including knowledge transfer, scientific collaboration and research uptake, and provide evidence on practical ways to address them. More specifically, the study had three specific objectives:
1. To examine whether the use of English, in the African context, is a barrier to the advancement and success of health science researchers either individually, nationally or internationally, and to the advancement in Africa of health science more widely; and,
2. To examine whether the use of English, in the African context, is contributing to wider structural inequalities within the general health science research ecosystem.
3. To recommend practical solutions to addressing concerns identified.

2. Background

It is estimated that the people of Africa speak 2,138 (30.1%) of the world's living languages [1]. Only the people of Asia speak more living languages, 2,301 (32.4%)[1], although the population of Asia is 42.6% greater than Africa's. The number and diversity of African languages is illustrated by a number of examples: there are over 500 languages spoken in Nigeria[2]; South Africa has 11 official languages [3]; and there is a 97% chance that two randomly selected Cameroonians will have different mother tongues [1].

Politically, the African Union (AU) is the regional body through which African countries coordinate their policy and the AU divides the continent into five sub-regions. Globally, for health issues, African countries are grouped into two WHO regions: the African Region (WHO-AFR), with 47 countries, and the Eastern Mediterranean Region (WHO-EMR), with 7 African countries[2]. Each of these regions has three working languages: English and French are working languages of both regions; Portuguese is the third working language of WHO-AFR; and Arabic is the third working language of WHO-EMR. The official languages of the AU are Arabic, English, French, Portuguese, Spanish, Swahili and any other African language[3].

Researchers from two African countries, South African and Egypt, produce almost 50% of all medical sciences publications on the continent [4]. These two counties, plus Nigeria in the West and Kenya in the East, act as the scientific hubs for the continent[5]. English is the principal language of higher education in each of these countries.

3. Methods

This research used a mixed method approach, employing both qualitative and quantitative data collection. Data collection approaches included: 1) a literature review; 2) key informant (KI) interviews; and 3) survey questionnaires. A grounded theory approach [6-8] with a constructivist worldview [9] was used to analyse the data and produce the findings. The Faculty of Health Sciences – Ethical Review Board, University of Buea, Cameroon, approved the research protocol (Ref: 2021-1259-12/UB/SG/IRB/FHS).

Articles were identified using PubMed, Medline, the Africa-Wide Information database at the University of Toronto online library, Google Scholar and Google. Search terms used combinations of the following words and phrases: English; French; Arabic; Portuguese; Swahili; Language; Africa; WHO-AFR; WHO-

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2.   WHO-EMR also include 15 Asian countries. See: http://www.emro.who.int/. Accessed 24 October 2020.

3.   See: https://au.int/. Accessed 25 October 2020.

EMR; health research; health science research; medical research; nursing research; public health research; pharmacy research; knowledge translation; knowledge uptake; non-English sources; medical and health science journals in Africa; capacity strengthening for health research writing in Africa; career advancement of health science researchers in Africa; PhD pedagogy; language barriers; language challenges; and language obstacles.

Ninety-five peer-reviewed papers and grey literature articles were selected and reviewed. The articles were mainly written in English and French, although one article in Arabic and one in Portuguese were also reviewed after they were translated into English.

The study had three groups of participants:

Sample 1 consisted of 45 key informant (KI) interviewees from approximately 140 individuals selected using purposive sampling from universities and research institutions – response rate of approximately 32%. The 45 KIs were chosen from 16 pre-selected African countries that were chosen because together they were representative of Africa overall. Specifically, representation was desired from at least two countries from each African Union sub-region, at least seven countries in which English is used as a language of instruction in medical schools, four countries in which French is used, two countries in which Portuguese is used and two countries in which Arabic is used, the four African research "hubs"[5]. In addition, all three of the WHO-AFR countries producing approximately 50% of the medical science publications, at least two of the five countries responsible for producing the next 25%, at least 3 of the 18 countries responsible for producing the next 15%, and at least four countries responsible for producing the final 10% were included. Finally, at least four low-income countries, nine lower-middle income countries and two upper-middle income countries were included. Finally, one island state was included. In addition, equal representation of women and men was desired among the KIs as was representation across the medical professionals, three age-ranges and location of the institution in the country (i.e. main city or capital city or secondary city). See Annex C for details on final representation by characteristics of the KIs.

Forty (40) of the KIs were health science researchers and five were representatives of university writing centres[4]. The invitation email was sent in English, French, Portuguese or Arabic depending on the country, institution, LinkedIn profile or other information known about the potential participant. The email also contained the participant information sheet for the study either in English, French, Portuguese and/or Arabic. Interviewees were asked to enrol in the study by completing a short survey sent via SurveyMonkey™, an electronic survey platform. Participants who enrolled provided consent and selected in which language - of English, French, Portuguese and Arabic – they wished to be interviewed. A few interviewees responded by email and consent was given at the start of their interviews. The interviews were conducted in English, French or Portuguese; no participant desired to be interviewed in Arabic. Four of the five project team members (AY, FT, DM and VS) conducted the interviews[5]. AY and DM led the interviews conducted in English. FT led the interviews conducted in French. AY led the interviews conducted in Portuguese supported by Portuguese interpreters from Portugal. All interviews were conducted on Zoom or WhatsApp, except for two that were written submissions, and were recorded and translated. The two written submissions were provided in French after bandwidth did not allow for verbal interviews to occur. All verbal interviews lasted between 30 and 90 minutes. All interviews were transcribed in-full, using the professional human transcribers at www.rev.com (English) and independent consultants from Portugal, Canada, France, Madagascar, Brazil, Egypt and Morocco. See Annex C for a copy of the key informant interview guide in English.

Sample 2 comprised three of 40 representatives invited from African networks and organisations to complete an online questionnaire via SurveyMonkey. The three representatives were from three countries.

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4. Generally, university-based writing centres are non-academic units that support the academic programmes of a university, or faculty or school within one, by offering workshops, non-degree courses and consultations to assist students and, to a lesser degree, faculty with their writing and related issues.

5. The project team consisted of five members: Aaron Yarmoshuk (AY); Doreen Mloka (DM); Fidèle Touré (FT), Samuel Wanji (SW); and, Vandana Sharma (VS).

Map 1 – Participation of African representatives in study, key informant interviewees (Sample 1) and questionnaire respondents (Sample 2)

Languages of Medical School Instruction

- ■ English
- ■ French
- ■ Portuguese
- ■ English/Arabic
- ■ English/French
- ☐ No study participants

Created with mapchart.net

Table 1: African participants by country and sample group

#	Country	Key informant interviewees (Sample 1)	Questionnaires completed (Sample 2)
1	South Africa	9	0
2	Tanzania	6	0
3	Mali	4	0
4	Cameroon	4	0
5	Cabo Verde	4	0
6	Kenya	3	1
7	Mozambique	3	0
8	Nigeria	2	0
9	DRC	2	0
10	Senegal	2	0
11	Ghana	1	0
12	Egypt	1	0
13	Sudan	1	0
14	Gabon	1	0
15	Cote d'Ivoire	1	0
16	Morocco	1	0
17	Angola	0	1
18	Benin	0	1
Total		**45**	**3**

Map 1 and Table 1 present the number of participants by country for Samples 1 and 2. Annex 2 - Names of Study Participants provides the names and affiliations of Sample 1 and 2 participants. Additionally, further details of the methods, including a copy of the questionnaire in English are included in Annex C: Detailed Methods.

Sample 3 included 16 representatives from 11 non-African organisations involved in research capacity strengthening in Africa who completed the questionnaire for non-African representatives. Please see Table 2 and Annex B – non-African study participants for further details. The questionnaire is available in Annex C.

Table 2: Non-African participants by Country (Sample 3)

#	Country	Number of Participants
1	Canada	7
2	UK	4
3	USA	2
4	Brazil	1
5	China	1
6	France	1
	TOTAL	**16**

Data collected during the literature review, key informant interviews and questionnaires were systematically extracted and entered into the pre-coded Excel spreadsheet. All non-English data was translated into English first. Data were analyzed thematically following the interview guide. An "other" category ensured novel concepts were captured. All members of the study team participated in the review of the transcriptions of the interviews. Each transcription was reviewed by at least two study team participants.

4. Findings

Findings identified in peer-reviewed and grey literature, on web-sites and from study participants (Samples 1, 2 and 3) are presented. For peer-reviewed and grey literature, where appropriate, the source of the finding is identified by referencing the article. Findings from study participants generally only mention a general characteristic (e.g. a Portuguese-speaking key informant, a Sample 3 participant) to prevent attribution of findings presented to a particular participant.

Participants had a range of perspectives on every issue. Unanimity was not found for any theme. Individual participants had a range of viewpoints on certain issues discussed. These differences are presented and discussed briefly below. Important nuances are raised.

4.1 Language Issues Identified

Finding 1: There are a multitude of languages used for health science education and research and health care service delivery in Africa.

Participants identified language issues that arose during numerous points in their lives. These issues can generally be grouped into three periods: 1) childhood and youth; 2) as trainees in university; and 3) during their careers.

Having English as one's mother tongue was seen as an advantage. Some participants spoke of the importance of being avid readers in English during their youth as this set the foundation of their ability to read and write academically and for being prolific health science researchers. Some Tanzanian participants identified the country's public school system as a challenge to acquiring professional fluency in English as English is only taught as a subject in primary school. It is not until secondary school that English is used throughout the curriculum in Tanzania. This contrasts with the Kenyan public school system, and many private schools in Tanzania, where English is the main language of instruction in primary schools.

At the trainee level – as students in higher education at the Bachelor's, Master's and PhD levels and within health professional programmes – different languages were described as being important or predominant depending on the which of the three missions of academic health science centres (AHSCs) [10]: 1) education; 2) research; or, 3) health care service delivery, was considered.

Health science lectures at universities are predominantly conducted in English, French or Portuguese, depending on the European language of higher education in each of the 16 countries represented by the 45 KIs (Sample 1), although Arabic is also used in some Sudanese universities[11]. Course reading materials are also in the main European language of the university, although numerous respondents from Samples 1 and 3 mentioned that most peer-reviewed articles read were in English. Writing was conducted in many languages, including indigenous African languages of the countries in addition to the European language(s) of each country.

Research required the use of many languages. Data collection was reported to be conducted in all four WHO working languages used in Africa in addition to many African languages. In addition, some researchers communicated research findings back to study participants in the indigenous languages in which they collected the data. One KI, stated "Interacting in indigenous languages can be a challenge. You may need an assistant to help you." The same issue was identified for engaging with the public and politicians about research findings.

Grant applications and manuscript submissions were reported to be mainly in English. In the case of grant applications, it was perceived that there were many more grant opportunities in English. Grant opportunities in other languages were few. As for research manuscripts, even researchers in French and Portuguese speaking countries preferred to submit manuscripts to English journals. They preferred publishing in English because they believed that there are more journals to submit to, most high impact journals are in English and more researchers would read their publications in English journals. As publications are crucial for promotion and networking, KIs stated it was best to publish in English for three reasons: to be recognised internationally; for promotion; and, because English journals articles published accepted articles more quickly.

