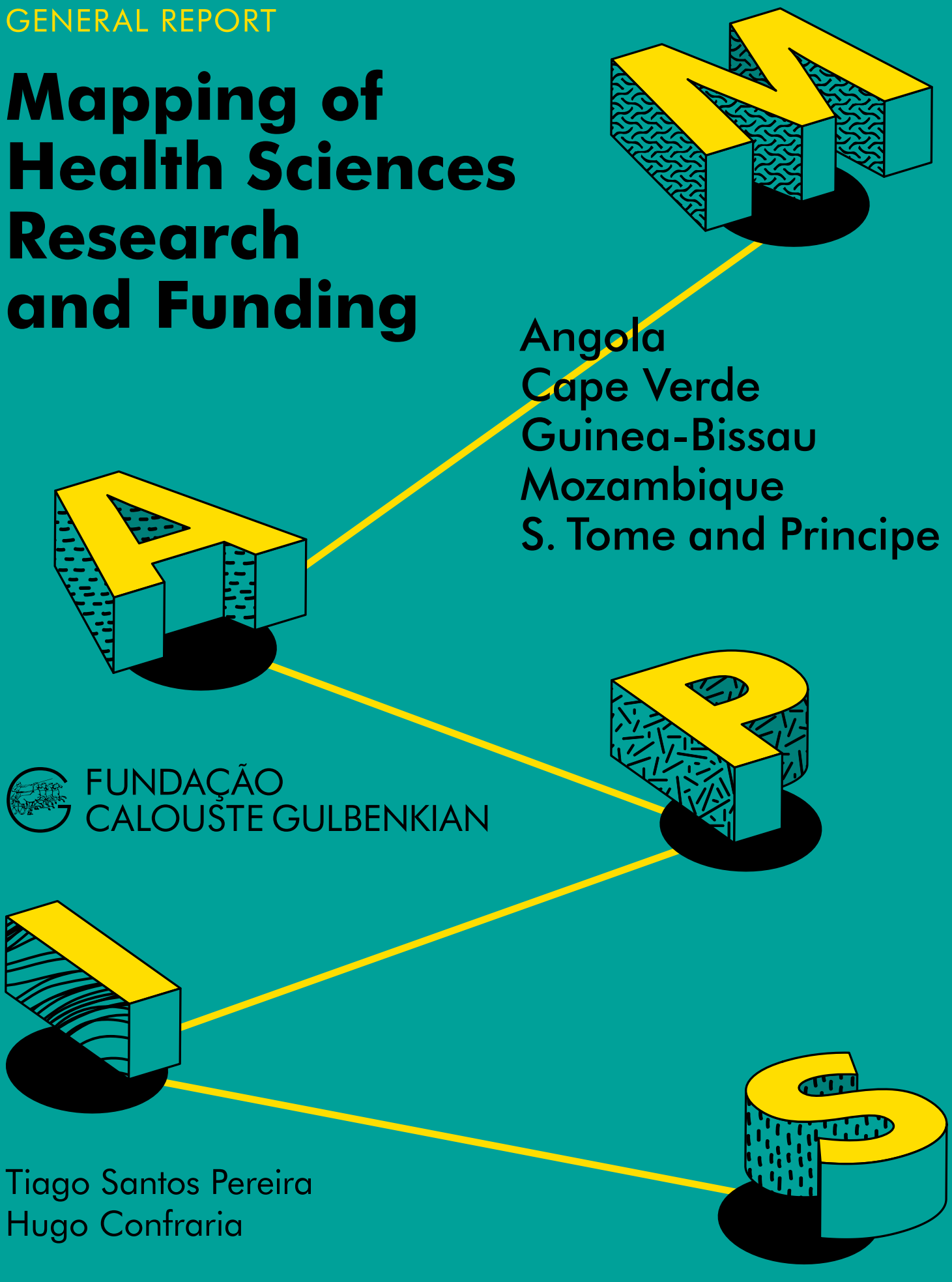
GENERAL REPORT

Mapping of Health Sciences Research and Funding



Angola
Cape Verde
Guinea-Bissau
Mozambique
S. Tome and Principe

FUNDAÇÃO
CALOUSTE GULBENKIAN

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MAPIS–PALOP
General Report

Mapping of Health Sciences Research and Funding in Angola, Cape Verde, Guinea-Bissau, Mozambique and Sao Tome and Principe

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Disclaimer: The conclusions and recommendations of this study are the sole responsibility of the authors.

Table of Contents

List of Figures

List of Tables

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Despite the wide inputs we recognize that any underlying limitations, imprecisions or errors are strictly the responsibility of the authors. Similarly, the conclusions of the report do not commit any of the above.

Executive Summary

The present report is a deliverable from a study commissioned by the Calouste Gulbenkian Foundation, through the Gulbenkian Partnerships for Development Programme (GPDP), which aims to map the research activities in health sciences by the research and medical community in the Portuguese-speaking African countries (from here onwards PALOP – *Países Africanos de Língua Oficial Portuguesa*), namely Angola, Cape Verde, Guinea-Bissau, Mozambique and Sao Tome and Principe. The study's wider objectives are to strengthen the visibility of existing research activities and research capabilities, highlighting their contribution to the social and economic progress in these countries, and promoting the wider support to research as a lever of development. The identification of existing capabilities, of international collaborations and networks, as well as the context and conditions for the development of the research and the promotion of its impact is of central importance to support the development of articulated strategies not just by national actors, but also by international research partners and donors.

This report characterises the research activity in the PALOP, through the identification of scientific publications in the health sciences in widely recognized international journals (indexed in the *Web of Science*), published between 2008 and 2020, which is led by or involves researchers affiliated with institutions in these countries.

The first conclusion from this study is that there has been a significant increase in research output in health sciences in these countries, particularly during the last decade. The level of research output is particularly significant in Mozambique, but its growth is also of note in the other countries (as should be expected from its population size, geography and economic activity, Sao Tome and Principe has a very limited scientific activity). While Angola has a lower than expected scientific activity, it has seen a consistent growth in output and institutionalisation of its research activities in the most recent years. The local development of research is an important opportunity not just in terms of appropriating research results to the local context, but also in developing capabilities and networks, and of the involvement between different actors in the health sector.

A second conclusion to be drawn is that most of this research is developed through international collaborations. International collaboration is increasingly the norm in research activity, namely in the health sciences, but it is particularly important for countries with a lower publication output and which undergo a significant growth in its scientific activity. International collaborations provide an important opportunity for learning, for institutional development as well as for articulating international research agendas with local needs and local practices (e.g. in clinical trials). The results also show that together with the level of international co-authorships there is a need to strengthen the local leadership of the research. Within this group of countries, Mozambique and Guinea-Bissau appear to have stronger ability to lead this research (as reflected by authorship patterns). As the interviews suggest, the involvement in international competitive funding processes are an important contribution towards stronger internationalisation and research leadership.

A third conclusion of this study is reflected in the topics addressed by the researchers in the different PALOP countries. The results show that the specialisation patterns reflect the patterns of incidence of different diseases locally. In Mozambique the relevance of diseases such as HIV or malaria is reflected in the topics more highly addressed in local research, while in Angola or Guinea-Bissau other topics emerge, such as those related to parasitosis (in Angola) or to measles (Guinea-Bissau). These results, together with the hospital affiliation of much of the research, also appear to reveal that the health sciences research is developed in relevant articulation with the medical sector and the concrete health needs of the local populations.

A fourth conclusion of the study is that the health sciences researchers in the PALOP countries have a wide international network, with some specificities. While Portugal is an important partner overall, it is not the most important partner in Mozambique or Guinea-Bissau, where the US and Denmark take that position respectively. It is also noteworthy that there are few intra-PALOP collaborations, and that the language links are less strong in a dynamic internationalisation process.

This study is also novel in the analysis of funding acknowledgements in scientific publications with authors from these countries. While this information has relevant limitations in terms of its detail, for example not distinguishing between the level of support of different funding sources in the same publication, it provides a picture of the participation of different funders of research in health sciences in the PALOP. These data show a significant number of funding agencies intervening, with a very significant increase in support in recent years from the Gates Foundation, together with the NIH (from the US) and the European Commission. The sponsoring agencies have activities in different sectors, including research councils, philanthropic organisations or government agencies in the health sector; originate from a variety of countries, often reflecting the international research networks mentioned above; and differ in their areas of activity, in some cases more targeted on specific diseases, and in other cases with a more transversal support. It is also clear that there is a clear space for partnering between funders, with some agencies acting often with privileged partnerships (such as the case of intervention of the Calouste Gulbenkian Foundation, in strong partnership with the Government of Angola and the Portuguese Camões Institute and, to a lesser extent, with the Portuguese Foundation for Science and Technology).

While the focus is on the mapping of research outputs, in the health sciences international clinical trials have a particularly important role in supporting research activity. The conclusions of this analysis suggest that clinical trials provide two main dynamics of internationalisation, with Mozambique and Guinea-Bissau leading the way, and other countries starting to catch-up more recently. The international competitiveness of Mozambique research organisations is particularly evident when analysing the data from EDCTP funded projects. While the success level of participants from these countries is generally low, Mozambique has been increasingly able to succeed in obtaining external funding, and of leading international research proposals, largely through the action of the Manhiça Health Research Centre (CISM) and the National Institute of Health (INS).

The interviews developed in the study lead us to conclude that the strengthening of the research systems is the result of a process of co-production of a research culture through internal, external and intermediating processes and institutions. This research culture is reflected, for example, in the establishment of research careers and research assessment that attract researchers and promote research competitiveness, in the valorisation of research-based knowledge by external actors of the broader research and health systems, namely in policy and practice, and through the implementation of modes of articulation of the internal and external dimensions of research culture. It is in the sound balance between these, and in the strengthening of the research culture at different system levels, that lays the strengthening of the research systems in the health sciences and their increased impact.

We hope this report can provide an indication for local governments and research institutes on how can research strategies be developed that contribute to strengthening local capabilities in areas with greater promise, through scientific impact as well as in response to health needs, and to identify those areas which are clearly underdeveloped. This report does not aim to identify these; we believe that this can be more appropriately developed by local actors, together with the network of collaborators and external funders. In particular, we expect that this report can contribute for external funders to consider the joint articulation of their support. As appears to be the case, although agencies with greater financial resources can have a particular role in strengthening the public health research more widely, the articulation of agencies with distinct, more targeted missions, can create levers for continued growth in dedicated areas.

1. Introduction

The Portuguese-speaking African countries (PALOP – *Países Africanos de Língua Oficial Portuguesa*) still suffer from severe and often unique health challenges. These countries have made significant progress during the last decades in reducing mortality and prolonging life, but its burden of disease per population continues to be significantly greater than that of higher-income countries.[1] At the same time, PALOP have difficulties in supporting Health Sciences and lack the qualified human capital (postgraduate or doctoral) to perform it. However, it has been widely acknowledged that health research conducted in low-income countries is of great importance. Domestic research plays an important role in creating the capabilities and human capital necessary for international development (DFID, 2014; Gibbons *et al.*, 1994). With limited research capacity, the skills and competences available in a country are constrained, and therefore the possibility for the realisation of societal challenges is reduced.

In this context, and in parallel with the creation of the Sustainable Development Goals (SDGs) for 2030 – with SDG3 being dedicated to the promotion of Good Health and Well-Being –, a growing interest has re-emerged related to the importance of advanced capacity building through research, in Africa. Examples of this are initiatives such as the European & Developing Countries Clinical Trials Partnership (EDCTP), in clinical research; the Science Granting Councils Initiative (Hanlin *et al.*, 2021), with a view to empowering research funding processes; DELTAS Africa, promoted by the Wellcome Trust to support research excellence in Africa; or African Union initiatives in the area of Science and Technology. These initiatives reaffirm that, although investments in scientific research are unlikely to lead to innovation in companies (and economic growth) in the short to medium term, as there is insufficient capacity in most African countries to develop new technologies which can be commercialised internationally, on the long run, scientific research develops advanced qualifications, problem-solving capacity and interventions in specific areas, namely in the area of health sciences, contributing as well to the retention of qualified staff and the development of international partnerships that promote the exchange of new scientific knowledge (Pavitt, 1998; Salter and Martin, 2001).

Furthermore, since the global investment in research in health sciences is still dominated by the priorities of economically more prosperous societies, resulting in a relative lack of attention to diseases that generate more burden in lower income countries (Evans *et al.*, 2014; Viergever *et al.*, 2013; Yegros-Yegros *et al.*, 2020), it is particularly important that investments in health sciences in African countries are oriented towards domestic health needs (Confraria and Wang, 2020). This fact is particularly relevant at the level of funding distribution – identified as the 10/90 gap – but it is also relevant at the level of research development, leadership and equity in research projects (Cardoso *et al.*, 2014; Iyer, 2018; Carvalho *et al.*, 2018).

[1] https://vizhub.healthdata.org/gbd-compare/

Despite these new initiatives and dynamics, which allow a relevant increase in the existing financial resources for health sciences in Africa, existing mappings of the research landscape are still limited and poorly focused on the Portuguese-speaking African countries (PALOP). A particularly significant research gap, in this context, is to identify the main research funders, what research areas are they prioritizing and what type of partnerships (co-funding) exist between funders. One of the few studies we could find related to these themes is a recent report, promoted by UNESCO (2021), which characterizes the research and innovation system in Mozambique, noting the importance of health sciences, representing almost 50% of research expenditure in the country. This example confirms the relevance of a specific analysis of this area, in the context of a process of progressive capacitation of PALOPs in science and technology.

This study has the aim of mapping the research activities in health sciences from PALOP countries and supporting the strategies of different actors, including international funding organizations and local actors, in the context of collaborative research initiatives for development related to health sciences. Specifically, this report will expect to contribute to the following objectives:

- to improve our understanding of the research carried out in health sciences in the PALOP countries, and help to increase the visibility of these activities;
- identify the main research funding agencies in health sciences in the PALOP, and the main thematic areas of intervention;
- assess and discuss the main challenges and opportunities in health sciences in the PALOP;
- to contribute to evidence-informed policy by different stakeholders, policy makers and international partners, and to promote the better articulation of initiatives in this area, namely through collaborative research strategies for development.

To contribute to the research objectives above, we use in this report a database of scientific publications (Web of Science) which indexes most international peer-reviewed journals in health sciences, and their bibliographic information. This approach allows for the identification of trends in research production in health sciences in the PALOP, main actors, international collaboration networks, funders, and dominant research topics. Bibliometric analysis methodologies will be applied, including citation analysis that allows to proxy the impact of research being done, and authorship analysis to identify leadership positions in the research being done (authorship order and/or corresponding author). We will also complement our analysis with co-authorship network analysis to capture the intensity of research collaborations between PALOP institutions and foreign collaborators and identify institutions in central positions within the PALOP research collaboration network. Furthermore, a particularly innovative approach in our study is the use of the funding acknowledgements paratext in every publication in WoS to identify the main funders, their priorities and co-funding trends. By combining all these approaches, we provide a comprehensive overview of the research landscape in PALOP, which can inform the strategies and policies of private and public research funders.

The report starts through a brief review of issues concerning the dynamics of research funding in Africa and of the context of research in the five countries analysed. This study uses a diverse set of data, with some innovative analytic dimensions, which are presented then, in section 3. Section 4 provides a brief overview of the research output in the PALOP, which is followed by zooming in on the health sciences output in particular. This analysis considers not only output, but also the content of the publications (the research areas) and the collaboration patterns. This is followed by a novel analysis of the activity of research funders support the health sciences publications from these countries. The analysis of research activity is extended to address participation in international clinical trials. On the basis of qualitative interviews, section 8 briefly considers internal, external and intermediation factors that are central to the strengthening of research cultures. This is then followed by the presentation of the main conclusions and recommendations.

2. The Changing Dynamics of Research in Africa

2.1. The organization of research and research funding

Recent research on the organization of research systems in African countries has identified a recent new surge of interest in the organization of research funding organisations and in the governance model of research systems, namely through the creation of dedicated Ministries of Science and Technology (in some cases articulated with Higher Education). Chataway *et al.'s* (2017) study of science granting councils (SGC) in five countries in Africa concluded, however, that the commitment to increasing funding was still weakly reflected in the overall levels of funding, which remain low.

Nevertheless, Mouton *et al.* (2015) see this development in the increasing relevance of science funding in the policy discourse in Southern African countries, which they also identify, as a positive sign of change, despite the similar practices of low investment in science or the inexistence of science funding agencies in several countries in Africa. Chataway *et al.* (2017) conclude that national Scientific Granting Councils (SGCs) had been established or emerging in the countries studied, and were having an increasing role in agenda setting and coordination.

Mouton (2019) identifies different science governance models across countries in Africa, often related to their historical roots. Some countries simply do not have any STI funding council. This is also the case among two of the PALOP countries (Guinea-Bissau and Sao Tome and Principe). Other countries have a dedicated science funding council, ongoing or under development. Mozambique has established, for over a decade, the *Fundo Nacional de Investigação*, FNI (National Research Fund), while Angola established in 2021 the FUNDECIT (*Fundo de Desenvolvimento Científico e Tecnológico* / Science and Technology Development Fund), formally initiating its activities in the beginning of 2022. Cape Verde has also established recently the Fundo para Investigação e Desenvolvimento (Research and Development Fund), which is also starting its first initiatives. In these cases, these science funding agencies have a broad remit and are not focused on any particular area of research, despite having specific priorities from the national policies to attend to. Considering their low level of funding (see Table 2), the wide scope of their action creates additional pressures on the limited resources.

Johann Mouton identifies a third organizational model, in countries "characterized by a multitude of funding agencies, programs, and instruments often organized around sectoral interests (e.g., health and agriculture)." While in these countries dedicated agencies may have a more clear plan of action, and a more limited number of stakeholders based on the corresponding sector of activity (as is the case, also, in countries such as the UK), Mouton notes that "these councils face a variety of challenges (e.g., resource constraints, governance issues, lack of clarity on institutional differentiation, lack of coordination within science systems, and marginalization of influence)." These limitations are often exacerbated by the weak practice of sharing of expertise and experience between similar agencies, at the national or the international level. In a context of low resources, an excessive institutional fragmentation of the system may make coordination more difficult, leading to competition for scarce resources.

In addition to the wider institutional setup of the research funding agencies in national systems, the literature in science policy has highlighted distinct modes of decision-making process to which these organizations respond. The distinctiveness of SGCs vis--à-vis other public policy agencies has been both their representativeness of the research community, reflected in the importance often attributed to their organization as a Council, as well as their autonomy from government, allowing that funding decisions are mainly based on intrinsic research qualities of the proposals, rather than on external policy preferences. This structure follows the theoretical approach of the Principal-Agent Model, in political theory. The principal (State/Government) has resources, namely financial, necessary to attain certain objectives, but not the specific ones. The agent (the research community), has the specific competences to apply the resources and provide the expected results (new knowledge). In between the principal and the agent, the SGCs function as Intermediary Organisations, responding to both, but not being controlled by either (Braun and Guston, 2003).

While these principles remain central to the organization of SGCs worldwide, there have been variations in form in the application of this model. Mouton identifies three distinct models. In what he calls the paradigmatic case, there is a clear distinction and identification of these three actors, the principal, the intermediary and the agent. But in other models existing the Southern African countries, there can be multiple principals, namely when international agencies have a level of funding that influences strongly the shape of the system and the activity of the agents, with funding similarly being managed by an intermediary organization, in what he terms the 'multiple principals-agent model'. Yet in other cases, the science funding agency, despite having an autonomous organizational existence, is embedded in the state organization, with a strong connection to the government. In this 'embedded "agent" case' the autonomy from government is less secured.

Other models can be identified, namely with regard to the multiplicity of funding agencies, of different principals intermediated by a single intermediary, or by the closeness of the intermediary to the agents. But the overall structure remains, with the essence of the funding decisions being 'protected' from interference from the principal or the agents.

Functions

The protection attributed to an intermediary organisation does not mean that the principal only provides financial resources; it also states concrete objectives for the contract, which the intermediary must 'reinterpret' in their decision-making. Equally, the agent (the research community) has interests and concerns which get represented in decision-making through knowledge representatives in the evaluation process and through the process of advice to the intermediary.

The different models can, however, have an implication in the breadth of functions, initiatives or instruments promoted by the SGCs. In the case of SGCs in Africa (the study led by Johann Mouton focused on sub-Saharan Africa), with the thinness of the local institutional setup, the SGCs tend to perform a wide variety of functions. These go from the main function of the evaluation and allocation of research grants, the award of

individual fellowships (namely at masters and doctoral level), the funding support for infrastructure development, or supporting journals and publications, to other transversal activities which in other cases may be developed by the research organisations themselves, such as the communication of research results, the management of scientific collaborations and agreements, or the capacity building and training of researchers, to activities which are part of the backbone of the system, such as the collection of data and statistics on STI/R&D, providing policy advice, setting research agendas and priorities, the coordination of the national innovation system or acting as advocates for STI.

More broadly, these activities can also be encompassed within the different objectives of the SGCI, promoted by Chataway *et al.* (2017), with the aims to strengthen the ability of SGCs to:

- Manage research;
- Design and monitor research programmes based on the use of robust science, technology and innovation (STI) indicators;
- Support exchange of knowledge with the private sector;
- Establish partnerships among SGCs, and with other science system actors.

In the work of Chataway and colleagues went beyond the structural organization of the SGCs, to delve more in detail at the different objectives and strategies in the different countries. In particular they highlight the weak involvement of the private sector, despite an increasing recognition of its potential role, the centrality of health and agriculture in research funding allocation, and the importance of the agendas at national and regional level which, however, are not always convergent. In particular they highlight that both the understanding of 'excellence' or goals-directed agendas are not always common in different regions/countries in Africa, suggesting that a sub-regional approach may be useful to establish locally shared approaches. This is of particular relevance when, as noted by Mouton *et al.* (2015: 162), "[t]here is little evidence of sharing of expertise and experience amongst SGCs – often within the same country, but definitely within regions and across the continent." (p. 162). In a way, the linguistic and historic connection that is provided by the CPLP forum and in this study is also a way of engaging with an understanding of local common approaches.

In considering the framing of innovation policy models characterized by Schot and Steinmueller (2018), which distinguishes three different frames – R&D, systems of innovation and the transformative change – , the case of the development of research policy structures in Africa appears to jump between the R&D based model, which highlights the importance of science-based activities, and the transformative change one. In countries where transformation and impact is of paramount importance, such frame is always present in public policies, and there is no space, no financial nor socially supportive space for the development of research which is not, in some way, connected to transformation. But, still, in a context where private sector innovation is weak and where the more advanced human resources, namely in the health sciences can be

attracted by research, which is a major mode of capacity building, the R&D frame takes precedence as a source of knowledge and of the structuring of a system that is weak transformed by innovation processes. The extent to which these countries may be undergoing a period of change in the political attention to research, namely in the health sciences, is relevant to understand conditions of political support as well as potential external focus on the societal impacts of research that can lead and different policy frame. As Mouton *et al.* (2015) note:

> *"The relatively poor investment in R&D in many sub- Saharan Africa countries, which has a direct impact on the science funding models, points to different 'inscriptions' of science in different countries as well as different values afforded to science. On the one hand, some governments clearly recognise the value and importance of science and hence invest in science funding and the establishment of a national funding agency. On the other hand, many governments have not – at least until very recently – judged science to be of sufficient value and importance to invest in the establishment of a relatively autonomous agency to disburse state funds for R&D. Having said this, the fact that there has been a surge of interest in the recent past in reformulating existing science policies, as well as the establishment of a separate ministry of science, may be indicative of a change, even amongst the latter categories of countries."*
> (Mouton *et al.*, 2015, p. 162-3)

The challenges of external support and internal support that these countries face, and Mouton *et al.* (2015) identify are not new. Other countries with a late development of the research system, such as Portugal (Pereira, 2002), have also faced similar tensions, both at the political and funding levels – does external funding crowd out the growth of national research funding? – as well as at the scientific level – international collaborations are central to local capacity building but can limit autonomy or the strengthening of local research priorities.

