Collaboration and Knowledge Creation Processes Through Coauthored Scientific Articles Between Africa, Sweden and Finland

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Abstract

The European Union and many individual European countries emphasize the value of partnerships with Africa, including in research and development. This article examined research collaborations and related knowledge creation processes between Africa, Sweden, and Finland. To analyse this topic, the article develops a nuanced model of centres and peripheries in knowledge production. The focus was on scientific outputs, particularly coauthored scientific articles in peer-reviewed international journals, with at least one affiliation from Africa and another from Sweden or Finland. The quantity of articles their topics, research areas, and scientific impacts were analysed, as well as the authors' affiliations and backgrounds. Between 2015 and 2021, almost 10,500 international peer-reviewed scientific coauthored articles were indexed in the Web of Science database coauthored by scholars affiliated with Africa and Sweden, and almost 4,600 such articles by scholars affiliated with Africa and Finland. On average, less than one collaboration article per year appeared with coauthors from Sweden or Finland and from most African countries. Proportionally more articles were published by scholars affiliated with those African countries in which Sweden and Finland conducted development policy initiatives. South African universities were present in almost half of the coauthored articles with Sweden and Finland. The Karolinska Institute and the University of Lund in Sweden, and the University of Helsinki in Finland, were the most active research collaborators with Africa. Only about one-fifth of coauthored articles focused specifically on Africa. Overall, collaborations between scholars in the academic centres of the Global North and those in the academically more peripheral African universities are hierarchical. Most coauthored international peer-reviewed scientific articles from Africa connected to global academic networks with Anglo-American universities leading in medical science and science. More engaged reciprocal collaborations are needed between Africa, Sweden, and Finland. Such critical edges of knowledge creation would promote novel and emancipating scientific perspectives and practices.

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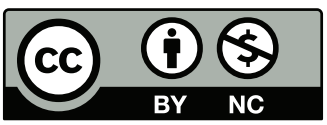

Keywords: Africa, Sweden, Finland, scientific article, collaboration

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Introduction

Research collaborations and partnerships with Africa have gained increasing attention in recent years in the European Union (EU), including in Sweden and Finland. The Swedish government has emphasized collaborations and mutually beneficial partnerships with African countries in research, development, and innovation, including capacity-building. These strategies include, for example, the strategy for Sweden's regional development cooperation with the Middle East and North Africa in 2021–2025 (Ministry for Foreign Affairs of Sweden 2021), and strategies and programmes of development cooperation and humanitarian assistance, often implemented through the Swedish International Development Cooperation Agency (SIDA). In Finland, there is broad political support for collaboration with Africa, as evidenced by the publication of "Finland's Africa Strategy: Towards a Stronger Political and Economic Partnership" in 2021 by the Government of Finland. The aim of this strategy is to strengthen political and economic relations, including research collaborations, for the mutual benefits of both Finland and Africa (Ministry for Foreign Affairs of Finland 2021). The Ministry of Education and Culture in Finland is also supporting networking, research, and teaching collaborations with Africa through funding for the years 2021–2024. This includes participation from all 13 of Finland's science universities and 19 out of 24 universities of applied sciences in four global networks (Jääskeläinen 2021). The internationalization strategies of several Finnish universities mention Africa, and the University of Helsinki (2020) has designed a specific Africa programme for 2021–2030.

Besides governments and scholars having an interest in Africa per se, there is a growing emphasis on the internationalization of universities as a response to globalization. International scientific collaborations and related peer-reviewed articles are important in the assessment of universities. Kwiek (2021) has noted that the recent growth in scientific publications in the EU is almost entirely due to internationally coauthored publications. Many researchers are aiming for stronger international academic outputs and prestige, and international collaborations are useful for achieving this goal (Pouris and Ho 2014; Kwiek 2021; Tahmooresnejad et al. 2021). Intensive collaborations with scholars in Africa can be particularly beneficial for collaborating scholars as they tend to publish more frequently, gain more citations for their articles, and have their academic contributions more widely recognized by wider audiences (Sonnenwald 2007). Coauthored articles with scholars in Africa are part of international scientific collaboration.