Finding 2: Academic Language is a language unto itself

It was stated that to be successful as a health science trainee and researcher, it is necessary to learn to converse well in scientific language, no matter what the language of higher education is. One has to be able to read academic journals, design a study, write in an academic form and speak using academic vocabulary and jargon. The expanded vocabulary is required to understand lecturers, read articles, write assignments and present orally.

> *Besides … [learning] the English, you also have to have somebody who trains you for the technical English for the research and for the science vocabulary.*

One writing centre representative stated that some professors believe that students entering university should already know how to write[6]. However, the proliferation of writing centres in South Africa during the last 25 years and at top ranked universities globally, illustrates that there is a demand to improve writing skills. University writing centres were also identified in other countries including at universities in Cameroon and Egypt. The Mohamed Taymour Writing Centre at the American University in Cairo is linked to other writing centres in the Middle East through the- Middle East-North Africa Writing Centre Alliance (MENAWCA)[12]. MENAWCA was the only formal regional network of writing centres identified. Some South African writing centre representatives were linked to the International Association of Writing Centers (https://writingcenters.org) based in the USA.

The demand for writing centres is unsurprising, because as another writing centre representative implied, there is not one specific Academic Language either. The individual stated:

> *… what I noticed was that every [health science] discipline has its own writing culture … for one to be a writing consultant, who could help the students coming from the different disciplines, you really needed to … learn … how writing was done in each of the disciplines.*

In addition, full credit courses are offered at some institutions to become academically literate; for example*, Academic Language and Literacy in English - ENG1503* is an undergraduate course offered at the online University of South Africa (UNISA) based in Pretoria[13]. The University of Nairobi Department of Communication Skills and Studies declares, "Writing is the most important skill that a university can bestow on its graduates" and offers a course in Communication Skills, CCS 001. The University of Buea in Cameroon offers two first year undergraduate courses designed to improve the writing skills of its students (ENG 101 & ENG 102).

Finding 3: English is the dominant language of science currently

English has been perceived as the dominant or international language of science for some time [14, 15], including in the field of medicine[16]. A search of UlrichsWeb Global Series Directory[17] for medical and health journals showing the current dominance of English, globally and in Africa, is presented in Table 3.

Table 3: Search results for medical and health journals in UlrichsWeb Global Series Directory published in one of the four languages of WHO in Africa (accessed: 2021-04-19)

	English	French	Portuguese	Arabic
Published anywhere	16,800	638	354	38
Published in an African country	339	24	1	8

Sabinet [18], an online database of journals published in South Africa, lists 98 medical and health journals. Ninety-six of them are available in English, only two are not. Eleven of the 98 journals are also available in other languages: Afrikaans, 6; French, 3; Portuguese, 1; and Spanish, 1. The "health" category of African Journals Online (AJOL) includes 168 journals but does not sort by language[19].

The dominance of English in science was supported by the publishing records and most comments made by KIs, although some nuance was expressed. All of the health science researchers (Sample 1, not including writing centre representatives, n=40) had published articles in English. Ten of these 40 researchers – 4 Portuguese-speaking, 4 French-speaking and 2 English-speaking - had also published in four other languages: French, 5; Portuguese, 4; Russian, 1; and Hebrew, 1. One KI was working on a manuscript in Finnish with colleagues in Finland.

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6.   A non-African representative (Sample 3) commented that a former Dean of a faculty in the health sciences at their university stated that their faculty would not be joining a new writing centre because "their students were exceptional and did not require the services of a writing centre".

Reasons given by KIs for submitting manuscripts principally in English included:
- English journals have higher impact factors because there is a greater audience for them.
- "It's a disadvantage to publish in Portuguese because the people funding grants read English."
- "… there is no [Portuguese publication outside Brazil] that has an international impact."
- "The best academic journals are in English."

Incentives mentioned for publishing in other languages included:
- Publishing in Portuguese journals in Brazil that were indexed was considered worthwhile.
- To widen one's international network and increase research opportunities.
- To ensure that health research was effectively communicated and health messages were received accurately to local populations.

Finding 3b: There are advantages and disadvantages of English being the dominant language of science

Advantages of English being the dominant language of science mentioned were:
- It allows for scientific communication in one language in many different countries, as English is the *lingua franca* of science.
- "I find it easier to write the results of my research in English than in French. Because, as I read all of my references are in English, it comes more easily."
- There is scientific / technical vocabulary in different disciplines that exists in English that does not exist in other languages.
- "English is one of the simplest languages, if you wish, in a good way, which makes it easier to write, to read, to communicate with. Its grammar is not as complicated as compared to other languages." – a multilingual KI

Disadvantages of English being the dominant language of science mentioned were:
- English is a requirement for researchers to use, for reading, writing and verbal communication, in order to succeed.
- Non-English-speakers have to learn English, including developing technical, oral and written proficiency in academic English, in addition to the knowledge of their field or discipline.
- There is the risk of research findings becoming lost or inaccurate when they are translated back from another language to English and vice-versa.
- It may be detrimental to the preservation of local languages.

Finding 4: The dominance of English in sciences is a barrier for non-English researchers

Reasons mentioned by non-English speakers for why the dominance of English is a barrier for them included:
- Leading articles in science often are only available in English and these therefore take additional time for non-English speakers to review and understand.
- Presentation of findings and networking at conferences is more difficult or limiting for non-English researchers. There are fewer participants at non-English presentations and some audience members do not use translation services at conferences even if they don't understand the presentation language.
- Accessing grant funding is more time consuming, as the majority of calls for proposals are in English and are required to be submitted in English.
- It is more difficult to produce manuscripts for publication.
- Language influences academic supervision, mentorship and support for trainees. The pool of supervisors and mentors who are experts in their field and speak English to a high standard, in addition to French, Portuguese or Arabic, is somewhat limited.

4.2 Non-language issues that intersect with language and potentially contribute to structural inequalities within the health science research ecosystem,

KIs had a wide range of perspectives considering potential intersecting non-language barriers to individual and scientific advancement in health science research institutions within Africa. Intersecting barriers are issues that potentially overlap with language further compounding the challenge of developing stronger health science research ecosystems in Africa.

Gender Issues

Finding 5: Gender intersects with language and other individual characteristics to multiply/compound vulnerabilities, especially for women

Gender intersects or overlaps with language and multiple other individual characteristics to contribute to researchers' experiences within the research ecosystem and in broader society. The cumulative and compounding effect of these group characteristics yield greater vulnerabilities particularly for women, and it is difficult if not impossible to untangle the effects of the intersecting barriers and characteristics. Specific findings supporting this included:

- A number of KIs, both men and women, noted that numerous societies in Africa are patriarchal. It was stated that this was especially true in rural areas in certain countries, although differences in representation of men and women on scientific academies in Africa illustrates that it may be a national issue in some countries. Recent research found that women account for only 10% of the membership, on average, of National Academy of Sciences in ten African countries [20]. Several key informants also described the social and cultural pressure for women to marry and have children instead of pursuing a PhD.
- Literature suggests that getting married during PhD training may limit women's publication productivity while increasing that of men, due to changes in terms of domestic labour responsibilities [21].
- Men outnumber women in faculty positions in Africa, as 70% of researchers across all subject areas are men [22]. This disparity was observed by one respondent who also noted that having a female head of the faculty in which he worked eliminated the disparity to the extent that less than 10 percent of the faculty in one unit are now men, although the college itself continued to have more men than woman faculty members.

Finding 6: Access to interventions to address language barriers is gendered

Two writing centre representatives perceived that women accessed writing centres more than men. This was supported by figures provided about the University of Cape Town Writing Centre: from 2018 to 2020 the centre had 357 female clients who made a total of 788 appointments compared to 138 male clients who made 356 appointments. A writing centre at another South African university suggested that men may be more hesitant to ask for assistance with academic writing, which may be related to social norms around men not wishing to demonstrate weakness or that they are seeking help. It could potentially be analogous to the fact that in some contexts, men have been found to delay seeking help when ill compared to women [23].

Financial Issues

Finding 7: Financial barriers are a leading barrier to individual and scientific advancement in health science research institutions across Africa and are greater for non-English speakers.

- Access to research funding was the leading barrier for conducting research (e.g. cost of equipment and supplies) and having research findings published (e.g. article processing fees).
- Many KIs noted that the lack of national funding required them to seek largely or solely international funding from North American and European donors. Furthermore, research grant calls were stated to be predominantly in English-only. There are exceptions to this; for example, donors such as the International Development Research Centres (IDRC) and others do accept proposals in other languages. A non-African respondent (Sample 3) stated that "IDRC has consistently provided support for researchers with multiple primary languages, including fellowship and grant review by multi-lingual colleagues". In addition, it was stated IDRC funds translation within research work it funds.

- Article processing fees for high profile journals were described as a significant barrier. Respondents described the need to publish in high-ranking journals in order to facilitate promotion and career advancement. In addition, citations were described as being important for success and publishing in high impact journals would help papers to be widely cited. One Portuguese-speaking representative stated they were now considering publishing in Brazilian journals because they are indexed internationally.

Institutional Issues

Finding 8: Some universities don't have a strong research culture

The curriculum for research development in some universities was stated to be lacking. One KI stated that the value placed on research varies from university to university within their country. Another KI stated that whereas in other regions of the world research training begins within Bachelor degrees, in Africa it begins within Master's and PhD programmes. The delay in gaining exposure to research earlier at university means there is less time for learning research methods, techniques and Academic Language.

Finding 9: Limited institutional resources and weak systems are a barrier to research.

- Numerous respondents stated their institutions had limited institutional resources including the lack of research facilities ranging from laboratories to grant offices. Direct links of these barriers to language barriers were limited except for Information and Communication Technologies (ICTs) and research management systems (RMS).
- ICT remain poor in some countries. Internet connections were not dependable and/or bandwidth being low. Although it was stated that internet services have improved in many countries over the past 10 years, intermittent and slower connections hinder voice communication over the internet via services such as WhatsApp, Skype, Zoom, and access to journal articles.
- RMS were reported to be weak by some KIs. Some institutions do not yet have strong research support officers or automated systems. This intersects, in part, with language as the strongest research management networks appear to be Southern African Research and Innovation Management Association (SARIMA) followed by the Eastern African Research and Innovations Management Association (EARIMA), both predominately English-speaking regions, although there are two Portuguese-speaking countries in southern Africa.

Regulatory Issues

Finding 10: Regulatory Issues pose a barrier to research at some institutions and in some countries

- Ethics approval was generally not considered a barrier, except in Tanzania where approval from NIMR and COSTECH is required for research with international involvement. In addition, one Tanzanian KI stated securing local government approval was sometimes lengthy, requiring 6 to 12 months.
- Some KIs noted that research planned was cancelled because of the lack of ethical guidelines for the research proposed.