But there are signs that countries in Africa are increasing R&D expenditure in response to wider commitments. There is still a path to follow to reach the target of 1% of GDP on R&D, agreed by African countries in 2005.

2.2. Brief overview of research in Angola, Cape Verde, Guinea-Bissau, Mozambique and Sao Tome and Principe

In this section we provide a brief overview of the health research systems in Angola, Cape Verde, Guinea-Bissau, Mozambique and Sao Tome and Principe. To consider the conditions for the effective development of research and for its impact on the health system we must firstly consider the overall context of the research system. This includes its wider socio-economic environment, the level of development and of investment in the research system more broadly and the concrete research capacity in the health sciences.

To provide an analysis of these systems we compare a set of main indicators of socio--economic and technological development. In addition to the five countries which are the object of this study, we included the five countries analysed in the study by Chataway *et al.* (2017) – Ethiopia, Kenya, Rwanda, Senegal and Tanzania. As these countries are, on average, of a larger size, namely population wise, and are geographically concentrated

in Western Africa, we also included five other countries which have a greater territorial proximity with the countries under study here and which have a distribution of population closer to that of the PALOP. Additionally, and considering the distinctive impact of the research and innovation system of South Africa, that makes it a regional reference as well as a regional leading collaborator within Southern Africa, we also include South Africa among the countries under the overall analysis here.

Starting by the basic socio-economic indicators (cf. Table 1) this group of 16 countries includes two countries classified by the World Bank as upper middle income countries – Equatorial Guinea well above the rest, including South Africa –, five countries classified as low income countries, among which the two with the lowest GDP per capita are PALOP – Guinea-Bissau and Mozambique –, and the remaining seven countries classified as lower middle income countries, including Angola and Cape Verde at the top of this group.

Table 1. Basic socio-economic indicators.

Country	World Bank income classification	Population 2018 (thousands)	GDP per capita 2018 (constant 2017 PPP$)	Internet users per 100 inhabitants	Human Development Index	Gobal Innovation Index
Equatorial Guinea	Upper middle income	1309	20360	26.24	144	–
South Africa	Upper middle income	57793	12631	56.17	113	63
Angola	**Lower middle income**	**30810**	**6934**	**14.34**	**149**	**–**
Cape Verde	**Lower middle income**	**544**	**6864**	**57.16**	**126**	**–**
Kenya	Lower middle income	51393	4204	22.6	147	77
Sao Tome and Principe	**Lower middle income**	**211**	**3945**	**29.93**	**137**	**–**
Zambia	Lower middle income	17352	3522	14.3	143	124
Senegal	Lower middle income	15854	3315	46	166	96
Zimbabwe	Lower middle income	14439	3130	27.06	150	122
Comoros	Lower middle income	832	3067	8.48	156	–
Tanzania	Lower middle income	56313	2590	13.5	159	97
Gambia	Low income	2280	2144	19.84	174	–
Ethiopia	Low income	109224	2104	15.37	173	111
Rwanda	Low income	12302	2089	21.77	157	94
Guinea-Bissau	**Low income**	**1874**	**1949**	**3.93**	**178**	**–**
Mozambique	**Low income**	**29496**	**1290**	**10**	**180**	**119**

Source: (UNESCO Science Report, 2021).
Note: Data is from 2018 or the latest available year (down to 2015).

In population terms, this group includes a country with over 100 million inhabitants (Ethiopia) and one with slightly over 200 thousand (Sao Tome and Principe), providing stark contrasts. Among the PALOP, while Angola and Mozambique have 30 million in population, the remaining three countries are among those with the lowest population, Guinea-Bissau, Cape Verde and Sao Tome and Principe having all less than 2 million inhabitants.

The remaining three indicators (internet usage, Human Development Index (HDI), Global Innovation Index (GII)) selected show that South Africa, despite its significant inequalities that impact the GDP per capita, has a clear higher performance in these outcome oriented indicators. On the contrary Guinea-Bissau and Mozambique are among those with lowest overall conditions. Interestingly, Mozambique has a GII above that of Zimbabwe or Zambia, presenting a level of technological capabilities that does not simply reflect the wider development conditions but, on the contrary, suggest distinctive competences in the S&T area.

The table shows that all these African countries did not attain yet the goal of spending at least 1% of GDP on R&D – a target which has been repeatedly stated in many African science policy documents.[2]

The fact that Mozambique, despite being the lowest income country, is among only half of the countries which collect systematized statistics on R&D, as shown in Table 2, is in itself a demonstration of political commitment to science and technology in the country. Angola has also collected R&D statistics, following the international standards in the area (OECD Frascati Manual and UNESCO Guidelines) but with less regularity (last survey from 2016).

Table 2. Main research indicators.

Country	Research expenditure as a share of GDP (%)	R&D expenditure funded from abroad (%)	Total researchers (head counts)	Researchers per million inhabitants (head counts)
South Africa	0.83	10.17	61840	1085
Rwanda	0.67	33.74	530	45
Senegal	0.58	7.89	14335	983
Mozambique	**0.34**	**39.88**	**2434**	**90**
Ethiopia	0.27	19.14	15464	145
Gambia	0.07	–	125	55
Angola	**0.03**	**–**	**1400**	**49**

Source: (UNESCO Science Report, 2021).
Note: Data is from 2018 or the latest available year (down to 2015).

[2] https://archive.uneca.org/publications/towards-achieving-african-union%E2%80%99s-recommendation-expenditure-1-gdp-research-and

A list of main policy documents with relevance to health sciences research in the PALOP is presented on Table A.13.

Cape Verde, Guinea-Bissau and Sao Tome and Principe are among the countries without a systematic R&D survey and corresponding R&D statistics. It is noteworthy the level of R&D in Mozambique, considering also that it is the lowest income country among this set. While Senegal and South Africa standout in terms of number of researchers per population, Mozambique has a research workforce which is higher than several of other countries and almost double that of Angola. The high level of R&D expenditure funded from abroad reveals not only the success in that endeavour by Mozambican research organisations[3], but also the international competitiveness and international credibility the Mozambican research system has gained.

Table 3. National health research capacity.

Country	Clinical trial capacity	Capacity to attract funding for health/clinical research	Capacity to produce research output in peer-reviewed journals	Aggregate measure of national health research capacity
South Africa	349	1 308	9 282	0.87
Kenya	87	676	1 982	0.76
Ethiopia	39	126	2 522	0.70
Tanzania	48	215	1 129	0.69
Zambia	33	178	457	0.63
Zimbabwe	26	189	443	0.62
Mozambique	**16**	**96**	**339**	**0.55**
Senegal	11	68	409	0.52
Rwanda	15	59	325	0.52
Gambia	14	40	166	0.46
Guinea-Bissau	**6**	**8**	**50**	**0.26**
Angola	**5**	**7**	**64**	**0.23**
Cape Verde	**3**	**2**	**18**	**0.10**
Equatorial Guinea	5	0	15	0.08
Comoros	4	0	9	0.04
Sao Tome and Principe	**3**	**0**	**3**	**0.04**

Source: (Cruz and Kilmarx. 2022).
Number of clinical trials registered in-country from 2018-2020 (annual average) from the WHO International Clinical Trials Registry Platform (ICTRP).
Number of health/clinical research activities in-country from 2018-2020 (annual average) from World RePORT (NIH).
Number of scientific publications in Scopus from 2018-2020 (annual average) for which any listed author had an affiliation to the country.
Colors reflect World Bank Income classification (cf. Table 1).

[3] Arvanitis *et al.* (2022).

If we consider in particular the indicators on the national health research capacity produced by the NIH Fogarty International Center, Mozambique emerges as the country with the highest research capacity in health among the PALOP and with indicators that are not so distant, in some respects, from some of the leading countries in this group. Guinea-Bissau is at a par with Angola in these indicators of health research capacity, while Cape Verde and Sao Tome and Principe are at a lower level. It must be noted that these indicator of capacity is an absolute measure, and does not consider the different sizes of the countries. In that sense, while it might not come as a surprise that Sao Tome and Principe, where the territorial and demographic conditions not only provide other economic priorities but also do not facilitate the existence of critical mass in research, have a lower research capacity, in the case of Cape Verde, it must be taken into account that it is the country among this group which has the second lowest number of population. In that regard, Angola emerges as the country which is proportionally lagging further and which has a significant potential for growth.

These figures show that the five PALOP countries have not only distinct socio--economic and research and innovation conditions, but also that there are still relevant gaps to other countries in Africa with similar socio-economic profiles. Nevertheless, the example of Mozambique, where there has been a significant level of capacity building in research despite the overall very low economic levels is noteworthy. And the existence of distinct profiles also provides opportunities for learning and institutional building that should be exploited. The health sciences is a particularly relevant area of the system to build that path, having the conditions to gather relevant support from local communities and political actors, through the contribution from research to local public health initiatives, internationalisation, and human capital.

3. Data and Methods

Our analytical section is composed of two segments. In Section 3 (Research output in the PALOP) we use descriptive statistics to analyse PALOP research publication trends, collaboration patterns and research specialisation in all areas of research. In Section 4 (Health sciences in the PALOP) we analyse in more detail research associated to health and medical sciences between 2008 and 2020.

3.1. Output and Collaboration Data

Publication data were extracted from the Web of Science Core Collection (WoS) (2021). We extracted scientific publications produced by at least one author from a PALOP institution, and we use the full counting method (e.g. an article done in international collaboration between researchers in Portugal, Mozambique and Angola would be credited to both Mozambique and Angola). Although some studies use the fractional counting method, attributing to authors/institutions/countries only the corresponding share in a multi-author/institution/country publication, we choose here to adopt the full counting method because our objective here is to map the participation of researchers from PALOP in the international research enterprise. While fractional counting is often used in assessment processes or studies oriented towards the production of rankings, whereby there is a particular concern with issues of attribution of authorship, that is not our focus here. Besides other methodological limitations of fractional counting, namely that it is also an estimation of the corresponding partial effort rather than a concrete measure, we consider that it is the opportunity of developing research recognized through international publication, and reflected in the corresponding authorship, that contributes to the strengthening of research capabilities, which is the focus of the mapping we undertake in this study. Hence, co-authorships, by these individual, institutional or international, are considered as a fully collaborative endeavour, that strengthens capabilities to all participants and is here recognized in full.

Another important methodological option to be considered in such bibliometric studies regards the sources to be considered. The Web of Science (WoS), the long-standing publications database, has been complemented with the emergence of Scopus as a comparable source, and more recently with the Dimensions database. PubMed is also a relevant source specifically for the health sciences. We made a preliminary analysis of the coverage of these three different sources in relation to the objectives of our study, namely coverage of publications from PALOP, categories available to classify the health sciences, quality of institutional information to identify authorship, and information regarding funding sources for the publications. Although we found that the Dimensions database covered a higher number of publications than WoS or Scopus, it has limitations regarding the affiliation data, which is essential to our country-based analysis, as confirmed by Guerrero-Bote *et al.* (2021). PubMed, although having a very good coverage in the clinical and life sciences, has limited citation information. We chose to use WoS instead of Scopus or other databases because we also wanted to gather data about funding institutions mentioned in the acknowledgements of every paper and this is arguably better with WoS (Kokol and Vošner, 2018). We are aware that WoS may

underrepresent journals from lower-income regions (Chavarro *et al.*, 2017), although there have been improvements in this regard, but it is a database that is otherwise reliable, with quality data regarding institutional affiliations, classification procedures, citation and funding data, and widely used for bibliometric studies.

We adopt several disciplinary breakdowns for our analysis. In section 3, we adopt the six broad OECD subject areas ('Agricultural Sciences', 'Engineering and Technology', 'Medical and Health Sciences', 'Natural Sciences', 'Social Sciences' and 'Humanities') to analyse how specialised each PALOP country is in each of these subject areas in comparison with the overall distribution in Africa and the World. Next, in order to identify research related to 'health sciences' we aimed to have a definition as wide as possible to cover the largest number of publications and approaches. As such, we operationalise the concept of 'health sciences' by combining all publications with an author from a PALOP country that is categorized by the WoS as OECD 'Medical and Health Sciences' or CWTS Macro Citation Topic 'Clinical & Life Sciences'. Our 'health sciences' dataset in section 4 is composed of 4029 publications which have at least one author from PALOP countries between 2008 and 2020.

In order to understand which topics each PALOP country is specialised within this set, we adopt two disciplinary breakdowns for our analysis. We use the 326 CWTS Meso Citation Topics[4] from InCites[5] in Tables 5 and 6 to assess the share of research done by authors from PALOP countries in each of these topics, and how many top 10% highly cited publications there are among all publications. To support our results and conclusions, we also use the 2444 CWTS Micro Citation Topics from InCites (results in Tables A.1-A.5, in the appendix).

One of our concerns in mapping research in the PALOP was to identify the main actors in these research systems, and to characterise their main collaborative linkages. To this end, a network of institutional research collaboration (co-authorship) was built, based on the institutional affiliation information. As is well known, institutional affiliations in publications can differ significantly, particularly if there is no specific institutional strategy promoting the harmonization of such identifications, as is the case in PALOP. As such, all institutional affiliations from PALOP were fully cleaned using manual searching methods. For the purpose of data presentation, we aggregated institutional affiliations at the higher level of the organisation (e.g. no Departmental information is considered). In this regard, information concerning the participation of Ministerial departments, or thematic offices, were aggregated under the corresponding Ministry (e.g. Ministry of Health includes specific health programmes). Exceptions were made for the national health research institutes, as these have a specific research function, distinct from direct provision of healthcare, and for hospitals, to identify the concrete participation of hospitals in the research process. Information on foreign collaborators,

[4] https://clarivate.com/blog/introducing-citation-topics/

[5] https://incites.clarivate.com. Data processed 26 May, 2021. Data source: Web of Science. This data is reproduced under a license from Thomson Reuters to the University of Sussex.

more extensive and less central to the project's objective, was cleaned on the basis of the 'organization enhanced' function available in the WoS. The network map in Fig. 6 is developed based on Gephi[6] software, using an adapted version of the "Fruchterman Reingold" layout. We constructed a network graph with the PALOP institutions that produce relatively more publications in WoS. Each node represents one institution (PALOP or foreign), and the size of the node represents the number of publications. The size of the edges displays the intensity of co-authorship between two institutions.

The research done by PALOP researchers and institutions relies substantially on international collaboration, which is defined in this report as research involving authors from different countries. To analyse collaboration dynamics beyond the percentage of research done in international collaboration, in this study we also analysed the percentage of publications from each PALOP country that have a first, last and corresponding author from that specific PALOP country. This is done by looking at the affiliations of the first, last and corresponding author in our dataset. Our analysis allowed us not only to understand the share of these relevant authorship positions in each PALOP country, but also their evolution in time and the country of affiliation of their partners that assume these "leading authorship" positions.

3.2. Funding Data

As already referred, this report presents a particularly innovative contribution through the analysis of the structure and sources of funding of the research developed in the PALOP. We use the acknowledgement paratext of scientific publications in WoS, where authors commonly acknowledge the support of the corresponding funding agencies (Grassano *et al.*, 2017; Rigby, 2011), to identify funding institutions in a given research area. In the identification of funders, we also use the full counting method, considering only the existence of a contribution from a funding organisation to the research presented in a paper, independently of how many funding organisations are involved.

In this analytical part we focus only on articles and reviews from 2008 to 2020, because WoS only provides systematic information from the funding text of acknowledgements for this type of publications since August 2008. We manually cleaned[7] the 'Funding Orgs' column from WoS by looking at the 'Funding Text' and comparing it with what WoS algorithms retrieve in the 'Funding Orgs' column.[8] Then we used OpenRefine[9] to group different name variations for the same funding institution (e.g. Bill and Melinda Gates Foundation, Gates Foundation or BMGF = Gates Foundation). In the institutional cleaning, we aggregate institutions that have seen name changes throughout this

[6] https://gephi.org/

[7] We thank Assucenio Chissaque for invaluable research assistance.

[8] Through this process we concluded that around 8% of WoS entries in the 'Funding Orgs' column have incorrect data.

[9] https://openrefine.org/

period. With regard to public funding organisations, we maintain distinctions between thematic agencies of a single country (e.g. development cooperation agency, research funding agency, health policy agency), except for the PALOP countries, where we aggregated all funding acknowledgements under 'Government of…' identification, as the thematic distinction tends to be less relevant and Ministries of Health take a particularly important role.

It is important to note that there are some relevant caveats regarding these data (cf. Grassano *et al.*, 2017). The funding data that is retrieved from publications do not cover the whole research funding directed towards the region, as not all research projects that are funded end up in publications in WoS. Additionally, not all papers include acknowledgements of research funding. This can be because some publications do not receive research funding that the authors consider deem to register or eventually because the author did not consider or decided not to include research funding acknowledgements. The implementation in research funding contracts of formal requirements to acknowledge the research funding in research outputs, such as research publications, has been changing, with differing practices in different research systems. Researchers also vary in their acknowledgement practices, but have been improving their reporting of funding received (also due to pressure from funders), and the quality of this information has been improving. Nevertheless, it must be noted that the information registered, and analysed here, does not identify the amount of the funding contribution, but simply the participation of the funding organisation. As such, the identification of different funding organisations in the support of a particular paper does not fully recognise their distinct contribution. The funding acknowledged may stem from the main funding of the supporting project or from an indirectly related project, from regular institutional funding, which may be acknowledged in most papers of a research institute, or from a specific contribution to a resource involved in the research, be it a training fellowship, instrumentation, or mobility support, for example. Such differences should be considered when analysing the funding data.

After cleaning the funding data for 3104 publications (articles and reviews), we identified 602 publications with no funding information, and 2502 publications which acknowledge 7142 funding relations. We then use this dataset to identify the top funders and corresponding co-funding relationships and to understand patterns of research funding specialisation by different funding organisations.

3.3. Data from clinical trials

In addition to the publication data, we analyse in this report data from international clinical trials. Clinical trials are an important activity, which is distinctive of the health sciences. Although it does not necessarily reflect high local engagement in the research, as research protocols may originate from foreign-based trial coordinators, they increasingly rely on the work of local teams, not just in implementing protocols but also in co-creating the trials and the corresponding protocols to adhere to the local context and health practices in the local communities. Additionally, the participation in international clinical trials often reflect the existence of specific research and

institutional capabilities that lead to the selection of the country and institution to participate. Nevertheless, some clinical trials may not require international partnership.

We have retrieved the data from the WHO's International Clinical Trials Registry Platform (ICTRP), which aggregates data from different primary registries and other providers which fulfil predefined criteria. We collected data for the same period for which health sciences publication data was analysed, 2008-2020, and which include at least one of the PALOP as a country where patients were recruited. During this period we identified a total of 195 trials with the participation of PALOP. Clinical trials data has information regarding the sponsoring organisations and, if different, of the corresponding funders (although this data is not fully robust), as well as from the conditions targeted by the trial and its main organizational factors, namely targeted sample, type of trial and countries involved.

In addition, we analyse data from projects funded by the EDCTP, which funds clinical trials as well as other related research activities, infrastructures and training. This data is available from the EDCTP project portal, and was presented by and discussed with the EDCTP Director, Dr. Michael Makanga.

3.4. Qualitative interviews and analysis

The quantitative analysis of data on scientific publications and international clinical trials provide a broad overview of patterns of research activity and international visibility of research in the health sciences developed in the PALOP countries. Such data is valuable in characterising evolution of such activity through time, as well the network of actors, research performers and funders, underlying it. However, the concrete experiences supporting the research activity that leads, at a later period, to the resulting publications can better be tapped into through qualitative methods.

We thus developed a set of complementary interviews to a broad set of actors. These included researchers, at an earlier stage of the career (with recent doctorates) as well as in leadership positions, from distinct types of institutions, namely in universities, national health institutes and in independent research institutes[10], and representatives of funding agencies, at national and international level. In total we made 16 interviews (none of the interviewees were located in Sao Tome and Principe).

The interviews were developed in a semi-structured format, and lasted, typically, one hour. The structure of the interviews was organised in six main sections. An initial section focused on the individual or institutional (depending on the interviewees responsibilities) strategies and research agendas, in recent years and in the near future,

[10]. International studies on research organisations classify such private non-profit research institutes as part of the public sector research system, as their research is largely developed with the support of public funding and their outputs are focused on publicly shared knowledge, through scientific publications or direct support to public policies rather than oriented towards commercialisation. The two dimensions are not exclusive; rather, it is an issue of the central focus of activity.

and its articulation with the broader institutional mission. This included discussions of the factors and processes to set up such strategies, if relevant, namely the involvement of different internal or external actors. This was followed by a discussion of the collaborative dimension of the research activity and the interaction with different funding organisations. In both these dimensions the national and international nature of the research, in its performance as well as in its sponsorship or competitive applications, was discussed. Although a more direct discussion of the main challenges faced was developed at the end of the interview, the discussion of the experiences in international collaborative research and in international application processes brought to light some of the challenges faced and how these have been addressed by local researchers and institutions or are seen from external actors. In particular, two issues were further explored in detail: the training and supply of advanced human resources, in research as well as in research support activities, and the engagement with local actors, namely in the health sector, civil society and decision-makers. These issues emerged clearly as important, both in relation to the development of the research as well as in considering the following topic on research impact. Interviewees were asked to present their views on the impact of the research developed, in their work and their organisations or more generally in these countries, and the activities developed to promote the impact of the research, both through internal resources or through the articulation with external stakeholders. A final part of the interview was dedicated to collect the broader views of the actors regarding the main challenges and barriers faced by the local research systems, in particular in the health sciences research. While, typically, some of these issues had been referred to indirectly in discussing prior topics, which facilitated their contextualisation and their articulation with the quantitative analysis, this was an opportunity to draw wider views on the system as a whole and potential ways forward.

The interviews were developed through online videoconferencing calls and were recorded (only the sound file was kept and used) for the purpose of primary analysis, through the development of synthesis of the interviews, and the identification of main issues arising. These were the focus for complementing the quantitative data.

Finally, a focus group was organised to discuss the preliminary conclusions of the report, involving researchers, decision-makers, stakeholders and external experts. The focus group provided a brief discussion of preliminary conclusions and recommendations, with views from the participants on the value of those and their communication, and, additionally, of technical details regarding the data analysed in the study. Although the final version of the report sought to incorporate some of the remarks made in the focus group, it cannot be considered to convey all the views that were presented or to be considered to reflect the views of all those present, committing only the authors of the report.

4. Research output in the PALOP: publications, collaboration and specialization

The PALOP world percentage of publication output in WoS™ has increased almost ten times in the last 30 years from 0.004% in 1991 to 0.034% in 2020, reflecting a positive trend from a very low baseline. However, its share of the global publication output is still way below the corresponding share of world population (0.9%). In comparison, this volume of research output is significantly below other African countries like South Africa, which is the African country with the highest share of global research, with 0.95%, or Tanzania (which has a similar population to all PALOP combined, and a GDPpc similar as the average PALOP country in 2020), which has 0.08% of global research.

In 2020, all the PALOP accounted for around 750 publications in WoS™ in all research areas. The distribution of these publications by PALOP country is, however, highly skewed, with most of the research being developed by authors from Mozambique (70% of total PALOP scientific output in 2020). The growth of scientific output in Mozambique happened despite the country having gone through periods of social and political instability (Adedokun, 2017), and lack of investment in their gross domestic expenditure in research and development (UNESCO, 2021) that limits opportunities for the advancement of scientific capabilities.