Scientific cooperation between the wealthier Global North countries, such as the EU member states, Australia, Canada, Israel, Japan, New Zealand, Singapore, South Korea, and the United States, and the poorer Global South, which includes most African countries, has been characterized by significant imbalances. Less developed countries remain under Euro-American dominance in the centre-periphery hierarchy of scientific development, despite the emerging pan-national network of global scientists (Marginson 2022). The Global North holds central positions and forms a global knowledge empire based on the perceived acceptability and superiority of its knowledge territories. Global science remains primarily Anglo-American in terms of language, leading institutions, disciplinary and publishing regimes, agendas, and topics, which excludes non-English language and indigenous knowledges from the knowledge creation processes that are perceived as globally relevant (Altbach et al. 2009; Ezechukwu 2022; Marginson and Xu 2023). This resonates with earlier debates regarding language as communication, culture, and consciousness, as well as post-colonial critiques in Africa regarding the prioritization of major European languages over local languages (e.g., Ngũgĩ

wa Thiong'o 1986).

Recent policies aim to promote more equal research partnerships between the Global North and the Global South, including Africa. For example, the European Commission's EU–Africa strategy emphasizes the need for more symmetrical and equitable collaboration between the EU and various African stakeholders, including the African Union and regional organizations, countries, businesses, and people in Africa (European Commission 2020). This collaboration can lead to the pooling of resources for scholars both in and out of Africa for addressing complex topics in African contexts such as climate change, the green economy transition, sustainable growth, job creation, and digitalization progress, as well as broader issues of peace, democracy, equality, and migration management. The EU's research framework programme, Horizon Europe, has increased funding for collaborative research with African organizations for 2021–2027.[1] Collaborative efforts can help implement international academic standards and practices from the Global North in African contexts, leading to permanent learning in international collaboration (Mirzenami and Beadry 2022). In addition, collaboration can support beneficial brain circulation, rather than the negative brain drain that currently exists between Africa and the Global North (Radwan and Sakr 2018).

Research collaborations between scholars from the Global North and the Global South are intertwined with the larger processes of knowledge creation and inclusion and exclusion in academia. Novel academic knowledge is created by building upon existing knowledge, through conceptual development, methodological improvements, or empirical data collection. Collaboration enables the combination of resources to generate new knowledge in a reciprocal, equal partnership that involves the intensive exchange of ideas and mutual learning practices. There are scholars from Africa who are actively involved in research from design to implementation and dissemination. However, studies have shown that collaborations between the Global North and the Global South are often characterized by unevenness and hierarchy (Schubert and Sooryamoorthy 2010; Ezechukwu 2022). According to Boshoff (2009), Global South scholars are frequently relegated to following pre-set guidelines and only assisting in fieldwork data collection, resulting in a top-down division of labour. This hierarchy is reinforced by the fact that resources and funding from outside Africa are fundamental to conducting research in and about Africa, leading to the continuation of top-down practices (Owusu-Nimo and Boshoff 2017).

In this article, I examine research collaborations between scholars from universities or research institutes in African countries and those from Sweden and Finland in the Global North. I also develop a nuanced model of centres and peripheries in knowledge production to analyse these collaborations, specifically in terms of coauthored scientific articles. Coauthored articles signify that research collaborations have occurred and that related scientific communications have been validated and recognized (Glänzel and Schubert 2004). My focus is on scientific collaborations resulting in published, peer-reviewed articles in international scientific journals between 2015 and 2021 which were coauthored by scholars affiliated with universities or research institutes in Africa and in Sweden or Finland.

For this study, I only considered scientific articles and reviews from peer-reviewed international journals indexed in the Web of Science database from 2015 to 2021. This database by Clarivate, owned by Thomson Reuters, includes over 18,000 international peer-reviewed scientific journals and tens of millions of publications across many disciplines. Although Scopus and Google Scholar databases have more articles and other types of

[1] European Commission. 2021. *Horizon Europe*. https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en

publications, not all of them are peer-reviewed or are from regularly appearing international journals with international editorial boards. According to Martín-Martín et al. (2018), publications included in the Web of Science tend to have a greater global scientific impact than those solely quoted outside of it. Additionally, articles in the Web of Science database are often used to evaluate the international scientific performance of universities. Therefore, scholars in Swedish and Finnish universities are encouraged to publish their research in journals indexed in the Web of Science to achieve greater international impact. This database is a suitable source for studying international peer-reviewed scientific publications related to Africa. However, to study wider scholarly research about Africa, particularly Southern Africa, and including less internationally oriented and non-peer-reviewed publications, one can use other platforms such as Sabinet.