Fluency in English and Academic Language could contribute to the regulatory barriers noted above, especially, the challenge or delay in securing local government approval and the establishment of ethical guidelines when knowledge of the primary language of higher education in the country is not well understood.

Other Issues

Finding 11: The national education systems at the primary and secondary school levels were stated not to be robust enough in some countries.

In Tanzania, a number of KIs stated that English instruction should be greater in primary school, although another KI stated it was important that Swahili be a focus to strengthen the national language. Another Tanzanian representative stated the problem was not language but "how they (students) think". He continued by stating, "Let them write in Swahili and see if they organise their ideas. [The challenge is] How to make them better thinkers."

Finding 12: the notion or understanding of research in some countries and on the continent, generally, is not well-established.

- Multiple KIs stated that the research mentality in their country was not strong and that many politicians don't value research. Other KIs stated that government support in their country is not strong as the government is not well-engaged with academia. It was stated by some KIs that having research findings translated into the national languages of a country may help address this challenge. This view has been expressed in written opinion pieces too[24].
- The delay and limited integration of research into secondary school and higher education was reported to result in graduates gaining limited to no exposure to research during their education. This links back to Finding 2 that Academic Language is a language unto itself.

Finding 13: Researchers face logistical challenges such as delays with customs clearance of supplies.

Importing research equipment and reagents is expensive and receiving shipments often takes long. It is possible that customs officials with limited knowledge of English in some countries are not able to review and approve customs documents quickly.

Finding 14: Lack of South-South networks.

South-South linkages are lacking or not well-established thereby limiting exchanges that could strengthen linkages between English-speaking and non-English-speaking researchers.

Finding 15: Vestiges of colonialism and the colonial legacy remain. Decolonialism is an important issue in some countries.

The legacy of colonialism and neo-colonial practices remains strong in many African countries and neo-colonial practices by some donors continue to exist. This is illustrated by a quote from one KI below and in recent opinion pieces and commentaries [25, 26] as well as social media networks [27]. These views are further supported by the fact that African researches collaborate mainly with researchers overseas rather than with other African researchers [5, 28].

> The call to decolonize curricula has not really been taken up very ardently in the health science faculties. They are so committed to a positivist kind of epistemology; they're really committed to science is the way. Even our dean was spouting the stuff and people were putting up their hands, some of our other colleagues but saying, "But how do we teach traditional medicine in a context that pits it against science the whole time?" [The answer is we won't] be teaching traditional African medicine, we'll be teaching ways of knowing the body or philosophies of medicine or medical thought and practice in Africa. We'll be teaching what is central to biomedical practice in Africa, where did it emerge, what are the tenants of thinking of this way of thinking about the body and its implications alongside or through a traditional African healer who would have kind of a comparative through which to teach himself. Because if we try to tell the people we want to teach traditional medicine at medical school they switch off, but if we tell them we want to teach medical humanities and have students have a strong understanding of the philosophy and history of medicine that's fine, that's not a problem.

Increasing the scientific vocabulary of indigenous African languages was reported to be a slow process by another KI.

5. Interpretation of Findings by Objective

Objective 1: To examine whether the use of English, in the African context, is a barrier to the advancement and success of health science researchers either individually, nationally or internationally, and to the advancement of health science more widely.

The findings from this study suggest the dominance of English, as the current *lingua franca* of science, poses a barrier to the advancement and success of many non-native English-speaking health science researchers in Africa. Furthermore, it appears likely that this barrier hinders the advancement and success of research ecosystems in some African countries, especially in those that do not have sufficiently robust primary and secondary school systems or do not use English as the principal teaching language of higher education; and for cross cultural research collaboration. This barrier was reported to impact the ability of researchers in these settings to secure grants and submit successful manuscripts for peer-reviewed publications, the two key metrics for academic advancement.

However, some English-speaking and non-English-speaking health science researchers in Africa reported that they have been able to overcome the potential barrier that the dominance of English presents them through a variety of means. Some force themselves to communicate in English (e.g. setting English as the default language on all their electronic devices). Others use online writing and editing tools (e.g. Grammarly). Many reported having native English speakers review their manuscripts. This final approach was considered most useful and was most common. These approaches have enabled them to develop their skills and given them the opportunity to participate more fully in scientific pursuits in their country and internationally.

The degree to which an individual health science researcher in Africa is able to overcome the challenge of becoming sufficiently comfortable in academic English to participate fully in scientific endeavours and advance their career depends on numerous factors that intersect. These factors begin in childhood, extend into their time as trainees and continue throughout their careers. Some of these factors are distinctly individual whereas others need to be examined at the institutional, national, regional and/or global levels. See Figure 1: Factors influencing language-based equity in African Health Science Research for the leading factors identified by this study.

The intersection of factors both at the individual level and between the individual level and the other four levels is important to examine. Each institution has its own history and culture, departmental make-ups and financial status and this will influence the research culture of the institution and the opportunities available to individual researchers. The same is true at the national level. Similarly, countries in some African sub-regions have greater integration of coordination mechanisms; for example, the East African Community (EAC) established the East African Health Research Commission (EAHRC) in 2008 "to coordinate, conduct, and promote the conduct of health research in the region"[29]. Finally, issues and actors at the global level will influence all the other levels.

The likely effect of the dominance of English on the advancement of health science more widely, appears to be mixed. On the one hand, Nussbaumer-Streit, Klerings [30] show that excluding non-English publications from evidence-syntheses did not change conclusions on clinical interventions. On the other hand, KIs in this study stated translating back and forth across English and other languages during the research process at best complicates, delays and increases the cost of conducting research and publishing findings and at worst potentially creates errors or misunderstandings. Moreover, the shortage of research findings and policy briefs in French, Portuguese and indigenous African languages surely hinders communication of health research findings with government officials and the general public who are not conversant in the principal language of higher education in a country.

Figure 1: Factors influencing language-based equity in African Health Science Research

Global: *journal policies, publishing of bilingual or multilingual manuscripts; concern for equality; development of information technology; funder interest and level and degree of support*

Regional: *level of regional cooperation/integration; commonality of language; exposure to other languages*

National: *primary and secondary school curriculum; government support of research, financially and interest in use of it; economic level; languages spoken; national language(s)*

Institutional: *research culture and emphasis on research – "research intensive university"; research infrastructure available; research management unit; size and diversity; access to skills development and continuing education opportunities; internet access (dependability and speed); access to open-access journals; policies; partnership – national and international; writing centre*

Individual: *natural language ability; social and cultural norms; gender; sufficient confidence*

Childhood and Youth
- *Mother tongue*
- *Early exposure to a 2ndlanguage*
- *Age introduced to English and extent to which it is spoken*
- *Access to reading material and interest in reading*
- *Socio-economic level of family*
- *Social support: family and friends*
- *Interest, motivation*
- *Perseverance, determination*

Trainee
- *Involvement in research: when introduced to research projects and involvement in them*
- *Supervision: skilled and supportive supervisor(s)*
- *Mentorship: access and quality of it*
- *Establishment of professional network*
- *Financial: sufficient funding to invest time and obtain resources*
- *Opportunity and ability to study internationally, especially an English setting*
- *Social support: family, partner, friends*
- *Interest, motivation perseverance, determination*

Career
- *Role(s) within organisations: % of time allocated to research*
- *Colleagues: sufficiently large network of varied skills (language, technical)*
- *Financial: sufficient renumeration*
- *Mentorship: access to and quality of it*
- *Opportunity and ability to travel professionally*
- *Social support: family, partner, friends*
- *Interest, motivation*
- *perseverance, determination*

Finally, our findings highlight that academic communication – verbal, reading and writing – is a language onto itself. All members of the academic community, including English-speaking and non-English-speaking researchers, are confronted with this fact.

Objective 2: To examine whether the use of English, in the African context, is contributing to wider structural inequalities within the general health science research ecosystem.

Structural inequality is defined as:

> *a condition where one category of people is attributed an unequal status in relation to other categories of people. This relationship is perpetuated and reinforced by a confluence of unequal relations in roles, functions, decisions, rights, and opportunities[31].*

The dominance of English in science, in the African context, is likely contributing to wider structural inequalities within the general health science research ecosystem. The top four countries in terms of medical sciences publications (South Africa, Egypt, Nigeria and Kenya) produce 58% of all these publications in Africa; these countries have in common that English is their primary language for health sciences higher education. The only country in the central sub-region of Africa in the top 25 of African medical sciences publications is Cameroon (ranked 12th) and it is the only country in the sub-region in which some of its universities higher education institutions use English as a principal language in health professional higher education. See Annex 1: countries of Africa with key indicators for this study sorted by publications by medical sciences in 2014.

The majority of grant opportunities by leading funders were stated by KIs to be available in English. However, a non-African representative (Sample 3) noted that calls from Canadian funders, including the International Development Research Centre (IDRC) are open to submission in French and English. Many, although not all, non-English-speaking health science researchers reported difficulties in preparing and submitting grant applications in English. Similarly, many non-English-speaking health science researchers reported requiring more time and assistance to produce manuscripts for submission to English language academic journals.

Objective 3: To recommend practical solutions to addressing concerns identified.

English is the current *lingua franca* of science although this does not mean that it is not desirable to conduct research and publish in other languages. As a Chinese participant in Sample 3 noted, in China institutions weigh English publications more than those in Chinese for the performance of health science researchers, but research papers published in Chinese languages are still numerous [32]. The challenge is how individual researchers, their institutions, national governments, regional bodies and concerned global actors, including funders and journals, can operate within their own national and regional health science ecosystems while also being able to engage with the globally, English-dominated, health science research ecosystem. An important question is how best to ensure a more supportive and inclusive environment that enables non-English speaking researchers in Africa to succeed in their training and advance their research careers. In particular, interventions that enable and support African health science researchers, especially those who are not fluent in English, to build their English language skills (oral, reading and written) while also strengthening the scientific engagement of other languages on the continent are needed.

Such interventions may take various shapes. As a multitude of concerns and challenges at various levels were raised by participants in this study, a variety of interventions will be needed to address the barriers faced. Interventions are needed at the individual level through to the global level. Individuals, research leaders and institutions should take the lead, but they will need assistance and support from their national governments, regional agencies and global actors. See Table 5: Recommended practical solutions to address concerns identified.