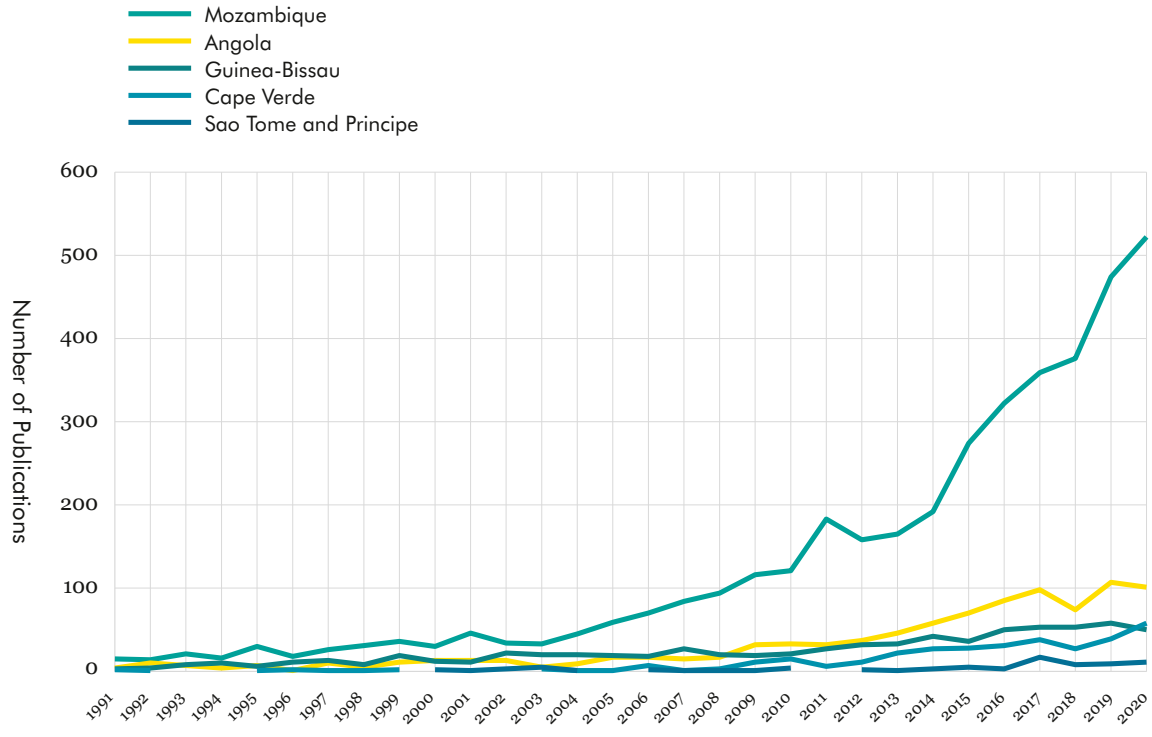

Figure 1. Research output trends (all areas) in the PALOP in the last 30 years. 1991-2020.

Source: WoS
Note: Articles and reviews only.

The data presented in Figure 1 reflects not only distinct national dynamics in scientific research but also distinct sizes of the PALOP with regard to both human and financial resources. In 2020, Angola and Mozambique had more than 30 million inhabitants, Guinea-Bissau around 2 million, Cape Verde around 500 thousand and Sao Tome and Principe around 200 thousand. Therefore, when comparing the scientific output of these countries, these differences should be considered. In Fig. 2 we divided the average scientific output of all countries by their average population in two periods (2008-2014 and 2015-2020). We find that smaller countries (Cape Verde, Sao Tome and Principe and Guinea-Bissau) actually have more publications per million population than Angola and Mozambique. However, these numbers are much lower than the world average for the same periods. Only in Cape Verde is the research productivity higher than the average for the African continent (strongly influenced by the research output of South Africa). In Figure 2 we also include Senegal and Rwanda (also included in Table 2 above), which are comparable in terms of income and population to Angola and Mozambique. We find that these two African countries (Senegal and Rwanda) have more than twice the number publications per million population of Mozambique and ten times more than Angola. Although there are dynamic improvements, this indicates that there is still a significant gap in research capabilities to overcome for PALOP countries, in comparison with other leading African countries and the World.

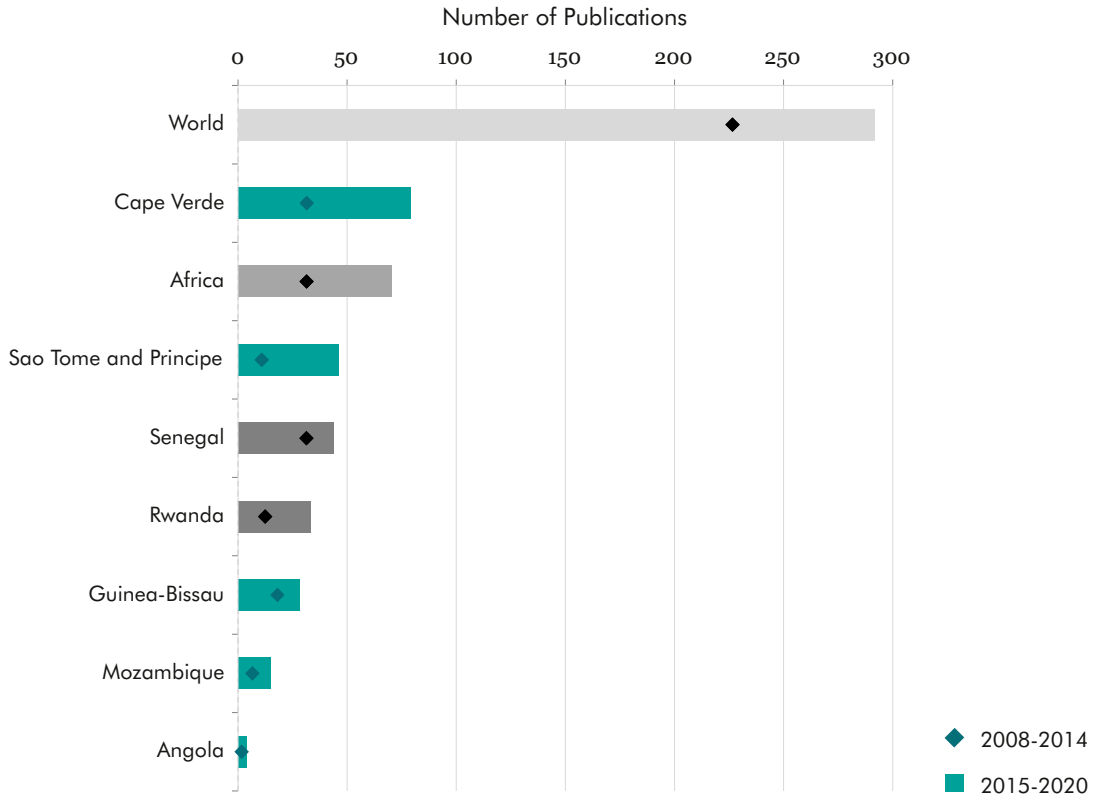

Figure 2. PALOP Research Productivity (Publications per million population) in all areas. 2008-2020.

Source: WoS & World Bank.
Note: The green bars are PALOP countries. The grey bars are reference countries (or groups of countries).

It is well known that African countries are highly dependent on international research collaboration to produce their research (AOSTI, 2014; Confraria *et al.*, 2020; Tijssen, 2007). Since Cape Verde and Sao Tome and Principe are relatively small countries, with less than 1 million people, this should be even more pronounced. To analyse the influence and importance of international research collaboration in the PALOP, in Figure 3 we plot a country's percentage of internationally co-authored articles versus the percentage of its internationally co-authored articles in which the country delivers the corresponding authorship (CA). We find a negative correlation between the two variables, meaning that, on average, countries that have higher levels of international research collaboration[11], have a lower share of publications where the CA is national. This inverse relation between a countries' share of international collaboration versus 'leadership' in international collaboration is not surprising since the more 'dependent' a country is on international collaboration the less capabilities it should have to lead research projects (Chinchilla--Rodríguez *et al.*, 2019; De Moya-Anegon *et al.*, 2018).

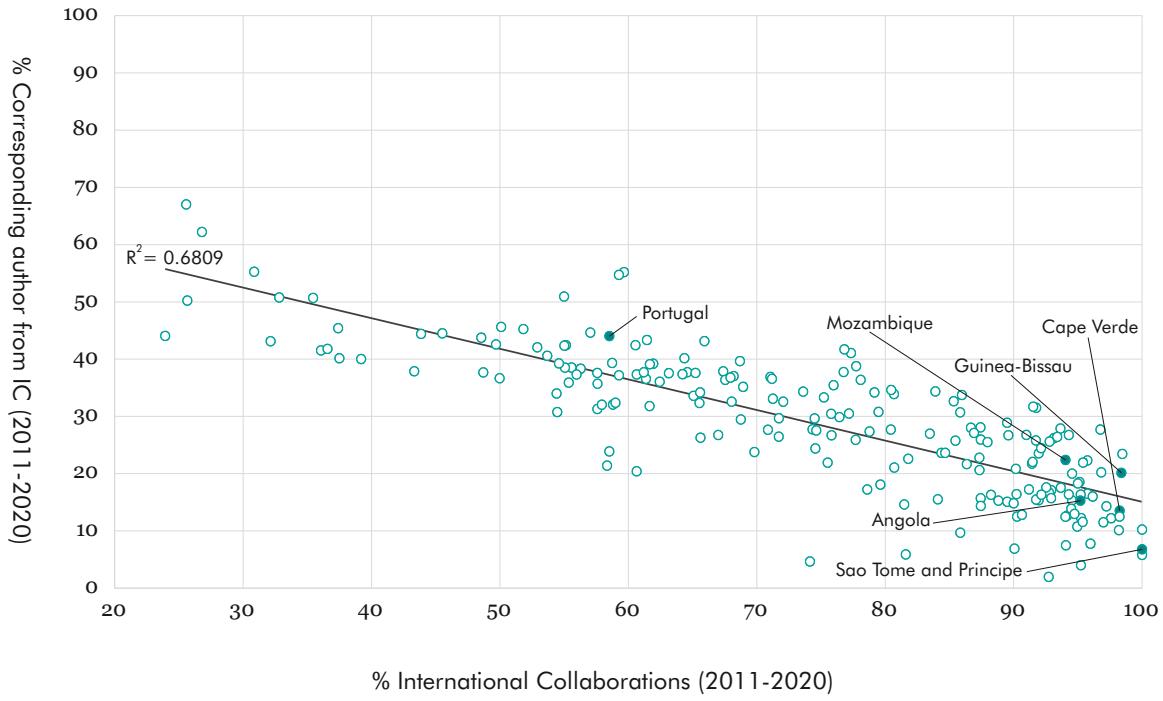

Figure 3. % int. collaborations vs % int. collaborations with CA from country in all areas. 2011-2020.

Source: WoS & InCites.

[11] Percentage of publications from a country with a foreign author in the affiliations list.

For PALOP (highlighted in the figure), we find that all of them produce more than 90% of their research in international collaboration, and from those international collaborations less then 25% have a corresponding author from a specific PALOP country. The dependence on foreign CA is higher in Sao Tome and Principe (93%), Cape Verde (86%) and Angola (85%). The two PALOP that are above the linear regression line are Guinea--Bissau and Mozambique, which indicate that their authors seem to have more 'leadership' roles than the world average for the same level of international collaboration.

The case of Guinea-Bissau is particularly interesting given that the percentage of publications with 1st and last author is also relatively high (see Figs. A.1 and A.2 in appendix). By analysing the names of the corresponding authors with more publications in Guinea-Bissau we found 26 publications from 'Peter Aaby', 7 publications from 'Christian Wejse' and 7 publications from 'Sanne M. Thysen'. All these researchers are affiliated to the Bandim Health Project[12] in those publications where they are the corresponding author. This finding indicates that this high 'leadership' indicator in Guinea-Bissau is mostly due to foreign (Danish) authors being affiliated to the Bandim Health Project (see also section 4.3).

Another contextual aspect worth looking is the research specialisation of the PALOP in comparison with the African and World average. In Figure 4, we analyse patterns by using the six broad OECD scientific areas (Agricultural Sciences, Engineering and Technology, Medical and Health Sciences, Natural Sciences, Social Sciences and Humanities). We find that more than 40% of all research done by authors in Angola, Guinea-Bissau and Mozambique is relate to 'Medical and Health Sciences', which is a much greater share then the world average (25%). Cape Verde and Sao Tome and Principe are relatively specialised in 'Natural Sciences' but their output is quite small as we have discussed in Figure 1. Except for Guinea-Bissau, all the PALOP are also relatively specialised in Agricultural Sciences. On the other hand, all the PALOP show a weak specialisation in 'Engineering and Technology'.

[12] https://www.bandim.org/

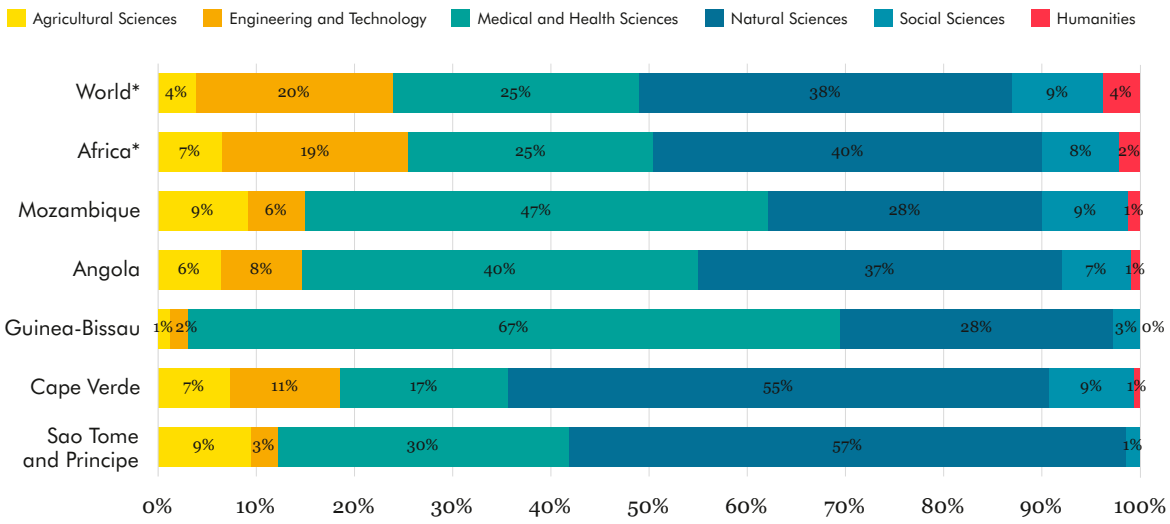

Figure 4. Research Specialization in PALOP in 6 OECD areas. 2008-2020.

Source: WoS.
Note: Articles and reviews only. Some publications might belong to more than one on OECD area (we normalised results in order to reach 100%).

5. Health sciences in the PALOP

In the previous section we studied the broad context of research production and collaboration in the PALOP in all research areas. In the next section we analyse with more detail the specialisation and collaboration patterns of the PALOP in health sciences. We operationalise the concept of 'health sciences' by combining all publications with an author from a PALOP country that are categorized by the WoS as 'OECD Medical and Health Sciences' or 'CWTS Clinical & Life Sciences'. This allows us to study a set of 4029 publications between 2008 and 2020.

5.1. PALOP Research Publications

In Fig. 5 we display how many of those publications in health sciences are from different PALOP. Similarly, as in Fig. 1, Mozambique has more than 70% of all PALOP publications and his the major responsible for the rise in output during this period. Angola and Guinea-Bissau have very similar output (14% and 13%, respectively) and Cape Verde and Sao Tome and Principe combine around 3% of total PALOP scientific output.

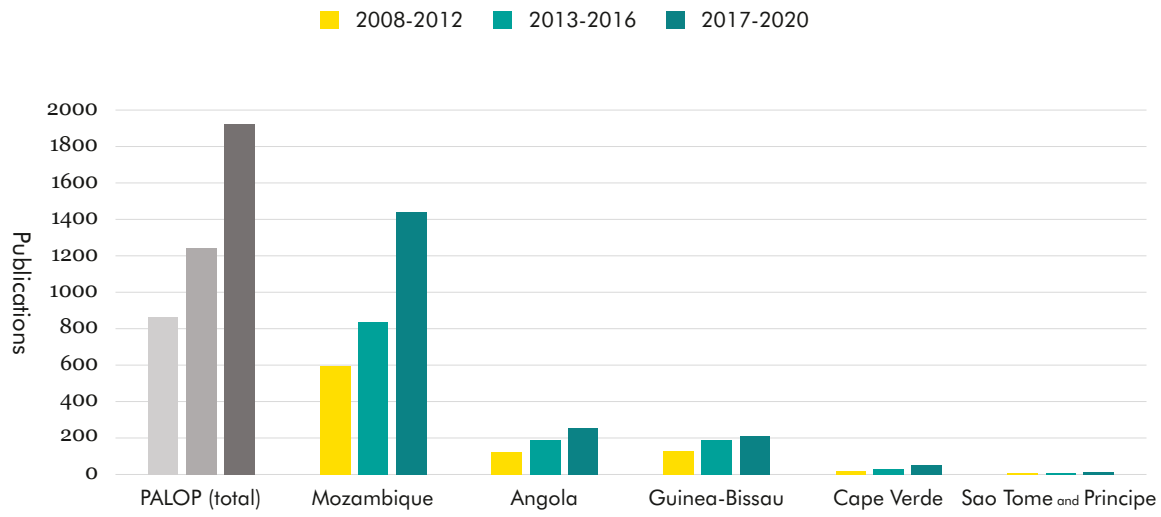

Figure 5. Research output trends in PALOP in 'health sciences'. 2008-2020.

Source: WoS.
Note: Please note that the first period has 5 years and the second and third 4 years.

Another indicator of the impact of a research system relates to the number of citations that are received by the publications with corresponding institutional affiliation in that country. In Table 4, besides the number of publications and citations received from 2008 and 2020, we also display six indicators to analyse the citation impact of PALOP research (percentage of cited publications – % Docs Cited; percentage of publications from a country that belong to the top 1% and top 10% in the world, controlling for year and research area – % Docs Top 1% & % Docs Top 10%), international collaboration (percentage of publications with at least one foreign author – % Int Collab), and scientific 'leadership' (percentage of publications in which the corresponding author has a national affiliation – % Corresp Author, percentage of publications in which the corresponding author has only a national/PALOP affiliation – % Unique CA).

Table 4. Research impact in PALOP in 'health sciences'. 2008-2020.

	Docs	Cits	% Docs Cited	% Docs Top 1%	% Docs Top 10%	% Int Collab	% Corresp Author	% Unique CA
Mozambique	2872	100248	79%	↑ 3.0%	↑ 14.0%	94%	21%	14%
Angola	563	11580	76%	↑ 2.0%	↘ 8.9%	92%	18%	14%
Guinea-Bissau	528	9931	87%	↑ 2.1%	↑ 13.1%	98%	22%	12%
Cape Verde	100	981	80%	→ 1.0%	↓ 7.0%	97%	13%	7%
Sao Tome and Principe	31	258	77%	↓ 0.0%	↓ 6.5%	97%	6%	6%
PALOP	4029	120513	80%	↑ 2.7%	↑ 12.9%	94%		

Source: WoS & InCites.

There are a number of insights emerging from Table 4. First, the indicator '% Docs Top 1%' shows that researchers in Mozambique, Angola and Guinea-Bissau participate in more highly cited publications than the world average (1%). Most of these publications are co-authored with several authors (>10) from other countries and are published in prestigious journals such as *The Lancet*. As for the indicator '% Docs Top 10%', although Mozambique and Guinea-Bissau still exhibit a performance above world average (10%), Angola performs below world average in this indicator, although not very far off the world average.

The high levels of citation impact in Mozambique and Guinea-Bissau may stem from the countries having a small group of scientists who produce scientific publications with highly reputed international co-authors (Confraria *et al.*, 2017; Confraria and Godinho, 2015). When we analysed publications with authors only from PALOP countries, citation impact is substantially lower in Mozambique and Angola (see Fig. A.3. in the appendix), approximately halving the corresponding figures for top cited publications from each country. Also, in line with what Tijssen and Kraemer-Mbula (2017) found for the entire African context, hardly any top 1% highly cited publications are the product of collaboration with other African countries exclusively. Nevertheless, the figure of 8% of the domestic-only publications from Mozambique among the 10% most cited world publications is noteworthy.

We also analysed the percentage of PALOP publications where the corresponding author (CA), first and last author is national. For CA, the results we obtained for 'Health sciences' are similar to what we found in Fig. 3 for all sciences, namely that less than 25% of publications have a CA from a specific PALOP country. However, when we analysed the percentage of CA who have a unique PALOP affiliation (i.e. that do not have an affiliation abroad in addition to the PALOP affiliation), the percentage decreases even further indicating that many of the PALOP corresponding authors are also affiliated to other foreign institutions.

In order to understand if there have been dynamic changes in leading authorship positions we analysed the evolution in the percentage of first, last and corresponding author for (co-)authors in Mozambique, Angola and Guinea-Bissau between 2009 and 2020 (2-year periods). We find that the share of PALOP publications in health sciences with a first, last and corresponding author from Mozambique and Guinea-Bissau has remained relatively stable during the period analysed (cf. Fig. A.4, in the appendix). Only Angola shows a positive slope in all indicators, showing improvements over time, although starting from a lower base.

Overall, we find that PALOP research systems are significantly open to the world, with a very large share of the publications developed in international collaboration, and that a large share of their most impactful research is developed with, and led by, authors with foreign affiliations. This suggests the need for improved leadership in these countries as part of an underlying internationalisation process.

5.2. Research Areas

Next in our analysis, we estimate which research areas within health sciences are more active in each one of the PALOP. In Table 5, we analyse this distribution by using the 326 CWTS Meso Citation Topics[13], which essentially correspond to groups of papers (research areas) related to one another via more intense relations of citation. We complement this analysis by comparing our results with a different, more detailed, classification – the 2444 CWTS Micro Citation Topics. This distribution by micro citation topics is available in Tables A.1-A.5 (for each of the PALOP), in the appendix.

As might be expected, the topics with the greater level of research activity are related to diseases with high prevalence locally. These topics are related to research areas in which African researchers in general tend to specialise – tropical medicine, parasitology, infectious diseases and public health (Arvanitis *et al.*, 2022; Confraria and Wang, 2020). One such key finding is that all the PALOP are specialised in research related to 'Malaria', a mosquito-borne infectious disease that affects humans and other animals and is endemic in Sub-Saharan Africa. Some highly cited publications with PALOP authors identified in our dataset related to this topic include malaria treatments

[13] https://clarivate.com/blog/introducing-citation-topics/

(Aponte *et al.*, 2009; Dondorp *et al.*, 2010), evaluation of efficacy and safety of malaria vaccination (Dobaño *et al.*, 2019; Tinto *et al.*, 2015), or research agendas for malaria eradication (Alonso *et al.*, 2011).

In Mozambique, there is also a substantial amount of health research related to 'HIV', 'Parasitology – Malaria, Toxoplasmosis & Coccidiosis', 'Healthcare Policy' and 'Tuberculosis & Leprosy' which reflect the burden of disease in the country related to the lethal combination of HIV, tuberculosis and malaria (UNESCO, 2021). These four research areas are also the ones with the higher absolute amount of top 10% highly cited publications of all (Table 6).

In Angola besides a high specialisation in 'Parasitology – Malaria, Toxoplasmosis & Coccidiosis' (16%), researchers also seem to be specialised in 'Schistosomiasis' (Parasitology – General) related research, which is high prevalence parasitosis in the country (Botelho *et al.*, 2015).

In Guinea-Bissau, 26% of all 'health sciences' research is related to Measles (Virology – General), followed by HIV (18%), 'Tuberculosis & Leprosy' (10%), Parasitology (7%) and Iron Deficiency (6%). One of the most impactful research outputs from researchers in Guinea-Bissau was that a new measles vaccine used in low-income countries was associated with a two-fold increase in mortality among girls (Aaby *et al.*, 2003). This discovery led to the withdrawal of the vaccine. Had it not been withdrawn; it would arguably have generated at least ½ million additional female deaths per year in Africa alone.[14] More recent research from the Bandim Health Project, and INDEPTH Network, has also been focused on the effects of vaccines, which go beyond the specific protective effects against the targeted diseases (e.g. Jensen *et al.*, 2015; Steiniche *et al.*, 2020).

In Cape Verde and Sao Tome and Principe the amount of research per topic is very limited to make any meaningful research specialisation analysis. However, we can observe some publications related to 'Parasitology' (e.g. 'Malaria') and Virology (e.g. 'Dengue').

In the context of research specialisation, it is important to distinguish excellence (e.g. top 10% highly cited publications) from relevance. Any Africa-centric notion of research prioritisation should go beyond international research publications and scientific impact in the academic community, to embrace the wider impacts of researchers in their local or domestic environments (Tijssen and Kraemer-Mbula, 2017). Furthermore, research in these contexts should pay special attention to the alignment of health research priorities with the disease burden of specific conditions. In PALOP countries there seems to exist a relative alignment since the top causes of DALYs (disability-adjusted life year) in these countries are Neonatal conditions, HIV/AIDS, Malaria, Tuberculosis, Lower respiratory infections and Diarrhoeal diseases.[15]

[14] https://en.wikipedia.org/wiki/Bandim_Health_Project

[15] https://www.who.int/data/gho/data/themes/mortality-and-global-health-estimates/global-health-estimates-leading-causes-of-dalys

Table 5. PALOP research specialisation in top 20 research areas. 2008-2020.

PALOP Meso Citation Topics	% Mozambique	% Angola	% Guinea--Bissau	% Cape Verde	% Sao Tome and Principe	Total PALOP
HIV	15%	6%	18%	9%	4%	491
Parasitology – Malaria, Toxoplasmosis & Coccidiosis	15%	17%	7%	9%	30%	489
Healthcare Policy	10%	4%	3%	4%	0%	290
Virology – General	4%	2%	26%	4%	0%	244
Tuberculosis & Leprosy	6%	4%	10%	1%	0%	200
Antibiotics & Antimicrobials	4%	5%	1%	1%	0%	129
Parasitology – General	3%	7%	1%	0%	11%	104
Nutrition & Dietetics	3%	1%	1%	3%	4%	91
Bacteriology	3%	1%	3%	1%	0%	85
Virology – Tropical Diseases	2%	3%	1%	11%	4%	82
Urology & Nephrology – General	2%	5%	0%	4%	7%	76
Diarrheal Diseases	2%	2%	2%	0%	7%	66
Cardiology – General	2%	3%	0%	0%	0%	55
Physiology & Metals	1%	1%	6%	0%	0%	50
Parasitology – Trypanosoma & Leishmania	1%	5%	0%	0%	0%	49
Obstetrics & Gynecology	1%	1%	2%	0%	0%	44
Sexually Transmitted Infections	1%	0%	3%	0%	0%	40
Zoonotic Diseases	1%	2%	0%	1%	11%	39
Allergy	1%	1%	0%	4%	0%	39
Nursing	1%	2%	0%	3%	0%	35
Hepatitis	1%	2%	1%	1%	7%	34
Trauma & Emergency Surgery	1%	0%	0%	0%	0%	34
Phytochemicals	1%	2%	0%	0%	0%	34
Oncology	1%	0%	0%	0%	0%	31
Total Health Pubs	2440	464	495	89	27	

Note: The share of publications per topic is calculated dividing the number of publications associated to a specific topic per total number of publications associated to any topic. There are 4029 PALOP docs and only 3451 associated to specific topics.

Table 6. PALOP number of top 10% highly cited publications in top 20 research areas. 2008-2020.

PALOP Meso Citation Topics	Mozambique	Angola	Guinea--Bissau	Cape Verde	Sao Tome and Principe	Total PALOP
HIV	35	0	9	0	0	491
Parasitology – Malaria, Toxoplasmosis & Coccidiosis	62	12	8	1	1	489
Healthcare Policy	61	6	3	0	0	290
Virology – General	15	1	16	0	0	244
Tuberculosis & Leprosy	23	1	4	0	0	200
Antibiotics & Antimicrobials	15	1	1	0	0	129
Parasitology – General	10	6	0	0	0	104
Nutrition & Dietetics	5	0	1	1	0	91
Bacteriology	11	0	4	0	0	85
Virology – Tropical Diseases	3	4	0	0	0	82
Urology & Nephrology – General	17	1	0	0	0	76
Diarrheal Diseases	14	1	0	0	0	66
Cardiology – General	9	0	0	0	0	55
Physiology & Metals	1	0	3	0	0	50
Parasitology – Trypanosoma & Leishmania	4	1	0	0	0	49
Obstetrics & Gynecology	1	1	1	0	0	44
Sexually Transmitted Infections	2	0	3	0	0	40
Zoonotic Diseases	0	0	0	0	0	39
Allergy	9	1	0	0	0	39
Nursing	4	0	0	0	0	35
Hepatitis	3	0	0	0	0	34
Trauma & Emergency Surgery	9	0	0	0	0	34
Phytochemicals	0	1	0	0	0	34
Oncology	2	0	0	0	0	31
Total Health Pubs	2440	464	495	89	27	

Note: We only calculated this indicator for research areas with more than 20 publications in a certain area.

5.3. Institutions and Collaboration Patterns

In order to understand who the main actors in the PALOP research systems are, and who are their main collaborators, we analysed the scientific production of all institutions in the five countries and which are the institutions that they co-author more publications with.

In Figure 6 we constructed a network graph with the main collaborators of top 10 institutions in Mozambique and Angola, and institutions that have more than 5 publications in Guinea-Bissau, Cape Verde and Sao Tome and Principe. For collaborators, we included all collaborators with more than 40 co-authorships or the top 5 collaborators of each institution (min 2 pubs). To support our analysis, in Tables A.6--A11, in appendix, we display the ranking of institutions with more publications per PALOP country, and the main international collaboration countries of each PALOP.

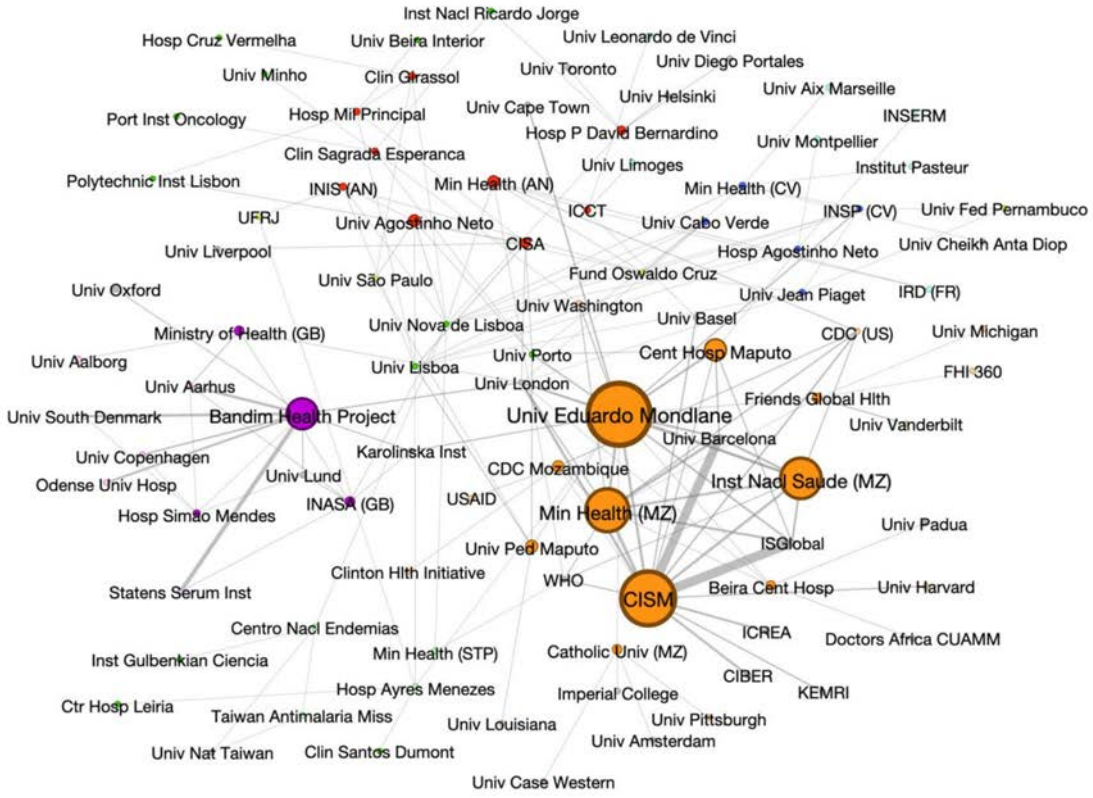

Figure 6. Collaboration research networks between PALOP institutions and other institutions in 'health sciences' (2008-2020).

Source: WoS.
Note 1: Node colours: Mozambique (Orange), Angola (Red), Guinea-Bissau (Dark purple), Cape Verde (Dark blue), Sao Tome and Principe (Green), Portugal (Light green), USA (Light green), France (Lightest blue), Denmark (Pink), Grey (Others).
Note 2: Node size for PALOP institutions: Number of publications (min=6, max=938), Size of 'foreign' nodes does not represent scientific output; Edge size: Number of collaborations (min=2, max=632).

In **Mozambique** we find that the four main actors (Univ Eduardo Mondlane, Ministry of Health and CISM – Centro de Investigacão em Saúde de Manhiça, INS – Instituto Nacional de Saúde) collaborate substantially among themselves. Univ Eduardo Mondlane is the institution with more publications. Their main collaborators are the Ministry of Health (which include Direccão Nacional de Saúde and Programa Nacional de Controlo de Malaria), INS and CISM[16], followed by the Univ Porto, Univ Cape Town and Univ London (most publications are from the The London School of Hygiene & Tropical Medicine). CISM has most (~75%) of its work developed in collaboration with institutions based in Barcelona (ISGlobal, Univ Barcelona, Hosp Clinic de Barcelona, CRESIB). The centre was founded in 1996 with the support of the Hospital Clínic de Barcelona and from 2008 it has also been supported by the Barcelona Institute for Global Health (ISGlobal) through scientific collaboration, capacity building, and administrative support.[17] Their collaboration is mostly on issues related to tropical medicine, infectious diseases and public health. The Ministry of Health from Mozambique has similar collaboration partners as the Univ Eduardo Mondlane and CISM, which also include to a lesser extent partner such as the Centers for Disease Control and Prevention (CDC) from USA, the World Health Organization, and the Univ Washington. There are also some other US institutions (e.g. USAID, Univ Vanderbilt, Clinton Hlth Initiative) which collaborate frequently with other Mozambican institutions, and which reflect the particular significance of international development assistance and cooperation aid, namely from the US, in Mozambique.

The other main actor in Figure 6 is the Bandim Health Project in **Guinea-Bissau**, which has most of its publications developed in collaboration with institutions from Denmark (e.g. Statens Serum Inst, Univ South Denmark, Univ Aarhus, Odense Univ Hosp, Univ Copenhagen). The Bandim Health Project was initiated in 1978 by Peter Aaby. The project is currently based on collaboration between the Ministry of Health in Guinea-Bissau, Statens Serum Institut in Denmark, and researchers affiliated to The University of Southern Denmark, as well as the University of Aarhus, Denmark. A significant amount of these collaborations was done on research related to effects of vaccines, measles and other infectious diseases. The other institutions in Figure 6 from Guinea-Bissau (Instituto Nacional de Saúde Pública (INASA), Ministry of Health and Hospital Simao Mendes) also benefit substantially from collaborations with institutions from Denmark.

In **Angola**, most collaborators are Portuguese (e.g. Univ Lisboa, Univ Nova Lisboa, Univ Porto, Inst Nacl Ricardo Jorge, Polytechnic Inst Lisbon) and Brazilian (e.g. Univ São Paulo, Fund Oswaldo Cruz) institutions. The Institut de recherche pour le développement (IRD) from France, and the CDC from the USA are also collaborators of three Angolan institutions. These results are in line with what was found by Sousa Costa (2017), namely that the main collaborating institutions are from Portugal, USA and Brazil.

[16]. Between 15 and 20% of Univ Eduardo Mondlane publications are done in collaboration with each one of these three Mozambique institutions.

[17]. https://www.isglobal.org/en/mozambique

Given the limited scientific output of institutions in **Cape Verde** and **Sao Tome and Principe**, the number of collaborators is also scarce. Cape Verde institutions (e.g. Univ Lisboa, Univ Porto, Univ Nova de Lisboa) and French institutions (e.g. Univ Aix Marseille, Institut Pasteur, Univ Montpellier). Sao Tome and Principe institutions also collaborate with some Portuguese institutions (including the Instituto Gulbenkian de Ciência[18]) but interestingly, one of the main partners is the National Taiwan University mostly because of the malaria research done within the Taiwan Antimalaria Advisory Mission in Sao Tome and Principe.[19]

To understand collaboration dynamics beyond co-authorship networks, we also analysed the percentage of first, last and corresponding authorship researchers from PALOP countries perform in their own countries, and what their main (country) partners in these relevant authorship positions are. In table 7, we rank the top 5 country collaborators of each PALOP, and analyse the percentage of first, last and corresponding authorship they represent for each PALOP. The results show different patterns for different PALOP. **Mozambique** main country partners are USA and Spain, which represent between 13% and 21% of all their first, last and corresponding authorships each. Given that colonial ties, culture and language tend to influence the research collaboration patterns of African countries (Adams *et al.*, 2013; Confraria and Godinho, 2015), the lower rank of Portugal (5th) was somehow surprising. **Guine-Bissau** is also an interesting case, with Denmark having more first, last and corresponding authorships than Guine-Bissau itself for their research. Given that the percentage of first authorships is 47% for Guine--Bissau and 49% for Denmark (and other countries also have a significant amount of first authorships), we can assume that many first authors from Guine-Bissau have double affiliation with institutions from Denmark. **Angola**, **Cape Verde** and **Sao Tome and Principe** strongest country partner is Portugal, which has more last and corresponding authorships than these three countries for all their own (co-)authored publications. This indicates that most "Health" research projects in Angola, Cape Verde and Sao Tome and Principe are probably led and designed by authors with Portuguese affiliations.

[18] The IGC also collaborates often (>2 pubs) with other PALOP institutions (e.g. Hosp Pediat David Bernardino, Univ Agostinho Neto, Univ Eduardo Mondlane). However, it is not among the top 5 collaborators of those institutions.

[19] https://taiwantoday.tw/news.php?unit=10&post=102488

Table 7. Top 5 Country collaborators and % of first, last and corresponding authorship they represent for each PALOP (2008-2020).

			Top 5 Country Collaborators (% First Author)				
	Docs	% First Author	1	2	3	4	5
Moçambique	2872	38%	USA (19%)	Spain (16%)	UK (6%)	South Africa (5%)	Portugal (6%)
Angola	563	42%	Portugal (25%)	USA (13%)	Brazil (12%)	UK (5%)	France (4%)
Guinea-Bissau	528	48%	Denmark (49%)	UK (9%)	Sweden (9%)	USA (6%)	Gambia (3%)
Cape Verde	100	27%	Portugal (34%)	USA (7%)	Brazil (10%)	UK (5%)	France (2%)
Sao Tome and Principe	31	10%	Portugal (37%)	Taiwan (37%)	Angola (3%)	Mozambique (0%)	USA (7%)
			Top 5 Country Collaborators (% Last Author)				
	Docs	% Last Author	1	2	3	4	5
Moçambique	2872	27%	USA (21%)	Spain (16%)	UK (7%)	South Africa (6%)	Portugal (7%)
Angola	563	19%	Portugal (28%)	USA (14%)	Brazil (13%)	UK (5%)	France (3%)
Guinea-Bissau	528	39%	Denmark (49%)	UK (11%)	Sweden (8%)	USA (6%)	Gambia (3%)
Cape Verde	100	10%	Portugal (30%)	USA (9%)	Brazil (8%)	UK (7%)	France (6%)
Sao Tome and Principe	31	13%	Portugal (43%)	Taiwan (30%)	Angola (7%)	Mozambique (0%)	USA (3%)
			Top 5 Country Collaborators (% Corresp. Author)				
	Docs	% Corresp. Author	1	2	3	4	5
Moçambique	2872	21%	USA (18%)	Spain (13%)	UK (6%)	South Africa (5%)	Portugal (5%)
Angola	563	18%	Portugal (21%)	USA (12%)	Brazil (10%)	UK (4%)	France (5%)
Guinea-Bissau	528	22%	Denmark (40%)	UK (8%)	Sweden (8%)	USA (5%)	Gambia (2%)
Cape Verde	100	13%	Portugal (33%)	USA (6%)	Brazil (9%)	UK (6%)	France (3%)
Sao Tome and Principe	31	6%	Portugal (37%)	Taiwan (23%)	Angola (0%)	Mozambique (0%)	USA (7%)

Source: WoS.
Notes: We highlight in red countries which have a % of first, last or corresponding authorship higher than the home (PALOP) country.

In Table A.12 (in the appendix) we also present the main locations where research is developed. As it is expected in research systems still in early phases of development, there is a high degree of concentration in the capital region. Nevertheless, in Angola and Mozambique there is non-negligible activity outside of the capitals (although in Mozambique the second location with highest activity, Manhiça, where CISM is located, is also in the Maputo Province). It must be noted that the full counting method is also applied on institutions or locations, and nationally collaborative research will be counted once for each different institution/location, thus adding to more than the total number of publications of the country.

Overall, we find that the institutions from some PALOP have their own main 'foreign' collaborators (e.g. Mozambique – Spain and USA, Guinea-Bissau – Denmark, Angola, Cape Verde and Sao Tome and Principe – Portugal) and that there are very few collaborations intra-PALOP. This finding is line with previous bibliometric studies looking into co-authorship patterns across African countries which usually find little collaboration between African countries and more collaboration intensity with high-income countries (Guns and Wang, 2017; Mêgnigbêto, 2013; Narváez-Berthelemot *et al.*, 2002).

Importantly, we find very few collaborations between institutions in different PALOP countries and that the only institutions that are in brokerage positions[20] are foreign institutions: Univ. Lisboa, Univ. Nova Lisboa, Univ. Porto, Univ. London and WHO. In Portugal, Greater Lisbon and Greater Porto are the main collaborating locations, with 42% and 38% of the total, respectively, and Coimbra with 7%.

[20] Collaborating with institutions from more than two PALOP countries.

6. Research Funding in PALOP

Research institutions in the PALOP, collaborate intensively with a diverse set of foreign institutions. At the same time several international funders of 'health' research have embarked on initiatives and projects to help improve the research capacity, research environment, create solutions and provide institutional support. In this section, we analyse the different contributions of various funding organisations to "health sciences" in the PALOP.

6.1. Main Funding Organisations of Research in PALOP (2008-2020)

Figure 7, highlights the top 30 funders contributing to the research developed with the participation of PALOP between 2008 and 2020. The number of publications funded by different organisations presented here refer to publications that have that entity in the acknowledgement paratext of that paper (Grassano *et al.*, 2017).[21] We can observe that there are three main funders supporting research developed by PALOP (Bill and Melinda Gates Foundation, National Institutes of Health (NIH) and the European Commission), which fund each around 13% of all funded research in the PALOP.[22] These three organisations reflect some of the diversity that we see in the overall participation of funding agencies. These include a private philanthropy (Gates Foundation) as well as public agencies (NIH and EC), originating from the US (Gates Foundation and NIH) and from Europe (EC), and with distinct global cooperation missions, including a mission focused on health in Africa (Gates Foundation), with a mission focused on health research (NIH), and a funder with a broader research scope (EC). While these funding organisations have a clearly more active role, we can also identify other international funders with a relevant contribution for research involving PALOP, which broadly fall into these categories.[23] Among the top 30 funding organisations we find public agencies from **Spain** (Instituto de Salud Carlos III, a public health research organisation, Spanish Agency for International Cooperation (AECID), Agencia de Gestio D'Ajuts Universitaris de Recerca Agaur (AGAUR) and the Spanish Ministry for Science and Innovation, with a wider research support), **USA** (in addition to the NIH, the United States Agency for International Development (USAID), Centers for Disease Control and Prevention (CDC) and the President's Emergency Plan for AIDS Relief (PEPFAR)), **Denmark** (Danish

[21] As noted above in the methodology section, there are some limitations with the funding data registered in the scientific publications and collected in WoS. In particular, not all research projects that are funded end up in publications in WoS, a substantial amount of publications have no funding info, and the data collected here identifies the existence of a contribution from each funding agency and does not differentiate the corresponding financial contribution.

[22] Around 18% of our sample doesn't have funding acknowledgements and we cannot know if it is 'unfunded' research or if the paper simply does not have a funding acknowledgements section.

[23] It is important to note that while most of the funding is likely to have been awarded to support research in the PALOP, to local researchers or to their collaborators (this is clearly the case in funding awarded by development cooperation agencies), some of the funding identified in the publications may not have been awarded specifically for research developed in the, or in collaboration with, PALOP but may simply have been institutional or individual funding for collaborators abroad who then engaged in collaboration with PALOP researchers (this might be the case with some of the national research funding agencies). It is not possible to identify this distinction. Nevertheless, it is clear that it was the existence of such funding, directly or indirectly, that enabled the development of the research with PALOP researchers that we have identified here.

National Research Foundation, Danish International Development Agency (DANIDA), Danish Council for Development Research, Danish Medical Research Council and the Independent Research Fund Denmark), **Portugal** (Fundação para a Ciência e a Tecnologia (FCT), the Gulbenkian Foundation and the Camões Institute), **United Kingdom** (UK Research and Innovation (UKRI)[24]), **Brazil** (National Council for Scientific and Technological Development (CNPq) and Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES)), **Sweden** (Swedish International Development Cooperation Agency (SIDA) and Swedish Research Council), the Australian National Health and Medical Research Council, **International Organisations** (World Health Organization (WHO), European Research Council (ERC),[25] European Developing Countries Clinical Trials Partnership (EDCTP), UNICEF), and **Philanthropies** (in addition to the Bill and Melinda Gates Foundation, the Novo Nordisk Foundation and the Aase and Ejnar Danielsens Foundation (both from Denmark), the Wellcome Trust (UK), and the Gulbenkian Foundation (Portugal). Finally, it is important to note the relevance of the contribution of local governments, namely from Mozambique and Angola, and the significant institutional support acknowledged from the Eduardo Mondlane University, in Mozambique.

The highest growth between the two periods analysed (2008-14 and 2015-20) has been observed for the Gates Foundation (>200%), reflecting its own increasing role in research funding in sub-Saharan Africa (Head *et al.*, 2017) and the growing importance of philanthropic partners in the structuration of research in the continent (Arvanitis *et al.*, 2022). However, other major funders have also expanded their support significantly (between 100% and 200%), namely the NIH, European Commission, Instituto de Salud Carlos III and USAID, as well as the Wellcome Trust, CAPES and EDCTP. The Gulbenkian Foundation also saw an increase in 67% of the number of papers developed with its support, between the first and second period.[26]

[24.] Includes the UK Medical Research Council, Economic & Social Research Council (ESRC), Biotechnology and Biological Sciences Research Council (BBSRC), among others.

[25.] Although it is an agency awarding funding within the European Commission's (EC) Framework Programmes (more recently the Horizon 2020 programme), we have distinguished the European Research Council (ERC) following the general principle applied of distinguishing between public health research institutes, development cooperation funding and public research funding. While references to the European Commission may include the latter two, the ERC has autonomy in its awards from the EC and can clearly be considered under public research funding organisation.

[26.] During 2008-2020, the Gulbenkian Foundation appears as a funder in 69 publications, which are authored by more than 300 researchers from 30 different countries. 41 of these researchers are affiliated to an institution in Mozambique, 28 from Angola, 3 from Guinea-Bissau, and 2 from Cape Verde and Sao Tome and Principe. This set of publications also includes 124 researchers with affiliations from Portugal, 24 from USA, 22 from Spain and 20 from Brazil.