Table 4: Recommended practical solutions to addressing concerns identified

Individual Researchers	Research Leaders / Principal Investigators	Institutional (e.g. universities and research institutions)	National (e.g. national governments and agencies)	Regional (e.g. regional networks and organisations)	Global (e.g. funders, journals, international organisations)
Enrol in an intensive writing course during undergraduate degree.	Encourage young researcher to publish in the most appropriate journal for their research. Publishing in a high-impact journals is not necessarily warranted. Local, non-English journals may be accessed by a more appropriate audience sometimes. [33]	Offer writing courses and high-quality academic writing workshops and short courses, and ensure access barriers are addressed.	Governments and national funding agencies could establish university-wide grant funding competitions.	Foster virtual (online) writing centre support between African institutions, intra-regional and inter-regional.	Journals – More journals could waive, or reduce, article processing fees for LMIC researchers in need.
Use institution's writing improvement opportunities, including writing workshops, short courses, writing centres.	Learn a second or third language in order to communicate with a broader range of junior researchers.	Offer online/virtual follow-up to writing workshops and short courses.	Require all universities to offer academic writing courses for undergraduates.	Foster intra-regional and inter-regional research partnerships and writing support networks between institutions in Africa.	Journals & Funders- Journals, especially Global Health journals, and funders could be more flexible with the various dialects of English they accept.
Join and participate in an online (virtual) network that provides support, mentoring, resources and training for researchers in low- and middle-income countries. For example, AuthorAID. Note, AuthorAID is currently available in English and Spanish only.	Actively seek non-English-speaking researchers to be members of research teams.	Establish a writing centre and improve use of them. Raise awareness of their existence. Enable continuous improvement of them by improving their availability, accessibility, acceptability and quality (AAAQ). Ensure bilingual and multilingual staff/consultants in them.	Review primary school and secondary school curriculum for language development, including English.	Fund collaboration, partnership and networking between English-speaking and French-speaking and Portuguese-speaking institutions within Africa.	Conference organizers- Conferences could institute a review process for abstract submissions that allows for revisions based on comments received during an initial review, allow submission in other languages and have sessions in other languages.
Write, produce and submit manuscripts in whichever language one is most comfortable to develop Academic Language skill set and ensure research is produced for a local or national audience.	Encourage non-English-speaking research team members to improve their English and English-speaking team members to improve their language skills in other languages.	Link with other writing centres in country, regionally and globally.	All African governments should meet the target of allocating 1.0% of their GDP research and development, as established by the AU in 2006.	Develop exchanges to share knowledge, skills and experiences between the staff of writing centres within regionals and nearby countries neighbouring country staff of writing centres.	Funders - Encourage bilingual partnerships that are structured to address challenges.

Table 4: Recommended practical solutions to addressing concerns identified continued

Individual Researchers	Research Leaders / Principal Investigators	Institutional (e.g. universities and research institutions)	National (e.g. national governments and agencies)	Regional (e.g. regional networks and organisations)	Global (e.g. funders, journals, international organisations)
Identify and engage a research mentor.	Include budget lines to pay for transcribing meetings, translating key project documents and simultaneously translating team meetings.	Establish a peer-to-peer network, ideally qualified and trained student consultants. Pay them.		Ensure the web-site of scientific organisations and networks in Africa (e.g. AAS) are in multiple languages and not only English.	Funders & Journals – Actively engage more Africans as peer-reviewers of grants and manuscripts and increase the number of Africans on relevant advisory panels/boards. Pay honorariums to compensate for time.
Use online writing and editing tools; for example, Grammarly - www.grammarly.com; Writer- https://www.zoho.com/writer/free-writing-assistant.html; WritingAssistant - www.writing-assistant.com.		Embed intensive writing courses into existing programmes by working with interested lecturers and professors.		Work to have all African health science journals indexed internationally.	Funders – Could develop more inclusive practices for non-English speaking researchers to be included in research calls, workshops, conferences.
Read more books in English and other languages.		Collaborate/Partner/Network with English-speaking institutions and vice-versa.			Funders – Could have grants calls requiring teams to have non-English-speaking and English-speaking co-led submissions.
Do an exchange placement with a research group that uses another language.		Enhance mentoring in research and promote it.			Journals – Are advised to publish an Almanac of top articles in French, Portuguese, Arabic and Swahili. Work with an African science organisation with a pan-African mandate, such as the AAS to realise.
Earn a health sciences degree at an English institution.		Collaborate with a leading international writing centre.			Funders – Are advised to allow generous budgets for transcription, key translations (oral and written).

6. Key Recommendations

Key Recommendation #1 – Support Institutionalised writing programmes and centres
Continued capacity strengthening of academic and research institutions in Africa is of paramount importance if self-sustaining structures are to be established. Building competency in the Academic Language(s) of the institution whether it is English, French, Portuguese and/or Arabic is key as all university graduates require a foundation in critical thinking and writing.

Many African universities offer workshops and short-courses in research design, and grant and manuscript writing for research trainees and faculty. These are appropriate capacity strengthening activities when financial and/or human resources are insufficient to allow for institutionalised or embedded interventions. However, these capacity strengthening activities tend to be intermittently implemented and thus not always available or accessible to those who might benefit. Irregular implementation of these activities likely renders them suboptimal. To maximize their potential effectiveness, the goal should be to institutionalize these efforts to ensure consistent access and promote sustainability.

Institutionalised programmes include embedding intensive writing courses into existing curricula and establishing full-time staffed writing centres. The former ensures every student can be exposed to academic writing as a trainee. The latter enables students and faculty to get one-on-one support as needed.

The move to virtual support by writing centres within South African universities during the COVID-19 pandemic has been reported to yield positive effects, thus suggesting that in-person interaction may not be required for impact. Further investigation into this, as COVID-19 subsides, could produce interesting results for consideration.

Encourage trainees to use a variety of support systems to improve their writing, including supervisors, writing centre representatives and peers.

Key Recommendation #2 - Funders are advised to support virtual and in-person learning exchanges between writing support personnel
The types of approaches and methods used to support academic writing vary greatly across the continent. Funders can support sharing of best practices and challenges and skills-development among academic writing support personnel at universities and research institutions within and between countries in Africa and between African and non-African institutions in whatever language(s) each institution desires.

Key Recommendation #3 - Increase research projects within the curricula
Trainees should gain direct experience in developing and implementing a research project during their first degree. All universities students should be required to take a course that requires a research project of some type to be implemented. This is important for developing and strengthening abilities in the language of science regardless of the teaching language(s) of the institution.

Key Recommendation #4 – increase direct interactions between early-career researchers in more than one language
Being immersed in another language is the fastest way to learn another language. Non-English-speaking early career researchers should be encouraged to conduct research at an English institution in an English-speaking community.

Key Recommendation #5 – Institutions and funders need to address their own policies and procedures that contribute to language and intersecting barriers
Institutions and funders need to provide conducive environments to enable individuals to overcome language-barriers faced and be committed to addressing inequities in their own processes. For universities and research institutions this would include maternity leave policies and promotion policies to address the intersection of gender and language barriers. For funders an equity lens around requests for proposals is suggested including having specific calls for non-English institutions and calls that encourage bilingual or multi-lingual research applications by teams and consortia.

7. Strengths, Limitations and Areas for Further Research

Strength and Limitations

One of the major strengths of this study was its effort to be representative of the diversity of Africa and inclusive of participants speaking different languages. The study sample aimed to be representative of the 54 countries of Africa and the five sub-regions of the African continent, and to ensure the roughly equal participation of both women and men participants. Additionally, the sampling strategy aimed to include diverse participants from across various disciplines within medicine and the health sciences, as well as include representative numbers of English-speaking, French-speaking and Portuguese-speaking researchers. To ensure accuracy of data, and enable participants to fully and freely participate, interviews and surveys were completed in the language in which they were most comfortable. Other strengths of the study include the large sample size, the mixed methods design which allowed for in-depth analysis and understanding, and triangulation of data from different sources.

This study also had several **limitations.** First, the study examined the issue of language-based equity in African health science research broadly in order to reflect the overall diversity of Africa, but did not conduct any in-depth evaluations of specific interventions. The authors of this study believe this approach was justified, however, to provide a broad range of relevant and feasible interventions applicable to a variety of stakeholders (i.e. individuals from trainee to principal investigators, institutions, governments, organisations, funders).

Second, this study collected minimal cost information related to the design, implementation and scaling of relevant interventions. This was partially because of the broad nature of the examination and the limited time available to undertake the study (and thus limited time to build sufficient trust with organisations accounted for this), but was also due to the limited knowledge and experience among study participants of relevant interventions. The limited participation (i.e. only three questionnaires completed) of Sample 2 participants (representatives of African organisations involved in capacity strengthening) contributed to this.

Finally, the study had insufficient time to explore in detail previous and existing interventions to tackle barriers related to health science research or the dominance of English in health sciences education and research. These interventions [34]and initiatives may be particularly relevant and should be examined and evaluated. See Table 6: Initiatives identified that warrant additional examination to determine the degree to which they support overcoming language-barriers in health science research in Africa.

Further Research

The findings have highlighted several areas for future research related to language barriers in health sciences research in Africa. Further research is recommended in the following areas:
*   Conduct cost-benefit analysis of the benefit of writing workshops, writing courses and writing centres to determine which approach is most beneficial and cost effective in what context. Ensure evaluations explore gender differences in access to, uptake of and effectiveness of these interventions. For example, at the individual-level evaluate the relative effectiveness of different capacity strengthening interventions (such as language centers, workshops, short courses and different mentorship models) to improve Academic Language capacity, and assess impact by gender.
*   Implement needs assessments for establishing academic writing centres in English-speaking and non-English-speaking countries.
*   Examine why women access university writing centres more than men. Explore whether women are more inclined to seek assistance with writing needs than are men or if men in university generally have more developed academic writing skills. Understand other barriers to access and use of interventions to address language equity issues.
*   Undertake evaluations of language initiatives such as those identified in Table 6 to build the evidence base on what works.

Table 5: Initiatives identified that warrant examination to determine the degree to which they support overcoming language-barriers in health science research in Africa

#	Name	Lead Organisation(s)	Purpose or Focus	Further information
1	ePORTUGUESe	World Health Organization	Provide reliable and up-to-date health information in Portuguese to 8 Portuguese countries worldwide - 4 in Africa.	https://www.who.int/eportuguese/en/; UNGERER, R. L. & NARVAI, P. C. 2020. The experience of Virtual Health Libraries in Portuguese speaking countries. RECIIS, 14.
2	WHO Arabic Programme (WAP)	World Health Organization	Meeting the needs of Arab-speaking countries for new and reliable information in all areas of health, developing scientific terminology, and institutionalizing health technology by translating WHO basic documents and presenting WHO activities in Arabic.	Sara, K. (2009). [Role of WHO Arabic Programme in scaling up the Arabic language]. EMHJ - Eastern Mediterranean Health Journal, 15 (3), 665-682, 2009 https://apps.who.int/iris/handle/10665/117685
3	King Abdullah bin Abdulaziz Arabic Health Encyclopedia	King Saud bin Abdualaziz University & Saudi Association of Health Informatics	To provide reliable health information in Arabic to increase health awareness and support the efforts of various health facilities in promoting the health of people.	https://kaahe.org/en-us/Pages/Home/Home.aspx
4	Science and Language Mobility Scheme Africa	African Academy of Sciences	A programme funding researchers from English-speaking and French-speaking institutions to undertake scientific research in language regions other than their own. Offer grants of up toUSD20,000 for placements of up to six months. Funded 6 researchers, 5 French-speaking and 1 English-speaking. The grantees were from Kenya, DRC, Madagascar, Mali, Cote d'Ivoire and Senegal and were placed in Senegal, South Africa, Tanzania, The Gambia, Tanzania and The Gambia, respectively.	https://www.aasciences.africa/aesa/programmes/mobility-schemes-science-and-language-mobility-scheme-africa
5	Joint conference between TUFH and RIFRESS in Tunisia in 2017	The Network: Towards Unity for Health (TUFH) and Réseau international francophone pour la responsabilité sociale en santé (RIFRESS) (francophone social accountability network)	Not available	Not available.
6	African Journal Partnership Program (AJPP)	Elsevier Foundation; National Institute of Health (NIH)	To boost the impact and discoverability of African health research.	https://elsevierfoundation.org/wp-content/uploads/2020/09/Research-without-Borders-Program-Overview.pdf
7	Health Science writing centre	University of Cape Town	Established in 2015, the e Faculty of Health Sciences Writing Lab provides students and staff of the Faculty with access to specialist writing support.	Muna, N., et al., Establishing a Health Sciences writing centre in the changing landscape of South African Higher Education. Critical studies in teaching and learning, 2019. 7(1): p. 19-41.
8	Writing Intensive Courses	University of Witwatersrand	In 2018 embedded writing intensive courses into its existing curricula by working with supportive lecturers and professors.	https://issuu.com/witsmarketing/docs/wits_review_teaching_and_learning_2015-2019
9	AuthorAid	International Network for the Availability of Scientific Publications (INASP)	AuthorAID is supported by the UK Department for International Development (DFID) and the Swedish International Development Cooperation Agency (Sida)	https://www.authoraid.info/en/

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Countries of Africa with key indicators for this study sorted by publications by medical sciences in 2014

#	Country	sub-Region of Africa (AU)	WHO Region	Primary Language(s) of Health Sciences Higher Education	Population-Total (2018)	% of Population of Africa	Publications by Field of Science - Medical Sciences (2014)	Percentage of Medical Sciences Publications in Africa	English Journals	French Journals	Portuguese Journals	Arabic Journals	Percentage of Medical Sciences Publications for Group of Countries	Group of Countries	Cumulative Percentage of Medical Sciences Publicalations in Africa
1	South Africa	South	AFR	English	57 779 622	4,5	1475	23,7%					62,7%	Top 5 producing countries of medical sciences publications	62,7%
2	Egypt	North	EMR	English	98 423 595	7,7	1453	23,3%							
3	Nigeria	West	AFR	English	195 874 740	15,4	377	6,1%							
4	Kenya	East	AFR	English	51 393 010	4,0	306	4,9%							
5	Tunisia	North	EMR	French	11 565 204	0,9	292	4,7%							
6	Tanzania, United Republic of	East	AFR	English	56 318 348	4,4	237	3,8%					16,9	Top 10 producing countries of medical sciences publications	79,6%
7	Uganda	East	AFR	English	42 723 139	3,4	234	3,8%							
8	Morocco	North	EMR	French	36 029 138	2,8	227	3,6%							
9	Ethiopia	East	AFR	English	109 224 559	8,6	198	3,2%							
10	Ghana	West	AFR	English	29 767 108	2,3	157	2,5%							
11	Malawi	South	AFR	English	18 143 315	1,4	118	1,9%					11,8	Top 20 producing countries of medical sciences publications	91,4%
12	Cameroon	Central	AFR	English	25 216 237	2,0	98	1,6%							
13	Zambia	South	AFR	English	17 351 822	1,4	83	1,3%							
14	Senegal	West	AFR	French	15 854 360	1,2	78	1,3%							
15	Algeria	North	AFR	French	42 228 429	3,3	71	1,1%							
16	Burkina Faso	West	AFR	French	19 751 535	1,6	67	1,1%							
17	Sudan	East	EMR	English, Arabic	41 801 533	3,3	67	1,1%							
18	Zimbabwe	South	AFR	English	14 439 018	1,1	57	0,9%							
19	Rwanda	East	AFR	English	12 301 939	1,0	49	0,8%							
20	Mozambique	South	AFR	Portuguese	29 495 962	2,3	48	0,8%							
21	Benin	West	AFR	French	11 485 048	0,9	47	0,8%						Remaining 34 countries (12 of the 34, also see next page)	
22	Côte d'Ivoire	West	AFR	French	25 069 229	2,0	45	0,7%							
23	Mali	West	AFR	French	19 077 690	1,5	43	0,7%							
24	Botswana	South	AFR	English	2 254 126	0,2	42	0,7%							
25	Gambia, The	West	AFR	English	2 280 102	0,2	39	0,6%							
26	Congo, Rep	Central	AFR	French	5 244 363	0,4	36	0,6%							
27	Congo, Dem. Rep	Central	AFR	French	84 068 091	6,6	35	0,6%							
28	Libya	North	EMR	English, Arabic	6 678 567	0,5	34	0,5%							
29	Gabon	Central	AFR	French	2 119 275	0,2	30	0,5%							
30	Namibia	South	AFR	English	2 448 255	0,2	26	0,4%							
31	Madagascar	East	AFR	French	26 262 368	2,1	25	0,4%							
32	Sierra Leone	West	AFR	English	7 650 154	0,6	23	0,4%							

#	Country	sub-Region of Africa (AU)	WHO Region	Primary Language(s) of Health Sciences Higher Education	Population-Total (2018)	% of Population of Africa	Publications by Field of Science - Medical Sciences (2014)	Percentage of Medical Sciences Publications in Africa						Percentage of Medical Sciences Publications for Group of Countries	Group of Countries	Cumulative Percentage of Medical Sciences Publicalations in Africa
33	Guinea	West	AFR	French	12 414 318	1,0	18	0,3%								
34	Niger	West	AFR	French	22 442 948	1,8	18	0,3%								
35	Guinea-Bissau	West	AFR	Portuguese	1 874 309	0,1	12	0,2%								
36	Angola	South	AFR	Portuguese	30 809 762	2,4	9	0,1%								
37	Central African Republic	Central	AFR	French	4 666 377	0,4	8	0,1%								
38	Mauritius	East	AFR	French	1 265 303	0,1	7	0,1%								
39	Chad	Central	AFR	French	15 477 751	1,2	6	0,1%								
40	Togo	West	AFR	French	7 889 094	0,6	6	0,1%								
41	Mauritania	North	AFR	French	4 403 319	0,3	5	0,1%								
42	Liberia	West	AFR	English	4 818 977	0,4	4	0,1%								
43	Somalia	East	EMR	English	15 008 154	1,2	4	0,1%						8,6	Remaining 34 countries (22 of the 34, also see previous)	100,0%
44	Djibouti	East	EMR	French	958 920	0,1	3	0,0%								
45	Eritrea	East	AFR	English	3 213 972	0,3	3	0,0%								
46	Seychelles	East	AFR	English	96 762	0,0	3	0,0%								
47	Eswatini	South	AFR	English	1 136 191	0,1	2	0,0%								
48	Lesotho	South	AFR	English	2 108 132	0,2	2	0,0%								
49	Burundi	Central	AFR	French	11 175 378	0,9	1	0,0%								
50	Cabo Verde	West	AFR	Portuguese	543 767	0,0	1	0,0%								
51	Comoros	East	AFR	French	832 322	0,1	0	0,0%								
52	Equatorial Guinea	Central	AFR	Spanish	1 308 974	0,1	0	0,0%								
53	São Tomé and Príncipe	Central	AFR	-	211 028	0,0	0	0,0%								
54	South Sudan	East	AFR	English	10 975 920	0,9	0	0,0%								
				Totals	**1 273 951 559**	**100**	**6 229**	**100,0%**								

Note: Highlighted countries had at least one African participant in the study.

Sources:

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Annex B1

Participants: Key Informant Interviewees (Sample 1)

Name	Institution	Country
Adilson de Pina	Ministry of Health	Cabo Verde
Isabel Inês Monteiro de Pina Araújo	University of Cabo Verde	Cabo Verde
Maria da Luz Lima	Instituto Nacional de Saúde Pública (INSP)	Cabo Verde
Silvania Veiga Leal	Ministry of Health	Cabo Verde
Diana B. Njweipi-Kongor	St Jerome Catholic University Institute, Douala	Cameroon
Njouendou Abdel Jelil	University of Buea	Cameroon
Nkouonlack Cyrille	University of Buea	Cameroon
Tazemda-Kuitsouc Gildas	University de Montaigne	Cameroon
Oussou Mienwoley Armel	Université Alassane Ouattara	Cote d'Ivoire
Ben Bepouka	University of Kinshasa	DRC
Eddy K. Lusamaki	Institut National de Recherche Biomédicale (INRB); Université de Kinshasa	DRC
Essraa Hegazy	Cairo University	Egypt
Jeannot Zinsou	Centre de Recherches Médicales de Lambaréné (CERMEL)	Gabon
Abigail Kusi Amponsah	Kwame Nkrumah University of Science and Technology	Ghana
Michelle Muthui	KEMRI-Wellcome Trust Research Programme	Kenya
Nadia Tagoe	KEMRI-Wellcome Trust Research Programme	Kenya
Primus Che Chi	KEMRI-Wellcome Trust Research Programme	Kenya
Diop Samba	University of Bamako	Mali
Elisabeth Sogodogo	Charles Mérieux Center for Infectious Disease	Mali
Karamoko Naire	Brown University, USA; West African Center for Cell Biology of Infectious Pathogens (WACCBIP), Ghana; Malaria Research Training Center (MRTC), Mali	Mali
Souleymane Dama	University of Science and Technology of Bamako	Mali
Imane Jroundi	Mohammed V University in Rabat	Morocco
Mouzinho Saide	Ministry of Health	Mozambique
Paulo Pires	Lurio University	Mozambique
Sisidoro Isidoro	Lurio University	Mozambique
Dr. Ugboma	University of Port Harcourt	Nigeria
Felix Anyiam	University of Port Harcourt	Nigeria
Fadima Yaya Bocoum	African Population Health Research Centre	Senegal
Fatimata Mbaye	Cheikh Anta Diop University of Dakar (UCAD)	Senegal
Eveline Muika	Stellenbosch University	South Africa
Ferdinand C. Mukumbang	University of the Western Cape; University of Washington, USA	South Africa
Henry Adeola	University of Cape Town	South Africa
Jimmy Volmink	Stellenbosch University	South Africa
Natashia Muna	University of Cape Town	South Africa
Pamela Nichols	University of Witwatersrand	South Africa
Rose Richards	Stellenbosch University	South Africa
Sharon Fonn	University of Witwatersrand	South Africa