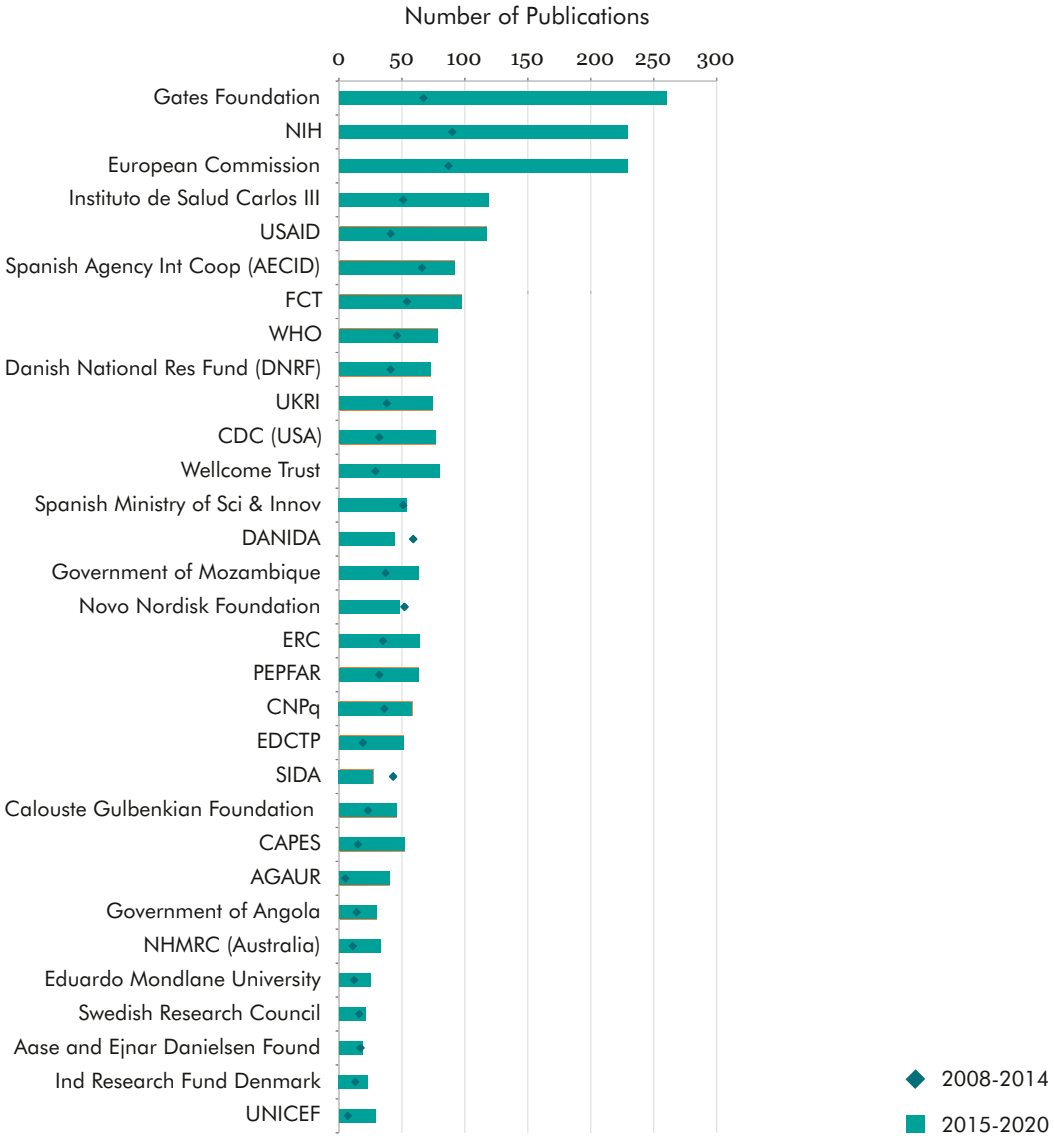

Figure 7. Top 30 Acknowledged-Funders of 'Health' Research in PALOP. 2008-2014 & 2015-2020.

Source: WoS.
Note: Funders are ordered by total amount of publications in 2008-2020. Articles and reviews only.

As would be expected from the significant higher number of total publications, Mozambique has seen the greatest contribution from a wider number of funding organisations. Table 8 shows the activity of the different funding organisations in each of the five countries considered, according to the corresponding number of publications acknowledging the corresponding support. Despite the fact that Mozambique has the greatest number of publications supported by 12 of the funding organisations listed in Table 8, other cases are noteworthy, reflecting the discussion presented above. While the important role of the Government of Angola might be expected therein, the significant share of support of the Camões Institute and the Calouste Gulbenkian Foundation, but also of the Portuguese Foundation for Science and Technology (despite the fact that a larger share of FCT's support is dedicated to Mozambique), to research in health sciences in Angola is also noteworthy (see below for an analysis of co-funding patterns).

Similarly, Guinea-Bissau has seen a distinct support profile, with very significant research activity supported by a set of Danish organisations (Danish National Research Foundation, DANIDA and the Novo Nordisk Foundation), as well as from the UKRI, the European Commission and the Wellcome Trust (with the latter two privileging support to research in Mozambique). FCT and the Gulbenkian Foundation emerge as providing the more continuous support in the whole group of PALOP countries, namely also in Cape Verde and Sao Tome and Principe.

Table 8. Share of research supported by top 15* (+4 selected) acknowledged research funders in PALOP by country. 2008-2020.

	Mozambique	Angola	Guinea--Bissau	Cape Verde	Sao Tome and Principe	Total
Gates Foundation	90%	5%	8%	1%	0%	327
NIH	77%	6%	15%	2%	0%	319
European Commission	55%	9%	34%	3%	0%	316
Instituto de Salud Carlos III	97%	3%	0%	0%	0%	170
Spanish Agency Int Coop (AECID)	98%	1%	0%	1%	0%	158
USAID	78%	15%	6%	0%	1%	158
FCT	50%	31%	9%	14%	3%	151
WHO	81%	13%	4%	4%	2%	124
Danish NRF	2%	0%	98%	0%	0%	114
UKRI	46%	4%	50%	2%	0%	112
CDC (USA)	87%	10%	2%	1%	1%	109
Wellcome Trust	61%	14%	25%	6%	0%	109
Spanish Ministry of Sci & Innov	91%	2%	3%	3%	1%	105
DANIDA	13%	0%	87%	0%	0%	103
Novo Nordisk Foundation	0%	0%	100%	0%	0%	100
Gov Mozambique	99%	1%	0%	0%	0%	100
Calouste Gulbenkian Foundation	35%	55%	6%	6%	6%	69
Gov Angola	0%	100%	0%	0%	0%	44
Camoes Institute	19%	84%	0%	0%	0%	32
Total	2192	422	440	81	26	

Source: WoS.
Notes: Articles and reviews only. Country is observed using affiliation data.

6.2. Research Areas and Collaboration by Funders

It is also relevant to consider whether each funder has particular priorities reflected in specific research areas of support. Table 9 highlights the top 15 research funders (plus the Calouste Gulbenkian Foundation, the Camões Institute and the Governments of Mozambique and Angola) in PALOP according to the research areas supported between 2008 and 2020. Research areas are generated by InCites Meso citation topics which are created based on backward and forward citation relations between all publications in WoS. We find that USA institutions (NIH, USAID, CDC) tend to fund more research related to 'HIV', 'Healthcare Policy' and 'Parasitology' ('Malaria'). 'Malaria' is also the topic most supported by Spanish funders (Carlos III, AECID and Spanish Ministry of Sci & Innov) and the Gates Foundation. Danish funders (Danish NRF, DANIDA, Novo Nordisk), mostly support research on 'Virology' ('Measles'), but also, to a lesser extent, research on 'Physiology & Metals' ('Iron Deficiency').

The other funders, in Table 9, are less specialized and fund research in several topics. The funding pattern of the Governments of Mozambique and Angola, Calouste Gulbenkian Foundation and Camões Institute are all very similar and related to 'Parasitology' ('Malaria'), 'Parasitology – General' (e.g. 'Schistosomiasis'), 'Healthcare Policy' (e.g. 'Maternal Mortality'), 'Diarrheal Diseases' and 'Urology & Nephrology'. Compared with the top 15 funders, these four funders tend to fund less research on "HIV" and 'Virology' ('Measles').

Table 9. Share of research supported by top 15* (+4 selected) acknowledged research funders in PALOP by research area. 2008-2020.

PALOP Meso Citation Topics	Gates Foundation	NIH	European Commission	Instituto de Salud Carlos III	Spanish Agency Int Coop (AECID)	USAID	FCT	WHO	Danish NRF	UKRI	CDC (USA)	Wellcome Trust	Spanish Ministry of Sci & Innov	DANIDA	Novo Nordisk Foundation	Gov Mozambique	Calouste Gulbenkian Foundation	Gov Angola	Camoes Institute	Total PALOP
HIV	6%	28%	7%	9%	12%	23%	8%	8%	3%	15%	42%	1%	17%	7%	0%	10%	3%	0%	0%	491
Parasitology – Malaria, Toxoplasmosis & Coccidiosis	29%	11%	15%	47%	47%	29%	11%	14%	0%	17%	7%	28%	45%	1%	0%	22%	14%	20%	19%	489
Healthcare Policy	13%	10%	8%	2%	5%	15%	1%	9%	4%	5%	6%	6%	2%	3%	1%	6%	7%	7%	9%	290
Virology – General	8%	2%	23%	2%	3%	2%	1%	11%	71%	10%	11%	6%	7%	50%	65%	2%	1%	5%	3%	244
Tuberculosis & Leprosy	2%	6%	9%	4%	1%	1%	5%	5%	4%	7%	1%	4%	2%	11%	10%	1%	7%	0%	0%	200
Antibiotics & Antimicrobials	5%	3%	3%	5%	12%	5%	3%	6%	2%	2%	1%	4%	3%	0%	0%	1%	3%	2%	3%	129
Parasitology – General	4%	2%	2%	1%	1%	1%	3%	3%	0%	3%	0%	5%	2%	8%	0%	9%	10%	16%	22%	104
Nutrition & Dietetics	1%	1%	1%	0%	0%	1%	5%	4%	0%	1%	0%	4%	0%	2%	1%	6%	1%	0%	0%	91
Bacteriology	10%	5%	1%	4%	5%	0%	1%	0%	0%	11%	4%	7%	0%	0%	0%	3%	3%	0%	0%	85
Virology – Tropical Diseases	0%	1%	1%	0%	0%	0%	5%	0%	0%	3%	6%	8%	2%	1%	0%	0%	0%	0%	0%	82
Urology & Nephrology – General	1%	1%	0%	0%	0%	0%	1%	4%	0%	0%	2%	2%	0%	0%	0%	4%	6%	14%	13%	76
Diarrheal Diseases	6%	1%	2%	3%	2%	3%	2%	5%	0%	1%	4%	2%	1%	0%	0%	4%	12%	9%	6%	66
Cardiology – General	0%	1%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	55
Physiology & Metals	0%	0%	2%	0%	1%	1%	0%	1%	13%	1%	0%	0%	0%	14%	16%	0%	1%	0%	0%	50
Parasitology – Trypanosoma & Leishmania	1%	0%	2%	0%	0%	0%	0%	2%	0%	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%	49
Obstetrics & Gynecology	1%	1%	1%	2%	2%	3%	0%	2%	0%	4%	0%	0%	1%	0%	2%	1%	1%	0%	0%	44
Sexually Transmitted Infections	0%	1%	0%	1%	1%	4%	0%	3%	0%	3%	1%	11%	0%	0%	0%	0%	0%	2%	0%	40
Zoonotic Diseases	0%	0%	3%	0%	0%	0%	5%	0%	0%	0%	0%	0%	1%	0%	0%	1%	3%	5%	0%	39
Allergy	0%	1%	1%	0%	0%	0%	1%	1%	0%	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	39
Nursing	0%	1%	1%	0%	0%	0%	1%	2%	0%	0%	2%	0%	0%	0%	0%	1%	6%	0%	6%	35
Hepatitis	0%	1%	0%	0%	0%	1%	1%	1%	0%	0%	1%	0%	0%	3%	0%	2%	3%	0%	3%	34
Trauma & Emergency Surgery	6%	0%	0%	8%	1%	0%	0%	1%	0%	0%	0%	1%	0%	0%	0%	2%	0%	0%	0%	34
Phytochemicals	0%	0%	0%	1%	1%	0%	6%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	5%	0%	34
Oncology	1%	1%	1%	1%	1%	1%	1%	1%	0%	0%	3%	0%	1%	0%	0%	2%	0%	0%	0%	31
Total	327	319	316	170	158	158	151	124	114	112	109	109	105	103	100	100	69	44	32	

Source: WoS & InCites.
Notes: Research areas are ordered by total amount of publications in 2008-2020. Funders are ordered by total amount of publications in 2008-2020. Calouste Gulbenkian Foundation, Gov. Mozambique, Gov. Angola and Camoes Institute were added by the authors to this table although they are not within the top 15 funders with more publications. Articles and reviews only.

Another important aspect of research funding are the patterns of co-funding between different institutions. In the past, research funders tended to select the countries they worked with, based on political affinities and colonial past (Gaillard, 1994). Now, in the era of co-construction and multi-agency schemes, few funding agencies would choose to work without engaging in some form of engagement with local authorities. International research funders and philanthropies participate in the design and delivery of instruments, under the assumption that 'co-constructed', 'co-owned', 'co-funded' measures between foreign partners and national policy bodies will have a better chance to create scientific research (Arvanitis *et al.*, 2022). However, there are few empirical studies analysing patterns of co-funding initiatives. In tables 10 and 11 we analyse the percentage of publications that are funded together by two different top 15* institutions, and the percentage of publications that a certain funder supports distributed according to the number of funding institutions involved (only 1, 2, 3 to 5 funders, 6 to 10 funders, or more than 10 funding institutions).

Overall, as expected, we found strong co-funding patterns between institutions that belong to the same countries. For example, Danish institutions (DANIDA, Danish NRF, Novo Nordisk) fund around 50% of the same research, and Spanish institutions (Carlos III, AECID and Spanish Ministry of Science and Innovation) co-fund together around 30% of the same research. The European Commission (EC) is a strong co-funder of both Danish and Spanish institutions. US institutions (USAID, CDC, NIH) also tend to co--fund substantially together, but less than Spanish or Danish institutions. There is very little co-funding between Danish institutions and other non-Danish/EC institutions (e.g. US, PT, Philanthropic). The Calouste Gulbenkian Foundation, Camões Institute and institutions from the Government of Angola also have significant joint co-funding of the research they sponsor.

Table 10. Co-funding share of top 15* acknowledged research funders in PALOP.

	Gates Foundation	NIH	European Commission	Instituto de Salud Carlos III	Spanish Agency Int Coop (AECID)	USAID	FCT	WHO	Danish NRF	UKRI	CDC (USA)	Wellcome Trust	Spanish Ministry of Sci & Innov	DANIDA	Novo Nordisk Foundation	Gov Mozambique	Calouste Gulbenkian Foundation	Gov Angola	Camoes Institute	Total
Gates Foundation	100%	13%	5%	25%	26%	14%	1%	14%	3%	18%	8%	28%	17%	2%	2%	18%	4%	0%	0%	327
NIH	13%	100%	9%	11%	4%	19%	6%	7%	3%	30%	15%	21%	11%	0%	4%	8%	6%	0%	3%	319
European Commission	5%	8%	100%	31%	18%	3%	33%	9%	54%	18%	1%	12%	30%	46%	52%	6%	10%	5%	16%	316
Instituto de Salud Carlos III	13%	6%	16%	100%	40%	3%	3%	8%	0%	4%	1%	5%	47%	0%	0%	10%	1%	0%	0%	170
Spanish Agency Int Coop (AECID)	13%	2%	9%	37%	100%	8%	1%	8%	0%	4%	1%	3%	43%	0%	0%	35%	6%	2%	0%	158
USAID	7%	9%	2%	3%	8%	100%	0%	9%	0%	1%	9%	6%	3%	1%	0%	2%	0%	0%	0%	158
FCT	1%	3%	16%	3%	1%	0%	100%	2%	1%	2%	0%	4%	4%	0%	1%	2%	22%	7%	9%	151
WHO	5%	3%	3%	6%	6%	7%	1%	100%	1%	3%	8%	6%	6%	0%	0%	17%	6%	5%	3%	124
Danish NRF	1%	1%	20%	0%	0%	0%	1%	1%	100%	4%	0%	1%	0%	53%	71%	0%	0%	0%	0%	114
UKRI	6%	11%	6%	2%	3%	1%	1%	2%	4%	100%	1%	27%	5%	5%	7%	3%	0%	0%	0%	112
CDC (USA)	3%	5%	0%	1%	1%	6%	0%	7%	0%	1%	100%	5%	0%	0%	0%	7%	0%	2%	0%	109
Wellcome Trust	9%	7%	4%	3%	2%	4%	3%	6%	1%	26%	5%	100%	3%	0%	1%	1%	1%	2%	3%	109
Spanish Ministry of Sci & Innov	6%	4%	10%	29%	28%	2%	3%	5%	0%	4%	0%	3%	100%	0%	1%	10%	0%	0%	0%	105
DANIDA	1%	0%	15%	0%	0%	1%	0%	0%	48%	4%	0%	0%	0%	100%	49%	0%	0%	0%	0%	103
Novo Nordisk Foundation	1%	1%	16%	0%	0%	0%	1%	0%	62%	6%	0%	1%	1%	48%	100%	0%	0%	0%	0%	100
Gov Mozambique	6%	3%	2%	6%	22%	1%	1%	14%	0%	3%	6%	1%	10%	0%	0%	100%	4%	0%	0%	100
Calouste Gulbenkian Foundation	1%	1%	2%	1%	3%	0%	10%	3%	0%	0%	0%	1%	0%	0%	0%	3%	100%	57%	91%	69
Gov Angola	0%	0%	1%	0%	1%	0%	2%	2%	0%	0%	1%	1%	0%	0%	0%	0%	36%	100%	78%	44
Camoes Institute	0%	0%	2%	0%	0%	0%	2%	1%	0%	0%	0%	1%	0%	0%	0%	0%	42%	57%	100%	32
Total	327	319	316	170	158	158	151	124	114	112	109	109	105	103	100	100	69	44	32	

Source: WoS.
Notes: Funders are ordered by total amount of publications in 2008-2020. The shares should be read in relation to the institution in the 1st row (e.g. 46% of DANIDA supported research is also supported by the European Commission, but only 15% of European Commission supported research is also supported by DANIDA). Articles and reviews only.

The network of co-funding activity underlying the data presented above can be easily seen in Figure 8. This figure shows clearly the co-funding links between the different organisations and the corresponding clustering surrounding their join intervention in particular countries. While the Gates Foundation, the NIH and the European Commission emerge clearly at the centre, with relevant links to most of the other organisations, different country groups emerge. These partly reflect co-funding activity between organisations from the same country – for example, Danish funding organisations are grouped, as are Portuguese funders and, to a lesser extent, Spanish ones. But they also reflect the country of activity, with the UKRI closely related to the Danish funders, due to their significant activity in supporting research in Guinea-Bissau. Similarly Portuguese funding organisations appear closer to the support activity of the Angolan Government, where much of their activity has been focused. And again, Spanish funders cluster around the Government of Mozambique's node, but here with a wider constellation of supporting organisations, and closer to the centre of the network.

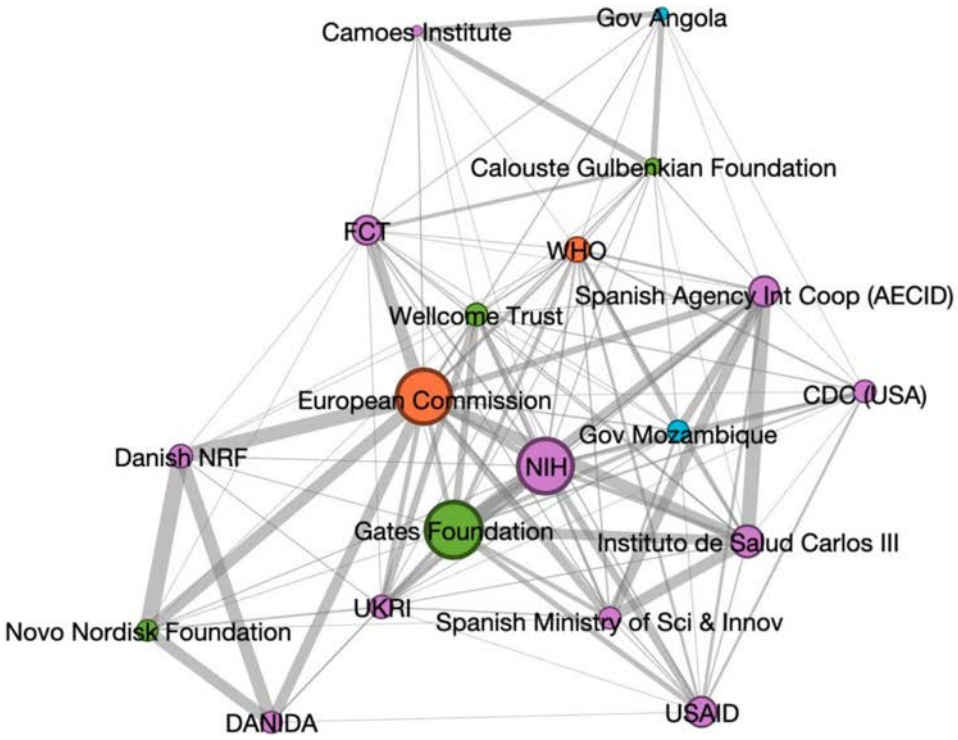

Figure 8. Co-funding network between Top 15* acknowledged research funders supporting 'health sciences' in the PALOP (2008-2020).

Source: WoS.
Note: Articles and reviews only. Green: Philanthropies, Purple: Public non-African, Blue: Public African, Orange: Multilateral.

The existence of such intense co-funding network is mostly due to the fact that a large share of the publications identified in this set acknowledges the support of more than one funder. However, the distribution is highly skewed with fifteen publications having more than 20 funders acknowledged, and two publications having more than 50 funders. Most funders in Table 11 tend to appear in publications with 2 or 3 funders. However, some funders support a substantial amount (>25%) of their research alone (e.g. Gates Foundation, NIH, USAID, FCT, WHO, CDC), and other funders tend to appear in the majority of their publications with 4 or more funders (e.g. European Commission, Carlos III, AECID, Danish NRF, UKRI, Spanish Ministry of Sci & Innov, DANIDA, Novo Nordisk). These co-funding arrangements tend to mirror some of the specialisation patterns of research funders. Danish funders (and the European Commission) tend to co-fund research related to 'Virology' ('Measles'). Spanish funders co-fund a lot of research related to 'Parasitology' ('Malaria').

Table 11. Co-funding patterns of top 15* acknowledged research funders in PALOP.

	1	2 to 3	4 to 9	>9	Total
Gates Foundation	33%	39%	25%	3%	327
NIH	25%	35%	32%	8%	319
European Commission	10%	31%	50%	8%	316
Instituto de Salud Carlos III	3%	44%	51%	3%	170
Spanish Agency Int Coop (AECID)	3%	41%	53%	4%	158
USAID	26%	46%	25%	3%	158
FCT	32%	39%	26%	3%	151
WHO	26%	34%	37%	3%	124
Danish NRF	4%	15%	75%	7%	114
UKRI	23%	24%	37%	16%	112
CDC (USA)	15%	67%	17%	2%	109
Wellcome Trust	19%	35%	37%	9%	109
Spanish Ministry of Sci & Innov	5%	24%	65%	7%	105
DANIDA	9%	20%	63%	8%	103
Novo Nordisk Foundation	2%	9%	79%	10%	100
Gov Mozambique	7%	53%	36%	4%	100
Calouste Gulbenkian Foundation	10%	42%	46%	1%	69
Gov Angola	9%	52%	36%	2%	44
Camoes Institute	0%	53%	44%	3%	32

Source: WoS.
Notes: Funders are ordered by total amount of publications in 2008-2020. The shares should be read in relation to the institution in the 1st row (e.g. FCT appears alone in 32% of the publications they fund). Articles and reviews only.

Interestingly, the distribution pattern of the number of funders per publication has not seen a significant change along this period. Figure 9 shows the distribution of publications according to the corresponding number of funders, for three distinct time periods. The distribution lines are strikingly similar for the three periods, with only a slight difference in the first period regarding the acknowledgement of a single funder. While this difference is negligible for the analysis herein, it might be linked to the emerging practice of more consistent acknowledgement of funding, which might have been less enforced in cases of single funders.