Name	Institution	Country
Stephen Pentz	University of Witwatersrand	South Africa
Ghaiath Hussein	College of Public Health and Health Informatics, King Saud Bin Abdulaziz University For Health Sciences, Saudi Arabia. (Graduate of Alzaiem Alazhari University, Sudan)	Sudan
Blandina Mmbaga	Kilimanjaro Christian Medical Centre	Tanzania
Declare Mushi	Kilimanjaro Christian Medicial University College	Tanzania
George Kiwango	Muhimbili University of Health and Allied Sciences	Tanzania
Honorati Masanja	Ifakara Health Institute (IHI)	Tanzania
Ritah Mutagonda	Muhimbili University of Health and Allied Sciences	Tanzania
Stephen Mshana	Catholic University of Health and Allied Sciences	Tanzania

Annex B2

Participants: Participants: Questionnaire for African Organisation Respondents (Sample 2)

Name	Organisation	Country
Dinis Fernando da Costa	Instituto Superior Politecnico Gregorio Semedo	Angola
Bibiane Ogue	Université d'Abomey-Calavi	Bénin
Lillian Mutengu	African Academy of Sciences - AESA	Kenya

Annex B3

Participants: Questionnaire for non-African Organisation Respondents (Sample 3)

Name	Institution	Country
Regina Ungerer	Fundação Oswaldo Cruz	Brazil
Christina Zarowsky	École de santé publique de l'Université de Montréal	Canada
David Cechetto	University of Western Ontario	Canada
Dena Taylor	University of Toronto	Canada
Donald Cole	Dalla Lana School Public Health, University of Toronto	Canada
Erica Di Ruggiero	University of Toronto	Canada
Karina Dubois-Nguyen	Unité de santé internationale UdeM-CHUM	Canada
Ronald Labonte	University of Ottawa	Canada
Anonymous	Anonymous	China
Hans Hagen	GloPID-R	France
Imelda Bates	Liverpool School of Tropical Medicine	United Kingdom
Jessica Amegee	Liverpool School of Tropical Medicine	United Kingdom
Jim Todd	London School of Hygiene and Tropical Medicine	United Kingdom
Justin Pulford	Liverpool School of Tropical Medicine	United Kingdom
Keith Martin	Consortium of Universities for Global Health	United States
William (Bill) Burdick	The Network: Towards Unity for Health (TUFH)	United States

Annex C: Detailed Methods

1. Introduction

This study used a mixed method approach, employing both qualitative and quantitative data collection. Data collection included: 1) a literature review; 2) key informant interviews; and 3) survey questionnaires. A grounded theory approach (Strauss and Corbin 1990; Barney G. Glaser 2014a, 2014b) with a constructivist worldview (Creswell and Plano Clark 2011) was used to analyse the data and produce the findings. The Faculty of Health Sciences – Ethical Review Board, University of Buea in Cameroon, approved the research protocol.

1.1 Parameters and Scope

The study sought to be representative of health science researchers across Africa, a large, diverse continent with many nations, languages and countries. Linguistically, English, French, Portuguese and Arabic are the principal languages of instruction at higher education health science institutions. Geographically, Africa has five sub-regions. Academically, including research output (e.g. publications per person), African countries vary considerably based on population, economic wealth and international partnerships. Therefore, representatives from a range of countries were included in this study.

Three main groups of stakeholders were participants in this study. The first group were health science researchers and representatives of educational institutions who support health researchers at academic institutions. The second group were representatives of organisations that support African health sciences researchers through capacity strengthening initiatives and through their work or research. The third group included representatives of non-African networks and organisations that support African health science researchers.

To achieve a representative sample of these individuals from across Africa, the study strove to interview between three to five individuals per country from the following groupings of countries:
- At least 2 countries from each African Union sub-region.
- At least 7 countries in which English is used as a language of instruction in medical schools, 4 countries in which French is used, 2 countries in which Portuguese is used and 2 countries in which Arabic is used[1].
- All 4 African research "hubs".
- All 3 WHO-AFR countries producing approximately 50% of the medical science publications; at least 2 of the 5 countries responsible for producing the next 25%; at least 3 of the 18 countries responsible for producing the next 15%; and at least 4 countries responsible for producing the final 10%.
- At least 4 low-income countries, 9 lower-middle income countries, 2 upper-middle income countries will be included
- At least one island state.

Health Science Researchers and Representatives of Supporting Educational Institutions and Organisations (Sample 1)

As noted, health science researchers and representatives of educational institutions and other organisations supporting health researchers were one group of key stakeholders. This group included health researchers (including post-graduate trainees), administrative and support staff at research institutions, and representatives of institutions in African countries that support research (e.g. representatives of writing centres, and government agencies).

Over 140 potential Sample 1 participants were invited to participate in the study. The precise number of invitations made is not known because some interviewees contacted colleagues to invite them to participate. The study was able to interview representatives from all the groupings mentioned above although it was only able to interview at least 3 representatives from 7 of the 16 countries from which representatives were sought.

A total of forty-five key informant (KI) interviews were conducted for Sample 1. See Table 1 (below) for the various characteristics of participants from Sample 1 and the distribution of them by characteristic. See Annexes B1, B2 and B3 for the names and affiliations of the KIs.

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1. Language of instruction is based on details presented by the World Directory of Medical Schools, https://wdoms.org/. Accessed 17 Oct 2020.

Table 1: Characteristics of the 45 Key Informants

Characteristic	Division of Key informants by Characteristic
Sex	Female (20) Male (25)
Highest Degree	Biomedical Sciences (5) Clinical Medicine (14) Nursing: (1) Pharmacy (4) Public Health (15) Dentistry (1) Medical Education/Medical Ethics (2) Social Sciences (3)
Age Range	Early Career: <35 years of age (7) Mid-Career: 35 to 55 years of age (29) Older: >55 years of age (9)
Language of Interview	English (27) French (13) Portuguese (5)
Location in Country	Main city of country: the capital or largest city (23) Secondary city: (22)

Africa Networks and Organisations Supporting Research Strengthening (Sample 2)

Forty invitations were emailed in English and French to representatives from African member organisations involved in research capacity strengthening to participate in an orientation workshop, complete a questionnaire on SurveyMonkey™ and provided feedback to initial findings in a second workshop. Three individuals completed questionnaires, all in English and no representatives of Sample 2 participated in the second workshop. The three participants were from three countries. See Annex B for their names and affiliations.

Non-African networks and organisations that support African health science researchers (Sample 3)

Forty invitations were emailed to representatives of non-African organisations, including universities, donor agencies and global health membership organisations, who have been involved in research capacity strengthening in the African region to complete a questionnaire on SurveyMonkey™. Sixteen of the 40 invitees (40% response ratee) completed the questionnaire. See Annex B for the names of the representatives.

1.2 Data Collection

Literature Review

Published articles were identified using PubMed, Medline, the Africa-Wide Information database at the University of Toronto online library, Google Scholar and Google. Search terms used combinations of the following words and phrases: English; French; Arabic; Portuguese; Swahili; Language; Africa; WHO-AFR; WHO-EMR; health research; health science research; medical research; nursing research; public health research; pharmacy research; knowledge translation; knowledge uptake; non-English sources; medical and health science journals in Africa; capacity strengthening for health research writing in Africa; career advancement of health science researchers in Africa; PhD pedagogy; language barriers; language challenges; and language obstacles.

Data from the literature review were entered into Microsoft Excel spreadsheet by theme for later analysis. The samples of African and non-African networks and organisations were created during the literature review.

Key Informant Interviews

Sample 1 consisted of 45 key informant (KI) interviewees from 16 African countries. Forty (40) of the KIs were health science researchers and five were representatives of university writing centres. Interviewees were sent a participant information sheet when initially contacted by email for the study. The invitation email was sent in English, French, Portuguese and/or Arabic depending on the country, institution, LinkedIn profile or other information known about the potential participant. The email also contained the participant information sheet for the study either in English, French, Portuguese or Arabic. Interviewees were asked to enrol in the study by completing a short questionnaire on SurveyMonkey™, an electronic survey platform. Participants who enrolled provided consent and selected in which language - English, French, Portuguese or Arabic – they wished to be interviewed. A few interviewees responded by email and consent was given at the start of their interviews.

The interviews were conducted in English, French or Portuguese; no participant desired to be interviewed in Arabic. Four of the five project team members (AY, FT, DM and VS) conducted the interviews[2]. AY and DM led the interviews conducted in English. FT led the interviews conducted in French. AY led the interviews conducted in Portuguese supported by Portuguese interpreters based in Portugal. All interviews were conducted using Zoom or WhatsApp, except for two that were written submissions, and were recorded and transcribed. The two written submissions were provided in French when bandwidth did not allow for verbal interviews to occur. All verbal interviews lasted between 30 and 90 minutes.

All interviews were recorded and transcribed in-full, using professional human transcribers at www.rev.com (English) and independent consultants from Portugal, Canada, France, Madagascar, Brazil, Egypt and Morocco identified on www.upwork.com. A total of 12 different independent translators and transcribers were used, in addition to the ones used by www.rev.com.

Questionnaires

Two online questionnaires using SurveyMonkey® - www.surveymonkey.com - were conducted. Three representatives of the African organisations (Sample 2) and 16 representatives non-African organisations (Sample 3) completed the questionnaires. The questionnaires were available in English and French and all respondents completed the questionnaire in English, except for one representative from Sample 3 who completed it in French.

Virtual Workshops – set 1 of 2

Six virtual workshops, conducted using Zoom, were scheduled with representatives of African networks and organisations (Sample 2). The first four workshops, two in English and two in French, were to introduce the workshop. The last two workshops, one in English and one in French, were to present initial findings and obtain feedback. There was one participant in each of the two initial English workshops. No one participated in the other workshops although two individuals registered to participate in them.

After the first set of workshops, a link to an electronic questionnaire was sent to all individuals who registered for them, in English or French - see Annex 3. They were asked to complete the questionnaire within two weeks of receiving it. Three representatives completed the questionnaire.

1.3 Data Analysis

Data collected during the literature review, key informant interviews and questionnaires were systematically extracted and entered into the pre-coded (by theme) Excel spreadsheet All non-English and non-French data were translated into English first. Data were analyzed thematically following the interview guide. A "other" category ensured novel concepts were captured. All members of the study team participated in the review of the transcriptions of the interviews. Each transcription was reviewed by at least two study team participants.

1.4 Ethics Considerations

The Faculty of Health Sciences – Ethical Review Board, University of Buea, Cameroon, approved the research protocol (Ref: 2021-1259-12/UB/SG/IRB/FHS). All individuals contacted by the research team

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2.   The project team consisted of five members: Aaron Yarmoshuk (AY); Doreen Mloka (DM); Fidèle Touré (FT), Samuel Wanji (SW); and, Vandana Sharma (VS).

were emailed a summary introduction to the study (see Annexes C1, C2 and C3) and asked to provide consent either online or orally before participating (see Annex C4, C6 and C7). Interviewees were informed that they could freely withdraw from the study with 48 hours of participating in the study.

The report submitted is worded so that no findings or quotations can be attributed to an individual by name unless they gave consent. The name of participant who did not wish to have their name appearing in the annex of the Final Report is listed as "anonymous" in Annex B.

Annex C1 – Participant Information Sheet (Sample 1) – English Version

Participant Information Sheet for:
Research into language-based equity in African health science research

Introducing the research team and the study

Hello. We are a team of five independent researchers contracted by the Wellcome Trust in the United Kingdom to implement the project, *Research into language-based equity in African health science research*. The members of the team are:

Dr. Aaron Yarmoshuk, PI-Canada & Team Leader
Dr. Doreen Mloka, Co-PI–Tanzania & Professional Development Expert
Dr. Fidèle Toure, Co-PI-Ivory Coast & Lead Francophone Interviewer
Dr. Vandana Sharma, Co-PI-Canada & Gender Analyst & Quality Assurance Expert
Dr. Samuel Wanji, co-PI-Cameroon & Senior Administration and Quality Assurance Expert

A key priority area for the Wellcome Trust is Research Ecosystems in Africa and Asia. It seeks to support self-sustaining research ecosystems that generate knowledge and improve health for a defined population or area. Promoting independent research leadership in Africa is an important component of this. This research project is examining a critical barrier to establishing a self-sustaining health research ecosystem in African countries and Africa overall: the potential impact of English being one of the dominant global languages of science on researchers in Africa whose first language is not English. The Faculty of Health Sciences – Ethical Review Board, University of Buea, Cameroon, approved the research protocol (Ref: 2021-1259-12/UB/SG/IRB/FHS)

The overall objective of this project is to identify actual and perceived language barriers, and other potential barriers facing African health science research in the short- and longer-term that constrain cross-language understanding, including knowledge transfer, scientific collaboration and research uptake, and provide evidence on practical ways to address them.

The project will examine whether the use of English, in the African context:
1. Is a barrier to the advancement and success of health science researchers individually, either nationally or internationally, and to the advancement of health science more widely; and,
2. Is contributing to wider structural inequalities within the general health science research ecosystem.

Methods

The study will include key informant interviews, virtual workshops and questionnaires. You will be involved as a key informant interview should you agree to participate in this study.

Key Informant Interviews

The key informant interview will be conducted using Zoom, Skype or WhatsApp. It will be scheduled sometime in February or March 2021. It will be your choice whether it is conducted in English, French, Portuguese or Arabic. If you chose for it to be in Portuguese or Arabic a translator will be used. The interview will be recorded and transcribed. We anticipate the interview will last between 30 and 60 minutes. The recordings of the interviews will be stored indefinitely on our password protected computers and Dropbox.

Keeping information you don't wish shared confidential

We will list your name as a study participant in the Annex of the Final Report, unless you tell us not to, but no comment or finding in the report will be attributed to you.

Informed Consent

If you agree to participate in the study, please complete the electronic consent form. Completing the electronic consent form will signify your acceptance to participate in the study. If for any reason you decide to withdraw from the study before, during or within 48 hours of completing the interview you may do so by emailing the research team leader, Dr. Yarmoshuk, at aaron.yarmoshuk@gmail.com, and we will remove your name and data from the study and we will respect your decision.

Compensation

You will receive no compensation for the time and effort that you spend with us. You will, however, be acknowledged in all publications in which information and perspectives you share with us are included. We will send you an electronic copy of the Final Report.

Contact details

If you have any questions regarding the study you may contact me by: e-mail, aaron.yarmoshuk@gmail.com; Skype, aaron.yarmoshuk@gmail; or, telephone/WhatsApp, +1.647.274.6363 or +27.83.874.1629.

Annex C2 – Participant Information Sheet (Sample 2) – English Version

Participant Information Sheet for:
Research into language-based equity in African health science research

Introducing the research team and the study

Hello. We are a team of five independent researchers contracted by the Wellcome Trust in the United Kingdom to implement the project, *Research into language-based equity in African health science research*. The members of the team are:

Dr. Aaron Yarmoshuk, PI-Canada & Team Leader
Dr. Doreen Mloka, Co-PI–Tanzania & Professional Development Expert
Dr. Fidèle Toure, Co-PI-Ivory Coast & Lead Francophone Interviewer
Dr. Vandana Sharma, Co-PI-Canada & Gender Analyst & Quality Assurance Expert
Dr. Samuel Wanji, co-PI-Cameroon & Senior Administration and Quality Assurance Expert

A key priority area for the Wellcome Trust is Research Ecosystems in Africa and Asia. It seeks to support self-sustaining research ecosystems that generate knowledge and improve health for a defined population or area. Promoting independent research leadership in Africa is an important component of this. This research project is examining a critical barrier to establishing a self-sustaining health research ecosystem in African countries and Africa overall: the potential impact of English being one of the dominant global languages of science on researchers in Africa whose first language is not English. The Faculty of Health Sciences – Ethical Review Board, University of Buea, Cameroon, approved the research protocol (Ref: 2021-1259-12/UB/SG/IRB/FHS)

The overall objective of this project is to identify actual and perceived language barriers, and potential other barriers facing African health science research in the short- and longer-term that constrain cross-language understanding, including knowledge transfer, scientific collaboration and research uptake, and provide evidence on practical ways to address them.

The project will examine whether the use of English, in the African context:
1. Is a barrier to the advancement and success of health science researchers individually, either nationally or internationally, and to the advancement of health science more widely; and,
2. Is contributing to wider structural inequalities within the general health science research ecosystem.

Methods

The study will include key informant interviews, virtual workshops and questionnaires. You will be involved in two virtual workshops and answering a questionnaire should you agree to participate in this study.

Virtual Workshops and Questionnaire

Four virtual workshops, conducted using Zoom, will be held with representatives of African networks, organisations and institutions involved in health science research and support research in Africa. The first two workshops, one in English and the other French, will introduce the project to these representatives, discuss the questionnaire and seek feedback from the participants. Translation services will NOT be provided. It will be your choice which workshop to participate. The workshops will be recorded and transcribed to improve the accuracy of data collected. The data will be kept indefinitely to maximise the research potential of time invested by all in the workshop and the pursuit of knowledge. These workshops are tentatively scheduled to be held in February 2021.

Soon after the first set of workshops, a link to an electronic questionnaire will be sent to all workshop participants, in their choice of English or French. They will be asked to complete the questionnaire within two weeks of receiving it. Only one reminder will be sent to participants reminding them to complete it.

The second set of workshops is tentatively scheduled to be held sometime in the second half of 19 March 2021, again one in English and one in French. These workshops will present the initial findings and

recommendations of the study and seek feedback from the representatives. Again, translation services will NOT be provided and the workshops will be recorded and transcribed to improve the accuracy of data collected. The data will be kept indefinitely.

Keeping information you don't wish shared confidential

We will list your name as a study participant in the Annex of the Final Report, unless you tell us not to, but no comment or finding in the report will be attributed to you or the organisation you represent.

Informed Consent

If you agree to participate in the study, please sign the electronic consent form before the first workshop. Completing the electronic consent form will signify your acceptance to participate in the study. If for any reason you decide to withdraw from the study before, during or within 48 hours of completing the first or second workshop or the questionnaire you may do so by emailing the research team leader, Dr. Yarmoshuk, at aaron.yarmoshuk@gmail.com, and we will remove your name and data from the study and we will respect your decision.

Compensation

You will receive no compensation for the time and effort that you spend with us. You will, however, be acknowledged in all publications in which information and perspectives you share with us are included. We will send you an electronic copy of the Final Report.

Contact details

If you have any questions regarding the study you may contact me by: e-mail, aaron.yarmoshuk@gmail.com; Skype, aaron.yarmoshuk@gmail; or, telephone/WhatsApp, +1.647.274.6363

Annex C3 – Participant Information Sheet (Sample 3) – English Version

Participant Information Sheet for:
Research into language-based equity in African health science research

Introducing the research team and the study

Hello. We are a team of five independent researchers contracted by the Wellcome Trust in the United Kingdom to implement the project, *Research into language-based equity in African health science research*. The members of the team are:

Dr. Aaron Yarmoshuk, PI-Canada & Team Leader
Dr. Doreen Mloka, Co-PI–Tanzania & Professional Development Expert
Dr. Fidèle Toure, Co-PI-Ivory Coast & Lead Francophone Interviewer
Dr. Vandana Sharma, Co-PI-Canada & Gender Analyst & Quality Assurance Expert
Dr. Samuel Wanji, co-PI-Cameroon & Senior Administration and Quality Assurance Expert

A key priority area for the Wellcome Trust is Research Ecosystems in Africa and Asia. It seeks to support self-sustaining research ecosystems that generate knowledge and improve health for a defined population or area. Promoting independent research leadership in Africa is an important component of this. This research project is examining a critical barrier to establishing a self-sustaining health research ecosystem in African countries and Africa overall: the potential impact of English being one of the dominant global languages of science on researchers in Africa whose first language is not English. The Faculty of Health Sciences – Ethical Review Board, University of Buea, Cameroon, approved the research protocol (Ref: 2021-1259-12/UB/SG/IRB/FHS)

The overall objective of this project is to identify actual and perceived language barriers, and potential other barriers facing African health science research in the short- and longer-term that constrain cross-language understanding, including knowledge transfer, scientific collaboration and research uptake, and provide evidence on practical ways to address them.

The project will examine whether the use of English, in the African context:
1. Is a barrier to the advancement and success of health science researchers individually, either nationally or internationally, and to the advancement of health science more widely; and,
2. Is contributing to wider structural inequalities within the general health science research ecosystem.

Methods

The study will include key informant interviews, virtual workshops and questionnaires. You will be asked to complete a questionnaire, should you agree to participate in this study.

Questionnaire

As a current or past representative of a non-African organisations supporting capacity strengthening of health science research in Africa, you will be sent a link to a questionnaire in SurveyMonkey® to complete. There will be English and French versions of the questionnaires. You will be asked to complete the questionnaire within two weeks of receiving it. Only one reminder will be sent to you to complete it.

Keeping information you don't wish shared confidential

We will list your name as a study participant in the Annex of the Final Report, unless you tell us not to, but no comment or finding in the report will be attributed to you or the organisation you represent.

Informed Consent

If you agree to participate in the study, you will be sent an electronic consent form to complete before completing the questionnaire. Completing the electronic consent form will signify your acceptance to participate in the study. If for any reason you decide to withdraw from the study before, during or within 48 hours of completing the questionnaire you may do so by emailing the research team leader, Dr. Yarmoshuk, at aaron.yarmoshuk@gmail.com, and we will remove your name and data from the study and we will respect your decision.

Compensation

You will receive no compensation for the time and effort that you spend with us. You will, however, be acknowledged in all publications in which information and perspectives you share with us are included. We will send you an electronic copy of the Final Report.