This similar pattern of co-funding along time suggests that these funding networks are, overall, largely institutionalised through consolidated research programmes and are not simply the result of occasional research support. Necessarily, some of the publications are outputs from individual research projects resulting from competitive research calls, with the corresponding support from a specific funding agency, but the consistently large number of funders acknowledged might indicate that there is an established network of funders to the different research organisations that are essential to the maintenance of research on a more permanent basis, and which is reflected in this continued distribution pattern. This is clearly the case with the consistent pattern of co-funding of some of these organisations, in Mozambique, Guinea-Bissau or in Angola with the case of the support by the Gulbenkian Foundation together with the Camões Institute and Government of Angola.

Such considerations point to wider questions on the organisation of research activities in these countries and the corresponding funding conditions, which will be addressed in section 8 of this report.

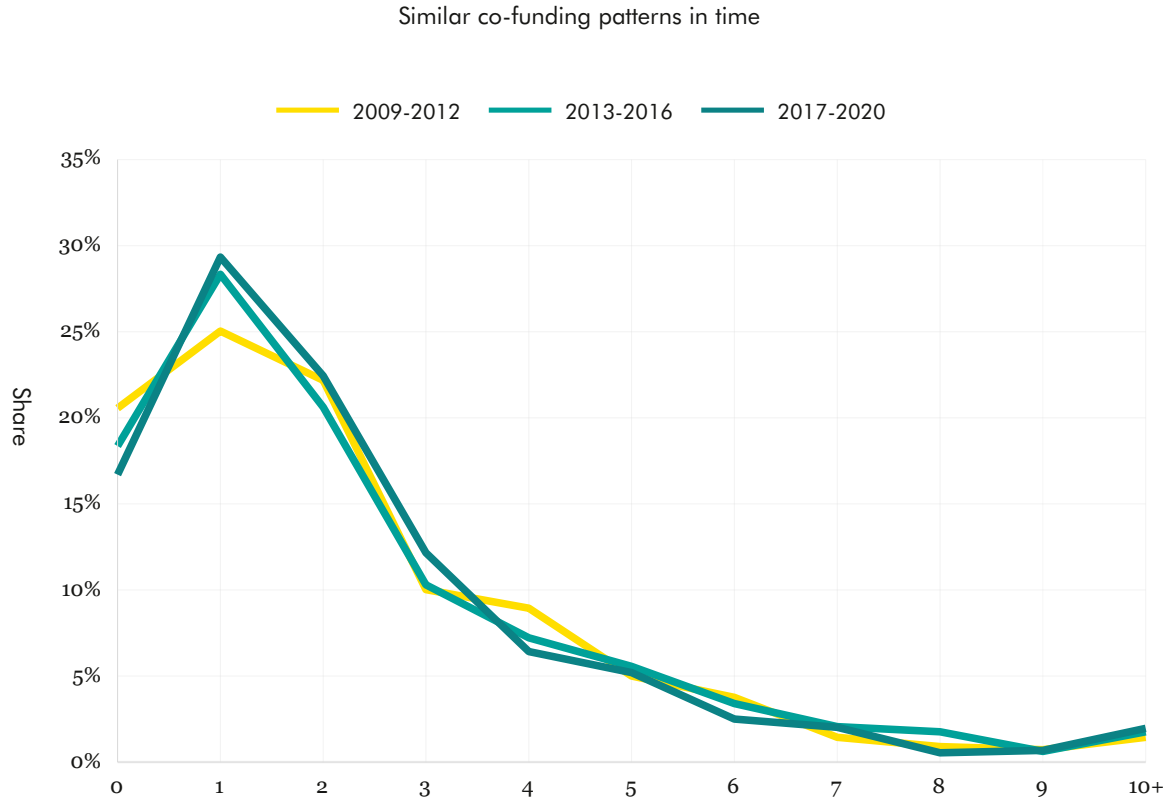

Figure 9. Distribution of the number of acknowledged co-funders per publication in different periods.

Source: WoS.
Note: Articles and reviews only.

7. Clinical Trials in PALOP

One of the distinctive research activities in the health sciences is the development of clinical trials, largely through international collaborative initiatives. Clinical trials are an important research activity to assess the effects of and develop the most appropriate medical interventions to address specific conditions. A clinical trial is defined by the WHO as:

> *"any research study that prospectively assigns human participants or groups of humans to one or more health-related interventions to evaluate the effects on health outcomes. Clinical trials may also be referred to as interventional trials. Interventions include but are not restricted to drugs, cells and other biological products, surgical procedures, radiologic procedures, devices, behavioural treatments, process-of-care changes, preventive care, etc. This definition includes Phase I to Phase IV trials."* (https://www.who.int/clinical-trials-registry-platform)

As noted in this definition, clinical trials are not only applied to interventions with drugs, but also include a wider set of medical interventions. In the context of PALOP countries, this is a relevant issue because, as mentioned by an interviewee from Cape Verde, clinical trials studying the effects of new drugs require specific legislation and in some PALOP countries this type of legislation is still under development. Therefore, in countries with less institutional capacity, clinical trials tend to focus on the provision of adequate medical responses to local health conditions, often poverty-related, in ways that go beyond drug development.

In this section we address two of these dimensions. Firstly, we analyse available data on international clinical trials from the WHO's International Clinical Trials Registry Platform (ICTRP). This data identifies participating countries, namely the PALOP countries under study here, as well as the conditions the trials specifically target.

Secondly, considering that the European & Developing Countries Clinical Trials Partnership (EDCTP) was set up with the mission of enhancing research capacity and promote the development of medical interventions to address poverty-related infectious diseases in Sub-Saharan Africa, we will analyse some of its activity in this regard and the involvement of PALOP countries.

7.1. The International Clinical Trials Registry Platform (ICTRP)

The World Health Organisation (WHO) has created a registry of international clinical trials, aggregating data from the different regional and national clinical trials databases (it is not itself a primary registry). The International Clinical Trials Registry Platform (ICTRP) thus provides a single point of access to data from different sources. These sources include among others the EU Clinical Trials Register (EU-CTR), the Pan African Clinical Trial Registry (PACTR) or ClinicalTrials.gov (data provider by the NIH which is also not a primary registry). The data aggregated from primary registries must fulfil several criteria, to guarantee the specific standards defined for the ICTRP, referring namely to issues of content, quality and validity, accessibility, unambiguous

identification, technical capacity and administration and governance. As stated by ICTRP, its "mission is to ensure that a complete view of research is accessible to all those involved in health care decision making" (ICTRP website).

We have retrieved the data from ICTRP for the same period for which health sciences publication data was analysed, 2008-2020, which include at least one of the PALOP as a country where patients were recruited. During this period, we identified a total of 195 trials with the participation of PALOP patients. Among these trials, only 6 were classified as interventional clinical trials of medicinal products. While 150 corresponded to other interventional trials, the remainder were observational trials. In observational trials participants may receive interventions (which can include medical products such as drugs or devices) or procedures as part of their routine medical care, but participants are not assigned to specific interventions by the investigator. As evident from Figure 10, the 195 international clinical trials identified reflect a clear increase of participation in recent years.

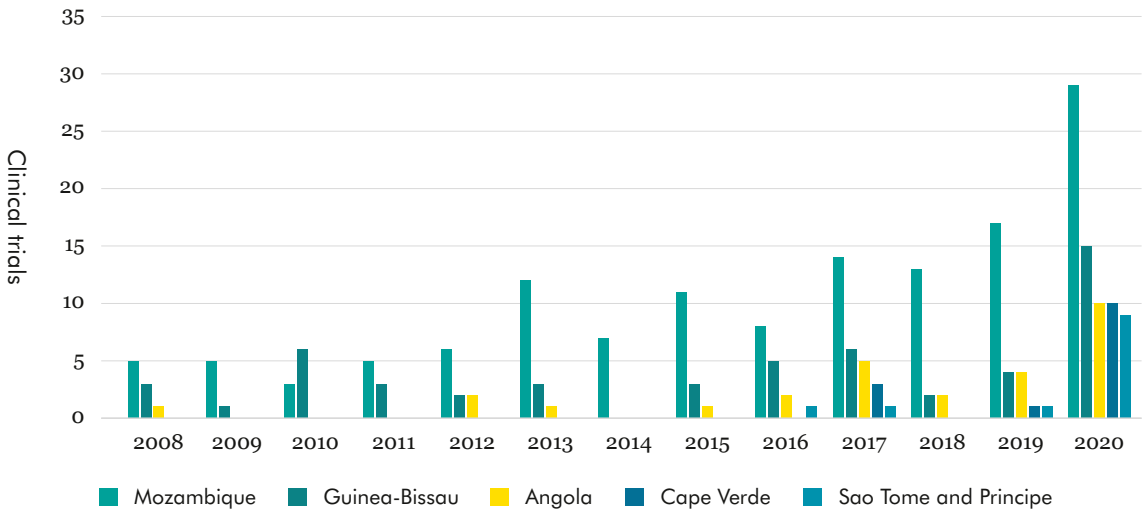

Figure 10. Participation of PALOP in international clinical trials (2008-2020).

Source: ICTRP (data downloaded in May 2022).

As has been the case with the publication activity, Mozambique is the country among the PALOP with the highest participation in international clinical trials, being identified as a participating country in 135 trials. It should be noted that the corresponding share of the participation of Mozambique among the PALOP countries in the identified international clinical trials, of 69%, is very similar to Mozambique's of share of in health sciences among the PALOP (70%). To the contrary, Guinea-Bissau has had a more significant and continued participation in international clinical trials than the other PALOP, with the participation in 53 international clinical trials, and in particular with approximately double the number of participations of Angola (with 28 participations), which is second with regard to research publications. The strong international network that has been developed in the Bandim Institute in Guinea-Bissau, an institute set up

through a collaboration with researchers from the University of Southern Denmark, is reflected in its longstanding participation in international clinical trials. Until recently Angola has only had occasional participations in these trials, while Cape Verde and Sao Tome and Principe have participated only more recently in international clinical trials (CTs).

Table 12. Number of participant countries in international clinical trials with PALOP (2008-2020).

	1	2-3	4-9	10-99	>99	Average Number of Countries	Total
Mozambique	33	10	38	43	11	27.4	135
Guinea-Bissau	34	0	4	4	11	49.3	53
Angola	7	0	2	7	12	100.9	28
Cape Verde	1	0	0	2	11	180.4	14
Sao Tome and Principe	1	0	0	0	11	203.5	12

Source: ICTRP (data downloaded in May 2022).

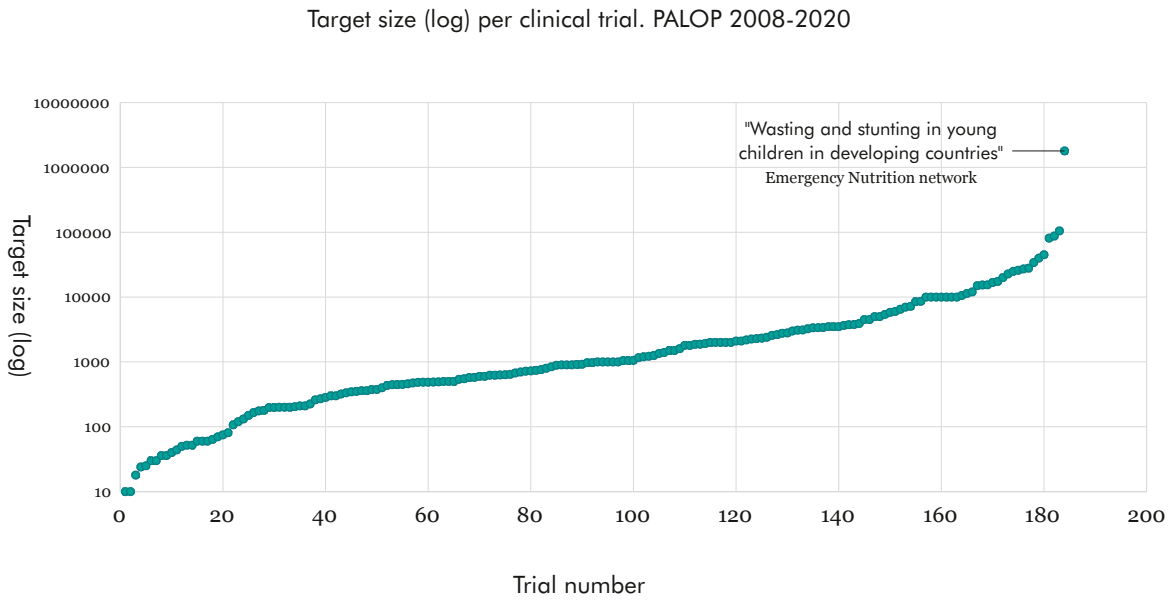

Figure 11. Distribution of international clinical trials with PALOP per target size (2008-2020).

Source: ICTRP (data downloaded in May 2022).

Beyond the different types of clinical trials (interventional or observational), the international clinical trials can also be differentiated with regards to their size, namely with reference to the number of countries involved, from where patients are recruited, as well as from the target number of cases to be recruited. As Table 12 shows both Cape Verde and Sao Tome and Principe were involved mainly in large scale clinical trials, which involved over 100 countries, including the other PALOP. On the contrary Guinea--Bissau and Mozambique were involved in many clinical trials developed only in its

borders, demonstrating already some autonomy to develop clinical trials independently. However, these two countries have different profiles. While on Guinea-Bissau more than half of total clinical trials were developed exclusively locally, in Mozambique these single country trials only represent around 25% of the total and 40% involve 10 countries or more. Angola has seen a more balanced participation across the different scales of trials, being solely responsible already for 7 clinical trials.

As to the target of patients involvement, the majority of the clinical trials registered in ICTRP with PALOP participation targeted less than 1000 patients while about 20% targeted 10.000 or more patient involvement. While the clinical trials with the participation of Cape Verde or Sao Tome and Principe typically involved over 1000 target patients, some 2/3 of the trials involving Mozambique were targeted at less than 1000 patients, also reflecting the importance of the international dimension mentioned above.

Table 13. Distribution of international clinical trials with PALOP per disease (2008-2020).

Main conditions	Malaria	HIV/AIDS	Maternal and child health*	Tuberculosis	COVID-19	Cardiovascular conditions*
Mozambique	29	36	8	20	14	13
Guinea-Bissau	7	2	14	2	6	2
Angola	1	0	1	0	3	4
Cape Verde	0	0	0	0	4	2
Sao Tome and Principe	1	0	0	0	3	2
PALOP trials	38	38	24	22	16	15
PALOP share	19.5%	19.5%	12.3%	11.3%	8.2%	7.7%

Source: ICTRP (data downloaded in May 2022).
Note: "Maternal and child health" includes conditions such as infant/child mortality, paediatrics, pregnancy and maternal health. "Cardiovascular conditions" include diseases such as heart failure, high blood pressure and cardiovascular diseases.

One of the characteristics of the large international clinical trials is that these are increasingly developed in lower-income countries, partly in response to the reduced costs associated with developing the clinical trials in these countries, and party related to the fact that there is a clear need to address the local burden of disease (Devasenapathy, 2009). While the importance of the financial factor often leads to the development of large scale clinical trials, identified above, led by researchers in the most developed countries, often in asymmetric collaborative relationships, the need to address the local disease burden is, nonetheless, increasingly relevant, as evident from the figures in Table 13. The four most targeted conditions (malaria, HIV/AIDS, maternal and child health and tuberculosis) are of great concern in local communities and are the main examples of the disease burden in the Global South, in particular in Africa. These targets are also well aligned with the most researched topics in PALOP, as reflected in the publication topics identified in Tables 5 and 6, in section 5.2. The cases of COVID-19 and cardiovascular conditions differ partly from the specific local disease incidence, being conditions of significant incidence in the higher income nations, but reflect the global distribution of the large scale international trials, as identified above. They reflect,

nonetheless, diseases of relevant concern in the local health systems, and potentially benefitting local populations in this regard. Surprisingly, none of the 13 clinical trials in Cape Verde is related to the most topical conditions in PALOP.

Table 14. Main sponsors of international clinical trials with PALOP (2008-2020).

Main Sponsor	Total
Bandim Health Project	29
European and Developing Countries Clinical Trials Partnership (EDCTP)	14
Centro de Investigacao em Saude de Manhica (CISM)	8
Instituto Nacional de Saude (INS)	7
Institut National de la Santé Et de la Recherche Médicale	6
United States Agency for International Development (USAID)	6
Bill & Melinda Gates Foundation	6
Janssen Vaccines & Prevention B.V.	6
Ministry of Health	6
Statens Serum Institut	5
World Health Organization (WHO)	5
Medicines for Malaria Venture (MMV)	5
Barcelona Institute for Global Health ISGlobal	5
Fundação Calouste Gulbenkian	3*

Source: ICTRP (data downloaded in May 2022).
Note: "Maternal and child health" includes conditions such as infant/child mortality, paediatrics, pregnancy and maternal health. "Cardiovascular conditions" include diseases such as heart failure, high blood pressure and cardiovascular diseases.
Note: 8 other organisations sponsoring 4 clinical trials and other 9 sponsoring 3 clinical trials are not included in this table.

Table 14 presents the main sponsoring organisations of clinical trials involving PALOP. It should be noted that the information on sponsors correspond to a mix of funding sponsors as well as organizational sponsors. It is in this context that the major sponsor is by far the Bandim Health Project, in Guinea-Bissau, which represents around 50% of all clinical trials in Guinea-Bissau. Not unexpectedly, the European and Developing Countries Clinical Trials Partnership (EDCTP) emerges as the second highest sponsor of these clinical trials. It is also noteworthy the significant activity by CISM, in Mozambique, in promoting clinical trials. In fact, as will be seen on the next section, CISM has been the most successful organisation among the PALOP in applying for EDCTP Competitive Funds.

7.2. The European & Development Countries Clinial Trials Partnership (EDCTP)

In 2003, the EDCTP was set up as a partnership promoted by 14 European and 18 African countries, and supported by the European Union. The EDCTP identifies its vision "to reduce the individual, social and economic burden of poverty-related infectious diseases in sub-Saharan Africa, by supporting collaborative research to develop accessible, suitable and affordable medical interventions" (EDCTP website). It promotes this vision through a number of different actions which "accelerate the development of new or improved medical interventions for the identification, treatment and prevention of poverty-related infectious diseases, including emerging and re-emerging diseases in sub-Saharan Africa, through all phases of clinical trials, with emphasis on phase II and III trials" (EDCTP website). In addition to research and innovation actions (RIA), the EDCTP includes two other main types of actions. The coordinating and support actions (CSA) contribute to enhance the research capacity in the countries and institutions in Africa, including both the physical infrastructure as well as the supporting infrastructure, such as regulatory/legislative or normative/ethical procedures that support research activity. The training and mobility actions or fellowships (TMA) includes fellowships for researchers at different steps of their careers, from the initiating period, with Preparatory Fellowships, up to Senior Fellowships. Considering the rationale of the EU-Africa partnership, EDCTP has also promoted Collaborative Mentorship Fellowships to promote global forms of training. As EDCTP presents, it focuses its activity on supporting people, processes and physical infrastructure, providing conditions for the training and development of future leaders, the development of new knowledge on medical interventions and the overall conditions that structure the well functioning of the system and the appropriate use and application of new knowledge. It addresses all major diseases prevalent in Sub-Saharan Africa.

Following its start in 2003, the EDCTP has seen the partnership renewed in 2014 for a second programme. So far, in both programmes, EDCTP has supported 435 projects, of which 90 have been CSA, 140 RIA, and 205 TMA. The five countries under study here have been involved in a total of 9 CSA, 25 RIA and only 3 TMA, very recently. Table 15 presents a summary of the participation of PALOP in the different EDCTP programmes.

As the data above makes clear, Mozambique is particularly successful, among the PALOP, in applying to the highly competitive calls run by the EDCTP. In particular, the Manhiça Health Research Centre (CISM), through its hosting organization, the Fundação Manhiça, has been particularly successful in guaranteeing the coordination of 8 projects, among the three typologies. But also in Mozambique the National Institute of Health (INS) has also achieved an important level of participation, in some cases in joint projects with CISM, that guarantee an increasingly relevant and international research activity in the health sciences. All the PALOP countries have been involved in at least one EDCTP project.

It is relevant to highlight that among the Coordination and Support Actions, there are a number of actions which can have an important wider impact in the structuring of the local clinical research capacity. The Trials of Excellence in Southern Africa (TESA) consortium was setup during "the first programme of EDCTP with the objective of creating

a framework for collaboration, capacity building and training among 9 institutions from 6 different Southern African countries" (EDCTP project portal). While no PALOP institution was involved then, it continued during the second phase of EDCTP, under the coordination of CISM and engaging also the participation of the National Institute of Health Research in Angola, to establish three specific referral laboratories, one of which precisely in Mozambique, at CISM, on malaria. Involving a training and exchange dimension, it expects to also contribute to provide conditions to retain talented researchers and to hence limit 'brain drain', an issue of particular concern in the region (Beaudry *et al.*, 2018). The TESA initiative has continued along two main streams, which reflect important approaches in the capacitation of health sciences and clinical research in the PALOP, and in Africa more generally. On the one hand, a new project under the third wave of the consortium aims to deepen the capacity of the reference infrastructures that were earlier established, namely through a reference data center at CISM. Building on the strength of the consortium, the network is also investing significantly on its own training programme, namely through partnering initiatives between the more and the less developed research sites involved. On the other hand, other TESA projects focus on supporting infrastructures and practices that are important to provide the appropriate logistic and organizational conditions for the virtuous growth of the institutions and of the nurturing of the appropriate research culture. In this vein, two other projects by the TESA consortium include participation from PALOP and address the accreditation of a Reference Data Management Center, at CISM, and the gender and diversity regional gaps in clinical research capacity, also coordinated by CISM.

It is noteworthy that these structural issues are taken on as central, early on in the development of these research systems, and considered at a par with the specific scientific competence related to clinical research. While the existence of a local critical mass is central to the enhancement of a culture of research excellence, building on questioning and learning, and which provides the conditions to be competitive in international programmes, such objective needs to go hand in hand with the nurturing of internal diversity, namely regarding gender, that fosters critical approaches, as well as the concern for territorial distribution of competences. As was also mentioned with regards to CISM strategy, the extension of the laboratory beyond the local community of Manhiça is important to create better conditions not only for the flourishing of future similar centres and capabilities, but also for the attraction of young kids to graduate education and to STEM areas. Such strategies have to be developed in a balanced and cautious way, to guarantee that the competences that have been developed are not made fragile but rather that a strategy of national partering provides the appropriate mentorship in other parts of the country.

One other structural competence that EDCTP have been supporting in the Lusophone countries in Africa is that of bioethics. This is an essential capacity that not only needs to be cared for, to guarantee appropriate capabilities to participate in international consortia, but also needs to be reflected upon locally and adapted to specific contexts and actors. As was mentioned in an interview, national governments feel they cannot open the door to international clinical trials without having the necessary regulatory conditions defined, which not only lay on bioethical opinions, but which will require the establishment of appropriate institutions which act swiftly in supporting promising research or in raising

questions and requirements to guarantee that procedures are appropriate and that the quest for new knowledge is not taking over the rights of the citizens, who often will be less versed on the technicalities of clinical trials procedures and less aware of its impacts, if not informed appropriately. These discussions are aggregating a consortium of Portuguese-speaking partners.

Table 15. Distribution of participation of PALOP in EDCTP actions.

Type of Actions	Angola	Cape Verde	Guinea-Bissau	Mozambique	Sao Tome and Principe
Coordination & Support Actions (CSAs)	5	3	3	8	1
Research and Innovation Actions (RIAs)		1	1	26	
Training and Mobility Actions or Fellowships (TMAs)			1	2	
Project Coordination			1	10	
Condition/Capacity Targeted					
TB	2	1	3	13	
HIV/AIDS	2		1	10	
Malaria	2		1	8	
Maternal and infant health				11	
Toxicology				1	
Leprosy				1	
Other respiratory diseases				2	
COVID-19		1	1	5	
Bioethics	2	2	1	2	1
Epidemiology	1	1	1	1	
Clinical research capacity				1	
Data management				1	

Source: Information provided by EDCTP; data analysed by the authors.

8. The need to strengthen a culture of research

It is clear from the interviews developed and wider information available that one of the main challenges facing these countries is related to the institutionalization of a culture of research. We can understand a 'culture of research' in two main dimensions.

Firstly, from an internalist perspective, we can associate the development of a 'culture of research' to the different practices, materials and ways of thought that characterize and embed the activity of research. Considering that a research centre like CISM, in Mozambique, has 1200 collaborators, among research, administrative, medical and fieldworking staff, there have to be a number of procedures in place that guarantee a shared approach to its different activities that have at the centre their contribution to the quality and credibility of the research outputs. But these different practices are not necessarily managerial, but have much to do with an understanding of the practice of science, that need to guarantee quality and the openness to critique through a responsible and ethical framework. For such a culture to emerge it has be a part of the overall culture of the research institution, and it takes time to build, through training, learning and exchange.

Secondly, from an externalist perspective, there is a culture of research as seen from actors not dedicated to research activities and who recognize a particular value to those research activities. Such valorization can, in sequence, lead to different forms of recognition for such value, developing distinct practices which also embed a culture of research in external stakeholders. This is particularly relevant with regard to government action, but addresses also such culture in other actors, such as the health sector, higher education, public administration and civil society at large.

In mentioning a culture of research and internalist/externalist perspectives it is important to note that this does not correspond to placing research on a pedestal, guaranteeing appropriate practices from the inside and being highly valued from the outside. This also means that those internal practices also have to do with how research relates to and involves other actors in a form of coproduction which, by such process, also shapes the culture of research throughout society. Additionally, it is important to note also that such process of coproduction does correspond to the spread of research as the dominant mode of knowledge throughout society. On the contrary, such coproduction highlights how research is deeply intertwined with different modes and practices of knowledge – be these medical, legal, indigenous – with which it enters into dialogue. Such mutual recognition is important to shape the wider culture of research and the societal impact of the research activities.

As one researcher interviewed stated: "I think there are several barriers [to the development of research in the country]. One of these is that we are still developing a research culture. There is already a lot of talk, but we are still missing the bases to develop research in a more effective way."

8.1. An internalist approach: Strengthening a research culture

In different countries, including the countries analysed here, there are three main organizational settings where research in the health sciences is developed: the national institutes of health, universities, hospitals and independent research institutes dedicated to health research. National institutes of health have a particular responsibility in the provision of support to public health policies and in initiatives of diagnosing and controlling the spread of diseases. Although not directly oriented towards research, they gather relevant human resource capabilities in the health sciences, articulate international health policies and follow the development of diseases in the countries. As such they become an important actor in research, with strong access to trained people, to institutional resources, to biological materials and to patients. Similarly, hospitals have an important link to the research process in public health in these countries. Although medical doctors may be more or less inclined to collaborate in research, research is a clear source of knowledge and the medical profession faces high numbers of cases that can be followed, often voicing the views of the patients. While universities may appear to more easily embody the culture of research, the main function of the universities remains that of training. And while research has been strengthening in universities, these may face different issues of access to laboratory infrastructure or to clinical knowledge.

But it is the independent research institutes that seem to be the central nodes of the system in these countries. These independent research institutes that have been developed in these countries are dedicated to research, institutionally, and sharing personnel through different forms of collaboration with other institutions. In Mozambique, with the Manhiça Health Research Centre (CISM – Centro de Investigação em Saúde de Manhiça), in Guinea-Bissau, with the Bandim Health Research Project, and in Angola, with the Angola Health Research Centre, in Caxito (CISA – Centro de Investigação em Saúde de Angola), are creating an internal research culture which is distinctive in its own right, in countries where research is still a marginal enterprise, and that, to a greater or lesser extent, is coproducing new research directions with different societal partners.

The existence of dedicated research institutes facilitates the emergence of complementary capabilities directly applied and essential to support the research activity and the interaction with external actors. Capabilities such as those of research management, financial accounting and financial planning, support to funding applications (both in structure and substance of proposals as well as in budgeting and applicable rules), regulatory processes, institutional support or science communication are increasingly important elements of the research enterprise for which specialised knowledge makes a significant difference. As one researcher mentioned, “we are still developing a culture of research”, noting that the issue is not about the laboratory infrastructure, but rather about the “how”, how to develop research, how to involve students, about gathering support in data analysis or in grant applications.

Across the interviews it was clear that the human resources, and the training of young researchers, are seen as central to the dynamics of the research activity. The process of training is not only about the technical capability to develop the research, which is of course essential, but also about the nurturing of a research culture, that, on the one hand, enables the development of research according to principles that reflect the local research culture – for example, that values research that is impactful in the local communities and also scientifically valid and innovative – and, on the other hand, is inspirational for young researchers – valuing mentorship, dialogue and international membership. But advanced human resources are not easy to retain, creating important challenges to institutional development. With external factors creating significant incentives towards alternative careers – in medical practice or with international NGOs – it is up to the development of appropriate internal incentives that such challenge needs mostly to be addressed. As such, the issue of research careers has become topical across different systems. While previously research was mostly a second affiliation, now, with dedicated researchers, alternative careers have to be devised that are attractive to the autonomous researchers. This emerged clearly as a central issue.

At the level of research institutes, with low numbers of internal research staff, the development of research careers is still at its early stages. This is, however, crucial for the ability of the systems to attract and retain the most talented researchers who train abroad and may be attracted to develop their research careers in other countries or who may be tempted by the private health sector with higher salaries and overall conditions. Without financially attractive conditions researchers stay because of their interest in research, their contribution to local capacity building and their contribution to the improvements of health and well-being of the population. But for that to happen, the institutions have to guarantee that there is a strong culture of research, that provides conditions for the development of valuable and competitive research.

In this process, it is important that the risks of the excessive quantification of research assessment do not contaminate local research cultures in the same way that others are trying to overcome it.[27]

8.2. An externalist approach: Strengthening the support to research

As mentioned above, one researcher identified specifically the importance of research culture, and noted that the talk about the importance of research is becoming more common, namely among political and academic leaders. For example, in Mozambique there is an objective to make the main university, the University Eduardo Mondlane, a research university. It is clear that there is a big ambition in that purpose, and that much remains to be done, but stating such objective is, necessarily, an important step in that direction. But what might that imply, from an organizational point of view?

[27] To be noted that in this report the emphasis is not on the individual quantitative performance as it is on the aggregate growth in research activity, which reflects the accumulation of competences, the development of the necessary critical mass, and the internationalization process.

Such objective of placing research at the centre of the university mission, in parallel with the education mission which is a primary objective of the university, requires that the importance and the impacts on research of different organizational strategies and decisions is considered at the different decision-making steps. There is, of course, an important constraint regarding budgetary issues, in countries, such as Mozambique, with low levels of economic development. But the challenge is to value the importance of research, supporting research activity and recognizing the results of research, at different levels of the organization.

There is a clear need of articulation between the state administration and the research and higher education organisations in this regard. The structure of public academic careers and their funding depend on governmental decisions. But universities have an important say in the definition of the incentives structuring careers and career progression. The extent to which research activity is recognized as an important dimension of assessment, and how it influences career progression, what in particular is valued, depends on organizational processes. There is a path to be walked through in this process, but it is important that organisations can value particularly impactful contributions, and particularly active researchers, and that there are strong incentives for an upgrade of objectives. As it is, it seems that the success in research may not be fully reflected in career progression in universities, which then does not work as an incentive for a strong, but demanding, research activity.

But other dimensions go well beyond research careers and budgetary conditions. In health sciences research in these countries, there is a clear experience of inter-institutional collaboration, across organizational types. Hospitals, universities, research institutes and the public health institutes often collaborate in different configurations. The specific conditions that enable these collaborations may not always be in place in other contexts. Also, the extent to which public administration supports evidence-based research, promoting wider articulation between public policy and research, namely outside of the public institutes, characterises that external research culture. Despite the existence of research collaboration, that may not reflect necessarily science-policy articulation. As one researcher said: “Our connection to the Health Ministry goes very much through the [public health institute]. So, there are no direct demands [for research in our institute]; there are talks about what could be interesting in terms of projects and research. But not direct demands from the Ministry.”

So, how can we characterize the research culture among the government? That is also partly what we can consider as the external research culture. One that supports politically, that supports in action, that supports institutionally, that supports in funding, or one that does not place science and research in health sciences among its priorities? While wider policy objectives may be more clear but of difficult implementation, other administrative procedures may be more invisible but have strong impacts and reflect a weak understanding of the research process. The extent to which administrative procedures, such as public procurement policies, hinder or enhance research is a case at hand. It is certainly difficult to argue for exemptions for the research sector, but if the difficulties imposed appear to be too large there is a need to extend that understanding of research to wider government departments.

The interviews also made clear that the external research culture is particularly important among local communities. Some of these research institutes, in particular those independent research institutes, have been able to develop relationships with local communities that are built on research practice and that extend a culture of research towards the wider community. The participation in trials, the following up of clinical cases, the implementation of research protocols, all gain from such links and, at the same time, build trust among the communities. These processes are an important part of the research culture.

8.3. The intermediating support infrastructure

It must be clear that there is no clear boundary between what we are considering here as internal and external research cultures. These are co-produced and both affect and are affected by the other perspective. Nevertheless, an important part of the research organisation lays precisely on the infrastructure that supports those intermediation processes.

These can be the project proposals to apply for external funding, the health research communication initiatives, or the laboratory infrastructure that is shared between different collaborating organisations. The extent to which the external and the internal weave more or less seamlessly together often depends on the technical competence of those supporting these processes. In this sense, the support infrastructure of staff that provide project management support, funding application support, the management of shared laboratory resources, science communication activities, or intermediation with policy actors, are important pillars of dissemination and co-production of different cultures of research and of their ability to develop and strengthen the research activity. For example, without appropriate support, “English is also a barrier to write projects, make presentations, write articles.” It is through the wider research support that different cultures of research are more easily able to meet productively.

9. Conclusions and Recommendations

Health research performed in the PALOP can play an important role in creating the capabilities, human capital and solutions necessary to solve the often unique health challenges in these countries. This report aimed to map the research activities in health sciences from the PALOP with the overall objective of supporting the research funding strategies of different actors, including international funding organizations and local actors. In the following we identify central conclusions of the report and related recommendations. While some recommendations may suggest the intervention of particular actors, the recommendations have been developed considering their potential relevance for the different actors of the system.

Limited research production in PALOP, but expanding and open to the world, showing relative high citation impact

We found that although the internationally published research output of PALOP researchers is still limited, the research output from these countries is relatively specialised in health sciences and their global research share is increasing. PALOP research systems are significantly open to the world, with a very large share of the publications developed in international collaboration with international funding. Mozambique (which comprises around 70% of all PALOP research) and Guinea-Bissau research production displays a relative high citation impact, but which is led (corresponding author) mostly by authors affiliated to foreign institutions.

Recommendation – Acknowledging the high quality of the research output there is a relevant potential for growth if further financial resources are allocated with appropriate instruments and if institutions (including Universities) value researchers publication output in their career structures without falling prey to using bibliometrics as the single most important criteria.

Research specialisation generally aligned with disease areas in which PALOP have a higher burden

The most prolific research areas in all PALOP are Malaria, HIV, Maternal Mortality, Tuberculosis and Measles, which tend to be aligned with the areas in which these countries have higher disease burden in relation to the world average. In Angola, there is a strong specialisation (>15% of their total output) in ‘Malaria’ related research, and in Guinea-Bissau in ‘Measles’ and ‘HIV’. We also identified that in Mozambique and Guinea-Bissau the research done in these areas receives more citations than the world average, which arguably derives from those few researchers collaborating very often with highly reputed international co-authors that are part of large research projects. This specialisation is strengthened by the articulation of the research organisations with the health sector, further promoting its local impact.

Recommendation – A travelling exhibition on the links between local research specialization and the disease areas with a local higher burden can contribute to show the impact of research and attract younger talent.

Countries have distinct main partner countries, with few intra-PALOP research collaborations

We find that the collaboration patterns of PALOP institutions are different depending on each country. Mozambique tends to collaborate more often with the USA and Spanish partners, Angola, Cape Verde and Sao Tome and Principe with Portuguese partners, Guinea-Bissau with Danish partners. We find that there are very few intra-PALOP collaborations and that the only institutions that collaborate with institutions from more than two PALOP countries are from Portugal (Univ Lisboa, Univ Nova Lisboa, Univ Porto), UK (Univ London) and multilateral (WHO).

Recommendation – The support to exchange and mentoring programmes between PALOP countries could strengthen institutional development, by sharing common difficulties and responses, and create conditions to increase collaborative research between these countries and promote research leadership.

Large diversity of research funders which often support specific areas with multiple funding partners

We also analysed the major funders identified in the PALOP publications, and their specialisation and co-funding patterns. There are three main funders (National Institutes of Health (NIH), Bill and Melinda Gates Foundation and the European Commission) which support between 12% and 13% of all funded research in these countries. We also identify strong co-funding patterns between institutions that belong to the same countries. For example, Danish institutions (DANIDA, Danish NRF, Novo Nordisk) are acknowledged in most (~50%) publications together, and Spanish institutions (Carlos III, AECID and Spanish Ministries) also tend to co-fund together very often. The European Research Council (ERC) and European Commission (EC) are strong co-funders with both Danish and Spanish institutions. US institutions (USAID, CDC, NIH) also tend to co-fund substantially together, but less so than Spanish or Danish institutions. We also identified strong co-funding patterns between Calouste Gulbenkian Foundation, Camões Institute and institutions from the Government of Angola in specific research topics. In general, we find that co-funding patterns mirror the specialisation patterns of specific funders. Meaning that when we observe that a group of funders is specialised in one topic, it usually co-funds more often with other funders that are also specialised in that topic. On the other hand, research funders that tend to be less specialised, also tend to co-fund less often.

Recommendation – Considering the high-level of co-funding, a regular meeting (e.g. every 3 years) of research funding agencies in the health sciences in these countries could contribute to better coordinate funding support measures.

Continued co-funding activity appears to be central to sustain research organisations

The existence of strong co-funding patterns between different funding organisations highlight that the funding activity cannot be seen as simply the result of individual organisational strategy, but rather has to be understood in the context of the action of a wider set of funding organisations. In some cases there is a clear collective action of different funding organisations that provide conditions of sustainability and consolidation to research organisations in these countries, involving some form of coordination with the local government. In other cases the co-funding patterns may be the result of distinct funding initiatives which, when brought together at the institutional level, provide funding complementarities to respond to funding uncertainties. Overall, the existence of some form of consistent funding support is essential to the organisational strengthening and sustainability.

Recommendation – Funding strategies should consider the balance between competitive funding and institutional funding; while the former provides incentives to improve research quality and international competitiveness, the latter is essential for a sustainable institutional development. Research culture is built on both models.

Organisational diversity is important for the development of locally relevant research in the health sciences

The heterogeneity of the institutional research landscape is characteristic of these research systems, emulating other international experiences. While higher education institutions have an important role in research, which is of great benefit to the higher education these provide, in the health sciences the public sector health system is particularly active in research. Necessarily, public hospitals deal with the concrete local health conditions, receive and treat patients, and diagnose diseases. Such processes are integral to much research which is clinically based and hence involves medical experts and their institutions of affiliation. Public health institutes also have relevant research activity in this domain. In addition, independent health research institutes were set up in some countries, with increased autonomy, facilitating decision-making processes and supporting dedicated cultures of research.

Recommendation – Initiatives that support organizational diversity, including independent research institutes, provide the conditions for the emergence of distinct research cultures, supporting different functions in the system. The support to inter--institutional research collaboration is important in this regard. Support to shared technological core facilities could promote collaboration and appropriate use of resources.

Research systems are still in the process of development

While research performing organisations have been progressively strengthened, increasing scientific outputs and impacts, at the system level, there are still some institutional building blocks largely in the process of development. In particular Science Granting Councils (SGC) and R&D statistics and indicators systems are at different levels of development across the studied countries and are important elements establishing the political support to research. SGC are central to promote a research culture, by supporting research through open calls, on the basis of quality and/or impact criteria. R&D statistics and indicators provide not only conditions of monitoring the system, namely at the overall system level, but also provide greater visibility to the system. These countries still lack significant capabilities in this regard.

Recommendation – Training to local staff and procedures to support the strengthening of SGCs and of R&D statistics should be promoted.

A strong research culture in the research organisations promotes competitiveness in external funding

While research organisations in Mozambique, led by the dynamism of CISM and INS, have seen relevant growth in success in international funding applications, other PALOP countries have been less successful in doing so. External funding is of particular importance in view of the limited national resources for research. However, the success in competitive funding is strongly dependent on the strengthening of a research culture and of the related research support capabilities. While scientific publications and research mobility, through the scientific and institutional learning these provide, are important tools to strengthen a research culture, the wider institutional capacity is central to support the ability to apply to external funding. The common language in these countries is also a common challenge in this regard, for which there are opportunities for shared learning.

Recommendation – Training courses in support of scientific writing, proposal writing (with an emphasis on English writing) or research management are important to improve the capabilities for successful external funding applications, including support for the institutional development of open access practices should be developed. Institutional support should also consider the hiring of technical support staff.

Qualified human resources are of central importance but difficult to retain

The activity of research has a very valuable by-product: the advanced training of younger researchers. In economies with low levels of qualification research training is a very valuable asset, for the individual, for the research institution and for the country. While there is an appropriate supply of motivated students, and conditions to train a relevant number through research, namely including international exchanges (e.g. CISM has 24 PhD students, only half of those Mozambican), it is often difficult to retain younger researchers. Private practice in the health sector and international NGOs provide more attractive financial rewards. Nevertheless, research often provides a much higher individual motivation. But this is increasingly not enough. The prospects of research careers in science need to be consolidated. This is an important discussion in different countries. Again, independent research institutes may have some greater flexibility in this regard, and career structures and career development emerge as central concerns.

Recommendation – Initiatives to develop research career structures should be developed, complemented with support to short-term international mobility for advanced training.

Science communication is important to guarantee wider support and provide conditions of stability

Research organisations in health sciences have a wide variety of actors with whom to interact. These include local communities, public health professionals, public decision--makers in health and in science and technology. While these interactions vary widely in type, the success in those external contacts depend both on internal capacities and on the value attributed to research in society. The importance of appropriate communication activities, often not costly, contribute to engage local communities in support to the research being developed, promoting a wider culture of research, and contribute to more successful engagement in public health measures and corresponding research. The support of local communities provides both a justification for the research developed and stable conditions for the development of research.

Recommendation – Initiatives of community engagement with the research institutions, that go beyond the specific involvement with the research, are important to guarantee local support, local impact and local dialogue. An example could be the engagement of high school students with health sciences research, which has already been developed. Training in science communication can also be considered.

A wider research culture can support stronger articulation between health decision--makers and research leaders as well as increased financial support

African countries have pledged to reach 1% of GDP invested in R&D activities by 2030. There is still a long way to go to reach that target, but it already reflects a commitment of support towards research and innovation. And while the financial support is of essence for the overall stability of research institutions, support can also be reflected in stronger evidence-based health policies, which tap into research organisations and their scientists. In that sense, the articulation between the different organisational research models – universities, research institutes, public health institutes and hospitals – has been, and will continue to be, central to the development of new research projects and to their impact. This can contribute to strengthen political support for research.

Recommendation – The existence of Advisory Councils, either at the level of government or at the level of research institutions, crossing institutional (e.g. involving researchers in advisory roles to government or public decision-makers in Advisory Councils for research institutions) and international boundaries, should be promoted.

Research needs to be timely and to have procedures which are swift and responsive

Several researchers noted that some legislation and administrative practices create significant burden on research, and may hinder the participation in international research projects or the organisation of international clinical trials, for example. Public procurement policies require procedural guarantees of competition policy that often make it difficult for the timely development of research, as several lengthy procedural steps must be guaranteed. Ethics review processes can also take a significant amount of time (partly unnecessarily) which often delays the research. In other cases, it is the absence of ethical reviews that impedes the participation in specific international clinical trials. Other bureaucratic steps may also create additional difficulties. Certainly researchers have to adapt to practices that are well established and seek to protect economic conditions and citizen's rights, but a more proper balance between the two dimensions, of protection of citizens rights and the promotion of research, might be achievable, considering international standards and guaranteeing simplified accountability mechanisms.

Recommendation – A review of procedures that hinder the research process could lead to improvements in this process, facilitating the participation in international research programs and projects.

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Appendix

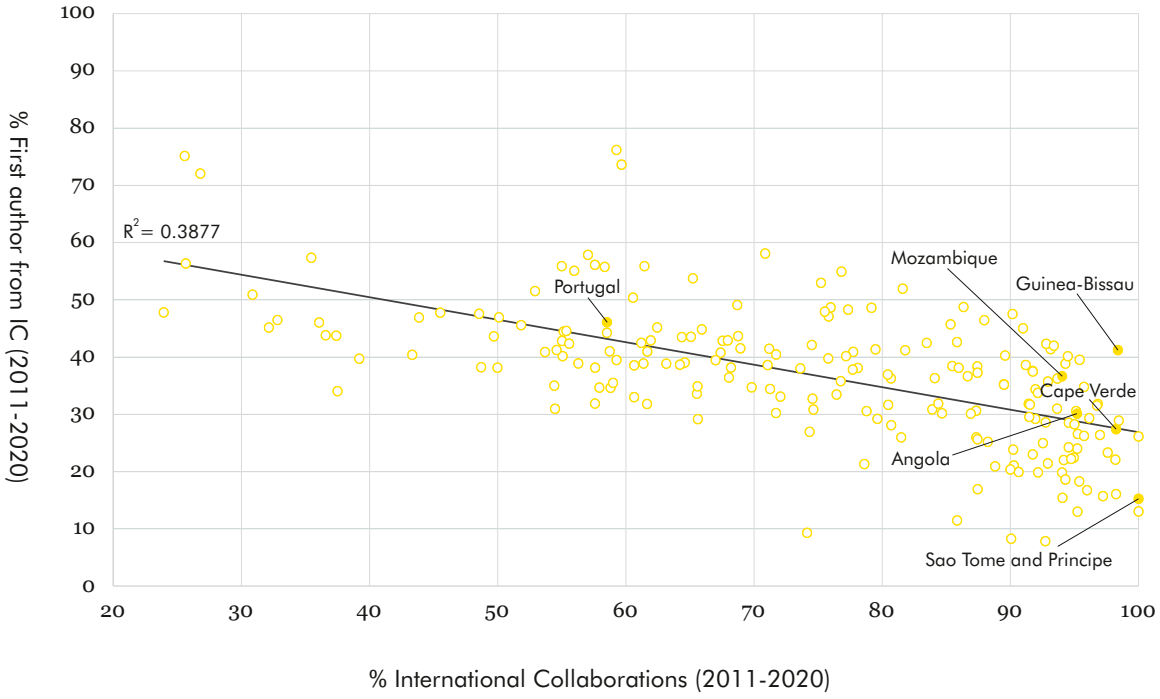

Figure A.1. % int. collaborations vs % int. collaborations with 1st author from country.