Contact details

If you have any questions regarding the study you may contact me by: e-mail, aaron.yarmoshuk@gmail.com; Skype, aaron.yarmoshuk@gmail; or, telephone/WhatsApp, +1.647.274.6363.

Annex C4 – Consent Form – English Version (Generic Version)

Title of Project: Research into language-based equity in African health science research

The evaluation has been described to me in language that I understand and I freely and voluntarily agree to participate. My questions about the evaluation have been answered. I understand that my identity will not be disclosed, with regards to any specific finding, and that I may withdraw from the evaluation without giving a reason, within 48 hours of participating in a formal activity (i.e. interview, workshop or questionnaire) of it, and this will not negatively affect me in any way.

Participant's name: ....

Participant's mobile #: ....

Participant's e-mail: ....

Participant's signature – by checking a box online: ....

Date: ....

Should you have any questions regarding this study or wish to report any problems you have experienced related to the study, please contact:

Team Leader: Aaron Yarmoshuk, PhD
Mobile/WhatsApp: +1.647.274.6363 or +27.83.874.1629
E-mail: aaron.yarmoshuk@gmail.com

Annex C5 – Interview Guide (for Sample 1) – English Version

1. Are you less than 35 years of age, between 35 and 55 years old, or over 55 years of age?

2. How many academic degrees do you have? Please name them, the country where you obtained each of them and the language of instruction at the institution where your earned each of them.

3. What is your mother tongue?

4. What other languages are you fluent in?

5. What languages do you have a working knowledge of?

6.   What is your primary health profession?

7. How long have you been a researcher?

8. What is your current research area/topic?

9. Do you, or did you, find English, as a dominant language in science, to be a barrier to your advancement as a health science researcher?
    *   If yes, how and why? If no, why not?
    (Note: depending on the response probe to inquire about current and/or previous workplaces.)

10. Do you think that English, as a dominant language of science, is a barrier to the advancement of health science research more widely in Africa?
    *   If no, why not
    *   If yes, what is the nature and extent of the barrier?

11. What do you consider to be the non-language barriers to individual and scientific advancement in health science research institutions within Africa?
    Depending on the answer to the Question 11, investigate by asking about whether the following are barriers to individual and scientific advancement in health science research institutions in Africa:
    *   Is gender a barrier to individual and scientific advancement in health science research institutions within Africa? If so, how? If possible, please give an example.
    *   Is class a barrier to individual and scientific advancement in health science research institutions within Africa? If so, how? If possible, please give an example.
    *   Is ethnicity a barrier to individual and scientific advancement in health science research institutions within Africa?
    *   Are there institutional characteristics that are barriers to individual and scientific advancement in health science research institutions within Africa? If yes, what? If possible, please give an example.
    *   Are there financial barriers to individual and scientific advancement in health science research institutions within Africa? If so, what? If possible, please give an example.
    *   Are there regulatory barriers to individual and scientific advancement in health science research institutions within Africa.
    *   What are other barriers to individual and scientific advancement in health science research institutions within Africa?

12. Are there structures or systems (formal or informal) in place at your institution to address language barriers related to health science research?
    *   If yes, what are they?
    *   If no, what structures or systems should be put in place
        Note: If the interviewee seems unsure about the question probe by asking if there are any support services for staff/faculty or students to improve academic writing; for example, a writing centre at the institution or access to short-courses (on or off-campus) to support academic writing.

13. What previous or existing institutional interventions have been tried to address language barriers in health science research and for scientific advancement?
    - To what extent have they been successful?
        - Investigate: How was success measured?
        - Investigate: What elements contributed to their success / failure
        - What have been the costs and benefits of each intervention?
        - How have these interventions been maintained or supported?

    Note: If the interviewee seems unsure about the question probe by asking if there are any support services for staff/faculty or students to improve academic writing; for example, a writing centre at the institution or access to short-courses (on or off-campus) to support academic writing.

14. Do you know of any previous or existing national or international interventions that have been attempted to address language barriers in health science research and for scientific advancement?
    - To what extent have they been successful?
        - Probe: How has success been measured?
        - Probe: What elements contributed to their success / failure
        - What have been the costs and benefits of each intervention?

    Note: If the interviewee seems unsure about the question probe by asking if there are any support services for staff/faculty or students to improve academic writing; for example, a writing centre at the institution or access to short-courses (on or off-campus) to support academic writing.

15. What are the biggest challenges you face in publishing your health science research?
    - How many peer-reviewed papers for which you are the corresponding author?
    - In what languages do you have peer-reviewed publications?

Annex C6 – Questionnaire for African Organisations (for Sample 2) – English Version

Note: Administered using SurveyMonkey™

1. I consent to participating in this study – yes or no?

2. What is your name?

3. What is the name of your organization?

4. I consent to having my names and the name of my organization appear in the Annex of the Final Report.

5. What is your position with the organisations?

6. From your perspective does your organisation consider English, as a dominant language in science, a barrier to the advancement of health science researchers and/or health research in Africa?
a. If yes, why?
b. If no, why not?

7. From your perspective does your organisation consider English, as a dominant language in science, contributing to wider structural inequalities within the general health science research ecosystem.
a. If yes, why?
b. If no, why not?

8. Please identify up to three, targeted initiatives (e.g. projects or programmes) that your organisation has to address language issues in research capacity strengthening and then describe each one briefly (one per line).

9. Please describe up to three systematic (embedded into the working environment) initiatives your organisation has to address issues in research capacity strengthening.

10. Do you know of any previous or existing interventions that have been tried by another organisation that have been used to address barriers in health science research, yes or no?
a. If yes, please list them and indicate if you consider them to be i) of high-value; ii) medium-value or ii) low-value. Please indicator the reason for how you value the intervention.

11. What do you see as the biggest challenges to publishing health science research in Africa?

12. Please email us at aaron.yarmoshuk@gmail.com any documents that you think are relevant to this subject.

13. May we contact you to discuss any of your replies, if we desire? If yes, please enter your email address here.

Annex C7 – Questionnaire for non-African Organisations (for Sample 3) – English Version

Note: Administered using SurveyMonkey™

1. I consent to participating in this study. (Yes or No).

2. What is your name?

3. What is your primary institutional affiliation?

4. I consent to having my name and institutional affiliation listed in the Annex of the report.

5. What is your position within your organisation?

6. From your perspective, is English, as a dominant language in science, a barrier to the advancement of health science researchers and/or health research in Africa?
   a. If yes, why?
   b. If no, why not?

7. From your perspective, is English, as a dominant language in science, contributing to wider structural inequalities within the general health science research ecosystem?
   a. If yes, why?
   b. If no, why not?

8. Please list and briefly describe up to three current initiatives your organisation has to address language issues in health science research in Africa?

9. Has your organisation had initiatives in the past to address language issues in health science research in Africa? Yes or no?
   a. If yes, please list them and indicate if you consider them to be higher-, medium- or lower-value for addressing language issues in health science in Africa. Please indicate the reason for how you value the intervention.

10. Do you know of any previous or existing interventions that have been tried by another organisation that have been used to address barriers in health science research, yes or no?
    a. If yes, please list up to three, briefly describe them and indicate if you consider them to be i) of higher-value; ii) medium-value or ii) lower-value for addressing language barriers in health system research in Africa. Please indicate the reason for how you valued the intervention.

11. What do you consider to be biggest challenges to publishing health science research by researchers from Africa?

12. Please upload here or email us at aaron.yarmoshuk@gmail.com any documents that you think are relevant to this research study.

13. May we contact you to discuss any of your replies, if desired? If yes, please enter your email address here.

References

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Creswell, J. W., & Plano Clark, V. L. (2011). *Designing and Conducting Mixed Rethods Research* (2nd Edition ed.). Thousands Oaks: SAGE Publications.

Strauss, A., & Corbin, J. M. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. London: Sage Publications, Inc.

Annex D: Study Team Composition

Aaron Yarmoshuk, Independent Consultant & Adjunct Lecturer, University of Toronto, Canada
DR YARMOSHUK *Team Leader,* is a Freelance Consultant and Researcher with over 25 years of experience in 16 African countries. He supports organisations with identifying, developing and monitoring and evaluating projects and programmes in the areas of capacity strengthening, public health, higher education internationalisation and community development. He has professional experience in academia and the not-for-profit and private sectors, specializing in strategy, project development and implementation, results-based management and cost-effective, robust monitoring and evaluation.

Sounan Fidèle Touré, *PhD Candidate, Université Alassane Ouattara, Côte d'Ivoire*
DR TOURE, *Lead Francophone Interviewer*, is a medical doctor specialising in Public health. He supports laboratory service and laboratory surveillance in infectious diseases. He supports decision making by data analysis et writing report. He develops research proposals for investigations and disease surveillance. He has worked for the University Hospital of Bouaké in Côte d'Ivoire for 2 years.

Doreen Mloka, *Senior Lecturer, Muhimbili University of Health and Allied Sciences, Tanzania*
DR. MLOKA, *Professional Development Expert,* is a senior lecturer and scientist in Microbiology and Medical Education based at the School of Pharmacy and Directorate of Continuing Education and Professional Development, Muhimbili University of Health and Allied Sciences (MUHAS) in Tanzania. Her background is in medical microbiology, she concurrently focuses on medical/health profession education. She has expertise in competency-based curriculum development. She has also been involved in curricular development, learning and assessment faculty development for faculty and tutors of both government and private health training institutions.

Vandana Sharma, *Global Health Researcher, Harvard University, USA*
DR. SHARMA, *Gender Analyst Expert,* is a global health researcher with more than 15 years of experience working internationally in impact evaluations, large scale randomized trials and capacity building. She holds an MD and MPH and has expertise in gender-based violence (GBV), HIV/AIDS, maternal and child health, and nutrition. She has provided technical assistance or conducted research in South Asia, sub-Saharan Africa and Latin America including in India, Bangladesh, Nepal, Guyana, Guatemala, Ethiopia, Togo, Nigeria, the Gambia, Benin, Cameroon and Kenya. She has significant experience in experimental study design, qualitative and quantitative research methods, measurement of health outcomes and data collection, development of protocols, and data analysis as well as program evaluations.

Samuel Wanji, *Professor, University of Buea and Executive Director, REFOTDE, Cameroon*
PROFESSOR WANJI, Senior Administration Expert, is a public health parasitologist and vector biologist. He received his doctoral training from the prestigious laboratory of Parasite biology of the Natural History Museum in Paris. Following the training in France, he returned to Cameroon in 1994 and started a career at the University of Buea where he successfully established a very fruitful network of collaboration with scientists from Africa, Europe, America and Australia. Parallel to the career at the University, Professor Wanji founded the Research Foundation for Tropical diseases and Environment (REFOTDE), Buea, Cameroon, which has become, in 20-years, a reference laboratory for research on parasites and vectors.