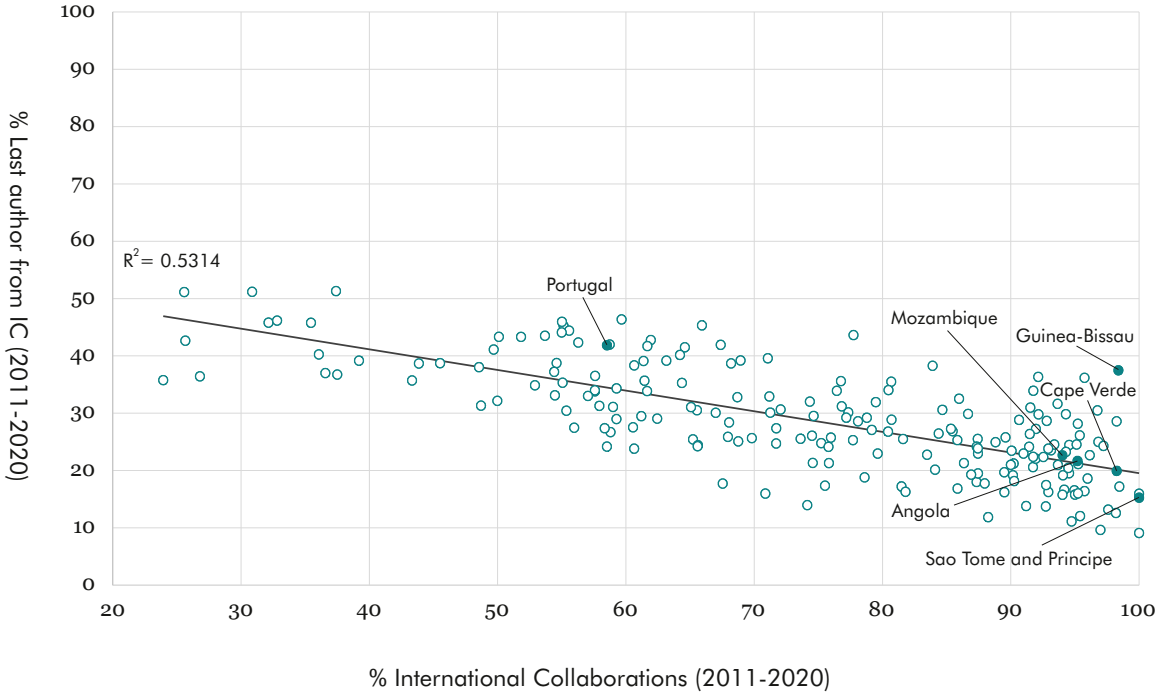

Figure A.2 % int. collaborations vs % int. collaborations with last author from country.

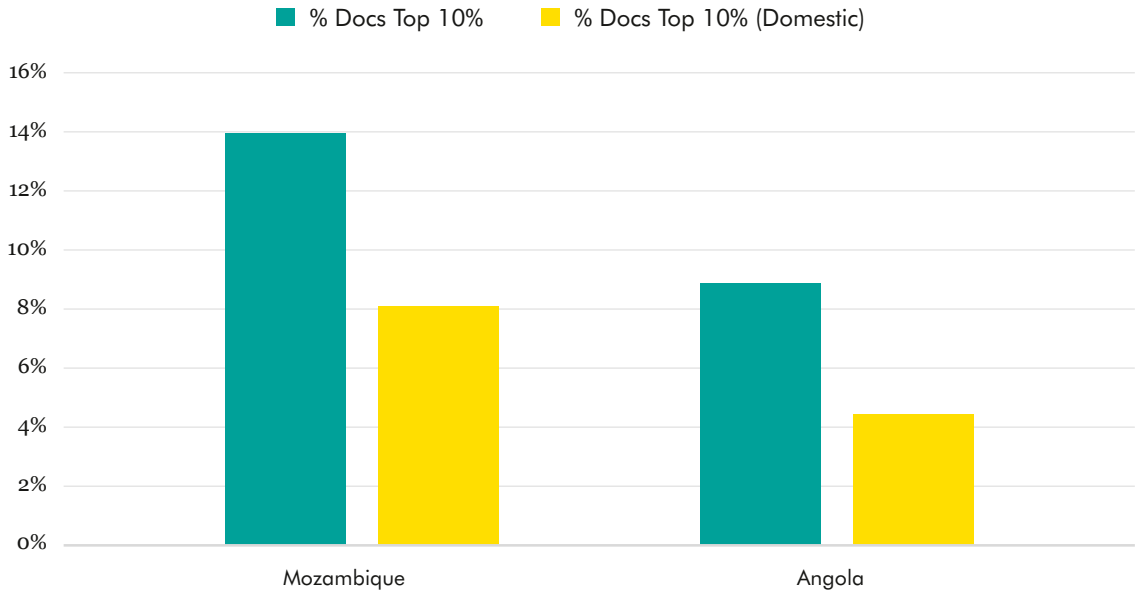

Figure A.3. '% Docs Top 10% highly cited publications in Mozambique and Angola (total vs domestic only). 2008-2020.

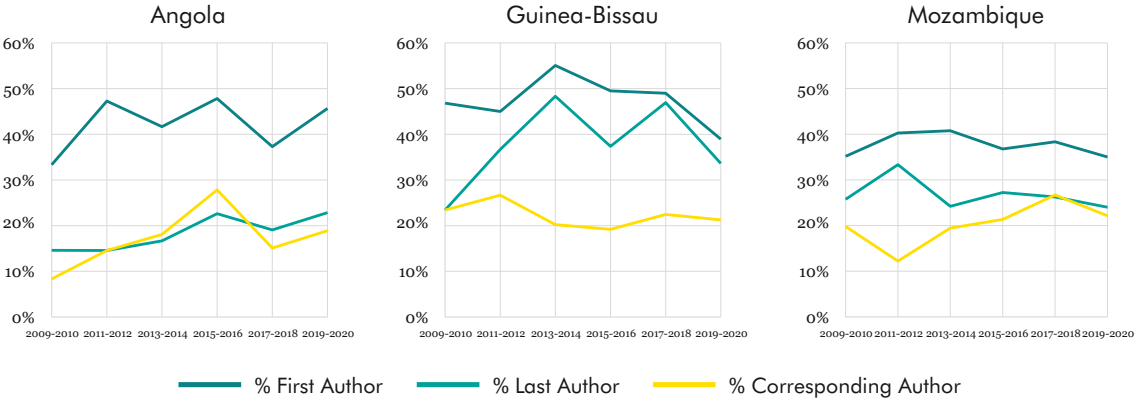

Figure A.4. Trends in share of first, last and corresponding author per PALOP country. 2009-2020.

Table A.1. Mozambique Top 20 Micro research topics. 2008-2020.

Micro Citation Topics	Docs	% Share	% Publications cited	% International Collaborations	% PPTop 10
1.217.59 MALARIA	368	15.1	93.8	96.5	13.9
1.66.11 HIV PREVALENCE & PROPHYLAXIS	323	13.2	89.5	95.7	10.5
1.156.381 MATERNAL MORTALITY	214	8.8	89.7	95.8	21.0
1.194.105 TUBERCULOSIS	114	4.7	85.1	99.1	13.2
1.55.197 HYPERTENSION	45	1.8	86.7	100.0	33.3
1.104.568 MEASLES	39	1.6	87.2	94.9	5.1
1.228.200 DENGUE	30	1.2	83.3	93.3	0.0
1.156.2047 GLOBAL SURGERY	29	1.2	79.3	100.0	17.2
1.23.1051 NECROTIZING FASCIITIS	29	1.2	89.7	75.9	34.5
1.42.853 VIBRIO CHOLERAE	29	1.2	96.6	96.6	10.3
1.44.1198 FOOD INSECURITY	29	1.2	82.8	89.7	0.0
1.104.975 RESPIRATORY SYNCYTIAL VIRUS	26	1.1	80.8	88.5	23.1
1.134.2010 VIRTOPSY	25	1.0	88.0	92.0	40.0
1.163.446 SCHISTOSOMIASIS	25	1.0	92.0	92.0	16.0
1.228.994 EBOLA VIRUS	25	1.0	96.0	100.0	8.0
1.261.596 TRYPANOSOMA CRUZI	25	1.0	100.0	96.0	16.0
1.23.347 STREPTOCOCCUS PNEUMONIAE	24	1.0	83.3	91.7	16.7
1.258.227 LYME DISEASE	24	1.0	87.5	100.0	0.0
1.44.103 PHYSICAL ACTIVITY	24	1.0	100.0	91.7	8.3
1.246.710 ROTAVIRUS	22	0.9	95.5	100.0	31.8

Source: WoS.

Table A.2. Angola Top 20 Micro research topics. 2008-2020.

Micro Citation Topics	Docs	% Share	% Publications cited	% International Collaborations	% PPTop 10
1.217.59 MALARIA	75	16.2	94.7	98.7	16.0
1.163.446 SCHISTOSOMIASIS	30	6.5	90.0	96.7	13.3
1.261.596 TRYPANOSOMA CRUZI	19	4.1	94.7	100.0	5.3
1.66.11 HIV PREVALENCE & PROPHYLAXIS	19	4.1	94.7	100.0	0.0
1.156.381 MATERNAL MORTALITY	16	3.4	87.5	93.8	37.5
1.194.105 TUBERCULOSIS	15	3.2	86.7	100.0	13.3
1.23.714 NEISSERIA MENINGITIDIS	14	3.0	92.9	92.9	7.1
1.55.197 HYPERTENSION	12	2.6	91.7	83.3	0.0
1.225.626 SICKLE CELL DISEASE	11	2.4	90.9	100.0	18.2
1.228.200 DENGUE	9	1.9	100.0	100.0	22.2
1.55.860 ARTERIAL STIFFNESS	8	1.7	87.5	100.0	0.0
1.258.227 LYME DISEASE	7	1.5	100.0	100.0	0.0
1.125.275 HBV	6	1.3	33.3	100.0	0.0
1.66.46 HIV-1	6	1.3	100.0	100.0	0.0
1.23.347 STREPTOCOCCUS PNEUMONIAE	5	1.1	80.0	100.0	20.0
1.246.710 ROTAVIRUS	5	1.1	100.0	100.0	0.0
1.37.309 CONGENITAL HEART DISEASE	5	1.1	80.0	60.0	0.0
1.128.482 CONTRACEPTION	4	0.9	75.0	100.0	0.0
1.189.310 ANCIENT DNA	4	0.9	100.0	100.0	0.0
1.37.164 AORTIC STENOSIS	4	0.9	75.0	75.0	0.0

Source: WoS.

Table A.3. Guinea-Bissau Top 20 Micro research topics. 2008-2020.

Micro Citation Topics	Docs	% Share	% Publications cited	% International Collaborations	% PPTop 10
1.104.568 MEASLES	129	26.1	87.6	98.4	22.5
1.66.46 HIV-1	54	10.9	98.1	100.0	5.6
1.194.105 TUBERCULOSIS	38	7.7	94.7	89.5	10.5
1.217.59 MALARIA	36	7.3	97.2	100.0	22.2
1.184.1245 IRON DEFICIENCY	32	6.5	90.6	100.0	15.6
1.66.11 HIV PREVALENCE & PROPHYLAXIS	20	4.0	85.0	100.0	5.0
1.156.381 MATERNAL MORTALITY	15	3.0	86.7	100.0	20.0
1.248.655 CHLAMYDIA TRACHOMATIS	12	2.4	100.0	100.0	16.7
1.66.1464 HTLV-1	12	2.4	91.7	100.0	0.0
1.194.273 MYCOBACTERIUM TUBERCULOSIS	11	2.2	90.9	100.0	0.0
1.42.376 SALMONELLA	11	2.2	100.0	100.0	36.4
1.189.455 GENOME-WIDE ASSOCIATION STUDIES	7	1.4	100.0	100.0	28.6
1.44.1198 FOOD INSECURITY	7	1.4	100.0	100.0	28.6
1.72.182 GESTATIONAL DIABETES MELLITUS	7	1.4	85.7	100.0	0.0
1.81.979 TWIN-TWIN TRANSFUSION SYNDROME	5	1.0	100.0	100.0	0.0
1.125.275 HBV	4	0.8	100.0	100.0	0.0
1.222.143 EPILEPSY	4	0.8	100.0	100.0	25.0
1.246.1380 MICROBIAL SOURCE TRACKING	4	0.8	100.0	100.0	0.0
1.163.446 SCHISTOSOMIASIS	3	0.6	66.7	100.0	0.0
1.228.994 EBOLA VIRUS	3	0.6	100.0	66.7	0.0

Source: WoS.

Table A.4. Cape Verde Top 20 Micro research topics. 2008-2020.

Micro Citation Topics	Docs	% Share	% Publications cited	% International Collaborations	% PPTop 10
1.228.200 DENGUE	10	11.2	90	100	0
1.217.59 MALARIA	7	7.9	71.42857	100	14.28571
1.273.1447 TELEMEDICINE	6	6.7	83.33333	100	16.66667
1.66.46 HIV-1	4	4.5	100	100	0
1.104.126 INFLUENZA	3	3.4	100	100	0
1.5.894 NICOTINE	3	3.4	66.66667	100	0
1.55.197 HYPERTENSION	3	3.4	66.66667	100	0
1.14.841 INTERNATIONAL MEDICAL GRADUATES	2	2.2	100	100	0
1.156.989 COMMUNITY-BASED PARTICIPATORY RESEARCH	2	2.2	100	100	0
1.252.74 SMOKING CESSATION	2	2.2	50	100	0
1.44.29 OBESITY	2	2.2	100	100	50
1.65.192 COPD	2	2.2	100	100	0
1.66.11 HIV PREVALENCE & PROPHYLAXIS	2	2.2	100	100	0
1.102.110 MESENCHYMAL STEM CELLS	1	1.1	100	0	0
1.104.1788 PARVOVIRUS B19	1	1.1	100	100	0
1.113.460 DIFFUSION TENSOR IMAGING	1	1.1	100	100	0
1.119.454 BREAST CANCER INCIDENCE	1	1.1	100	100	0
1.120.384 GUT MICROBIOTA	1	1.1	100	100	0
1.125.275 HBV	1	1.1	100	100	0
1.14.1115 READMISSION	1	1.1	100	100	0

Source: WoS.

Table A.5. Sao Tome and Principe Top 17 Micro research topics. 2008-2020.

Micro Citation Topics	Docs	% Share	% Publications cited	% International Collaborations	% PPTop 10
1.217.59 MALARIA	6	22.2	100	100	0
1.163.446 SCHISTOSOMIASIS	2	7.4	100	100	0
1.217.1038 TOXOPLASMA GONDII	2	7.4	100	100	50
1.252.74 SMOKING CESSATION	2	7.4	50	100	0
1.258.227 LYME DISEASE	2	7.4	50	100	0
1.55.197 HYPERTENSION	2	7.4	100	100	0
1.125.1718 HEPATITIS E VIRUS	1	3.7	100	100	0
1.125.275 HBV	1	3.7	0	100	0
1.148.94 CANDIDA ALBICANS	1	3.7	100	100	0
1.163.1393 ONCHOCERCIASIS	1	3.7	0	100	0
1.189.310 ANCIENT DNA	1	3.7	100	100	0
1.228.200 DENGUE	1	3.7	100	100	0
1.246.710 ROTAVIRUS	1	3.7	100	100	0
1.246.985 CRYPTOSPORIDIUM	1	3.7	100	100	0
1.258.2263 COXIELLA BURNETII	1	3.7	100	100	0
1.44.1198 FOOD INSECURITY	1	3.7	100	100	0
1.66.11 HIV PREVALENCE & PROPHYLAXIS	1	3.7	100	0	0

Source: WoS.

Table A.6. Mozambique Top research institutions.

Rank	Institution	% Publications	% Share	Organisation Type
1	Universidade Eduardo Mondlane	938	32.7%	Higher Education
2	CISM – Centro de Investigacao em Saude de Manhica	799	27.8%	Research Institute
3	Minist Hlth (MZ)	618	21.5%	Government
4	Inst Nacl Saude (MZ)	580	20.2%	Government
5	Cent Hosp Maputo	264	9.2%	Hospital
6	Universidade Pedagógica de Maputo	107	3.7%	Higher Education
7	CDC Mozambique	85	3.0%	Health
8	Catholic Univ Mozambique	63	2.2%	Higher Education
9	Friends Global Hlth	62	2.2%	Health
10	Beira Cent Hosp	60	2.1%	Hospital
11	Provincial Health Directorates	59	2.1%	Government
12	Hlth Alliance International	53	1.8%	Health
13	ICOR – Instituto de Coração	53	1.8%	Health
14	Medecins Sans Frontieres	35	1.2%	Health
15	Universidade Lúrio	31	1.1%	Higher Education
16	Clinton Hlth Access Initiat	30	1.0%	Health
17	Jhpiego Mozambique	30	1.0%	Health

Note: Only institutions with more than 1% are displayed in the table above.

Table A.7. Angola Top research institutions.

Rank	Institution	% Publications	% Share	Organisation Type
1	Univ Agostinho Neto	98	17.4%	Higher Education
2	Ministry of Health (AN)	97	17.2%	Government
3	CISA - Ctr Invest Saude Angola	67	11.9%	Research Institute
4	Hosp Pediat David Bernardino	55	9.8%	Hospital
5	Clin Girassol	27	4.8%	Health
6	Inst Nacl Invest Saude (AN)	26	4.6%	Government
7	Hosp Mil Principal	25	4.4%	Hospital
8	Clin Sagrada Esperanca	18	3.2%	Health
9	ICCT	18	3.2%	Health
10	Hosp Nossa Senhora da Paz	16	2.8%	Hospital
11	Univ Jose Eduardo dos Santos	13	2.3%	Higher Education
12	Hosp Amer Boavida	12	2.1%	Hospital
13	CDC	11	2.0%	Health
14	Hosp Divina Providencia	11	2.0%	Hospital

Note: Only institutions with more than 1% are displayed in the table above.

Table A.8. Guinea-Bissau Top research institutions.

Rank	Institution	% Publications	% Share	Organisation Type
1	Bandim Health Project	418	79.2%	Research Institute
2	Instituto Nacional de Saúde Pública (INASA)	70	13.3%	Government
3	Ministry of Health	65	12.3%	Government
4	Hosp Nacl Simao Mendes	25	4.7%	Hospital

Note: Only institutions with more than 1% and more than 2 pubs are displayed in the table above.

Table A.9. Cape Verde Top research institutions.

Rank	Institution	% Publications	% Share	Organisation Type
1	Ministry of Health (CV)	25	25.0%	Government
2	Univ Cabo Verde	22	22.0%	Higher Education
3	Hosp. Agostinho Neto	10	10.0%	Hospital
4	INSP - Inst Nacl Saude Publ (CV)	8	8.0%	Government
5	Univ Jean Piaget	6	6.0%	Higher Education
6	Ordem Med Cabo Verde	5	5.0%	Health
7	WHO (CV)	4	4.0%	Health

Note: Only institutions with more than 1% and more than 2 pubs are displayed in the table above.

Table A.10. Sao Tome and Principe Top research institutions.

Rank	Institution	% Publications	% Share	Organisation Type
1	Centro Nacional de Endemias	11	36.7%	Health
2	Taiwan Antimalaria Advisory Mission (STP)	7	23.3%	Health
3	Hosp Dr Ayres de Menezes	6	20.0%	Hospital
4	Minist Hlth (STP)	6	20.0%	Government

Note: Only institutions with more than 1% and more than 2 pubs are displayed in the table above.

Table A.11. International collaboration countries of PALOP research in 'health sciences' (2008-2020).

	Angola	Cape Verde	Guinea-Bissau	Mozambique	Sao Tome and Principe	Total
USA	130	16	92	1098	6	1342
Spain	41	10	20	798	1	870
England	66	14	128	511	0	719
Portugal	200	49	39	342	17	647
South Africa	18	2	25	494	0	539
Denmark	6	2	373	105	0	486
Brazil	93	17	13	303	5	431
Switzerland	35	4	22	326	2	389
Kenya	22	0	24	291	1	338
France	43	11	18	261	2	335
Sweden	16	0	114	189	1	320
Australia	23	3	45	239	0	310
Italy	32	4	38	215	0	289
Netherlands	15	1	61	209	1	287
Belgium	14	4	23	218	0	259
Germany	29	5	30	189	0	253
Tanzania	13	0	23	198	0	234
Nigeria	15	1	14	174	2	206
Uganda	29	0	18	158	1	206
Canada	16	7	21	160	1	205
India	6	1	6	186	2	201
Ghana	8	3	26	111	0	148
Gambia	4	0	62	71	0	137
Cameroon	19	1	8	102	1	131
Senegal	15	9	32	64	0	120
Peoples R China	10	4	15	83	2	114
Finland	36	1	11	59	0	107
Burkina Faso	8	0	27	68	1	104
Dem. Rep Congo	24	0	2	61	0	87
Chile	28	0	1	49	0	78
South Korea	3	0	24	50	0	77
Poland	4	4	0	54	0	62
Mozambique	31	8	10	2872	6	55
Angola	563	8	8	31	7	54
Guinea	2	3	5	31	0	41
Cape Verde	8	100	2	8	4	22
Guinea-Bissau	8	2	528	10	2	22
Mauritania	1	3	2	15	0	21
Sao Tome & Prin	7	4	2	6	31	19

Table A.12. Distribution of main locations of research in 'health sciences' in PALOP.

Rank	Angola		Cape Verde		Guinea-Bissau		Mozambique		Sao Tome and Principe	
1	Luanda	72%	Praia	77%	Bissau	98%	Maputo	69%	Sao Tome	93%
2	Caxito	6%	Mindelo	7%	Cumura	1%	Manhica	18%	Principe	5%
3	Huambo	3%	Maio	3%	Bubaque	1%	Beira	5%		
4	Bengo	3%	Assomada	1%			Nampula	1.4%		
5	Cubal	2%	Boa Vista	1%			Tete	1.4%		
6	Lubango	2%					Quelimane	1.2%		
7	Cabinda	2%					Chokwe	0.8%		
8	Lobito	1.3%					Pemba	0.5%		
9	Malanje	1.3%					Chimoio	0.4%		
10	Uige	1.2%					Marracuene	0.4%		

Table A.13. Reference documents on health sciences research policy in PALOP.

Angola
Estratégia Nacional de Ciência, Tecnologia e Inovação – *National Strategy for Science, Technology and Innovation* (Presidential Decree Nº 196/11, 11 July)
Plano de Desenvolvimento Nacional – *National Development Plan* (2018-2022)
Política Nacional de Ciência, Tecnologia e Inovação – *National Policy for Science, Technology and Innovation* (Presidential Decree Nº 201/11, 20 July)
Plano Nacional de Desenvolvimento Sanitário – *National Health Development Plan* (2012-2025)

Cape Verde
Agenda Nacional de Investigação – *National Research Agenda*
Carta de Política para a Ciência – *Charter for Science Policy* (Resolution no 47/2016, 15 April)
Ciência, Tecnologia e Inovação em Cabo Verde – *Science, Technology and Innovation in Cape Verde*
Plano Estratégico de Desenvolvimento Sustentável – *Sustainable Development Strategic Plan* 2017/2021 (PEDS)
Plano Nacional de Desenvolvimento Sanitário – *National Health Development Plan* (2017-2021)

Guinea-Bissau
Plano Nacional de Desenvolvimento – *National Development Plan* (2020)
Plano Nacional de Desenvolvimento Sanitário – *National Health Development Plan* (2018-2022)

Mozambique
Estratégia de Ciência, Tecnologia e Inovação de Moçambique – *National Strategy for Science, Technology and Innovation* (ECTIM) (2006, under revision)
Mapeamento da Investigação e Inovação na República de Moçambique – *Mapping Research and Innovation in the Republic of Mozambique*, UNESCO, Michael Kahn. GO-SPIN Country Profiles in Science, Technology and Innovation Policy, vol. 9, 2021.
Política da Ciência e Tecnologia – *Science and Technology Policy* (2003, under revision)

Sao Tome and Principe
Plano Nacional do Desenvolvimento da Saúde – *National Health Development Plan*

Table A.14. Interviewees.

Angola
Joana Morais, INIS
Jocelyne Vasconcelos, Centro de Investigação em Saúde de Angola
Mário Fresta, FUNDECIT
Miguel Brito, Centro de Investigação em Saúde de Angola
Cape Verde
Maria da Luz Lima, Instituto Nacional de Saúde Pública
Pâmela Borges, Hospital Agostinho Neto
Guinea-Bissau
Baltazar Cá, INASA-Bandim Health Project
Peter Aaby, Bandim Health Project and University of Southern Denmark
Mozambique
Carla Carrilho, UEM
Francisco Saúte, CISM
International Partners
Matiana Gonzalez, ISGlobal
Michaeld Makanga, EDCTP
Peter Kilmarx, NIH Fogarty Center
Pilar Montero, AECID
Regina Rabinovich, ISGlobal
Ulla Tawiah, DANIDA

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