The primary focus of this study was to investigate coauthored peer-reviewed scientific articles by scholars affiliated with institutions in Africa and in Sweden and Finland. The study aimed to answer the following research questions: How many coauthored articles were published, and what were the research topics and areas covered by these articles? Additionally, the study examined the scientific impact of the coauthorships, considering citation counts, publication venue prestige, and accessibility. In order to gain insight into the practices of research collaboration and knowledge creation between scholars from Africa, Sweden, and Finland, the study also looked into authors' affiliations, publishing networks, and academic backgrounds. To achieve these objectives, only peer-reviewed scientific articles indexed in the Web of Science database from 2015 to 2021 were considered.

After this introduction, the conceptual framework regarding centres and peripheries in scientific collaboration and knowledge creation practices between the Global North and the Global South is presented. Following this, I describe the materials used for analysing coauthored articles and the methods employed. The empirical analysis and the results are then presented. Finally, the key findings are summarized and further research topics are suggested in the conclusions.

International research collaboration and knowledge creation practices

International scientific collaboration has become an increasingly important aspect of the expanding global geography of science (see Olechnicka et al. 2019). Scholars affiliated with academic centres in the most advanced countries possess relevant resources for conducting scientific research, allowing them to publish their results in significant international journals. They create important scientific paradigms and findings that are legitimized by their peers and later followed by other scholars. Such scientific activities place these scholars and their affiliated universities among the top institutions in international rankings. In contrast, scholars in the periphery, both in less developed regions of the Global North and in most areas of the Global South, often lack resources and face difficulties in accessing the most recent scientific knowledge in international journals. This limits their ability to conduct impactful research, report their results internationally, and influence the development of international scientific paradigms. Despite these challenges, international scientific collaboration provides an opportunity for scholars in the periphery to engage in knowledge creation practices with their peers in the centre.

Scientific knowledge about Africa has been gathered for centuries, primarily to benefit the Global North countries, as part of the broader colonization of the continent. Many universities and scholars of the Global North have used scholars and universities in the Global South to produce scientific knowledge, with most of the benefits accruing to the Global North (see Samoff and Bidemi 2004).

In fact, the modern scientific interests, techniques, and practices of the Global North have largely dictated what is scientifically relevant and proper for research in Africa and other colonized regions (Seth 2009; Heleta 2016; Keikelame and Swartz 2019). The current structure of international scientific collaboration has been built on centre–periphery hierarchies, with Africa serving as an empirical data source for certain European countries (see Schubert and Sooryamoorthy 2010; Marginson 2022). Epistemology has been deployed instrumentally and strategically to suit the colonizer's model of the world (Ndlovu-Gatsheni 2020; Ezechukwu 2022). Scholars in the periphery have, in general, merely followed the paradigms of the centre and provided the necessary assistance with collecting empirical material, translating local languages, and providing specific information about African contexts. The scholars and universities of the Global North have published the main results, thus accruing valuable knowledge based on empirical material from Africa to themselves. Rarely have African scholars and organizations been involved in the research design, although some have been mentioned in international peer-reviewed publications, sometimes also as authors (Tijssen 2007; Seth 2009; Matunhu 2011; Cloete et al. 2018; Ndofirepi and Gwaravanda 2019; Barnard 2020). Although the direct colonization of African countries mostly ended in the 1960s and 1970s, the centre–periphery structure of scientific research has remained highly stable (Schubert and Sooryamoorthy 2010).

The uniformity of approaches to the formation of scientific paradigms contributes to the loss of diverse knowledge, including indigenous knowledge (Marginson and Xu 2023). Research methodologies and practices originating from Africa have rarely been developed or applied, so African scholars have persistently lacked adequate academic impact, and have thus remained at the periphery of the global scientific community (Tijssen 2007). This imbalance is reflected in the fact that only about one percent of Nobel laureates in the sciences are from Africa (see Olechnicka et al. 2019, 15). Despite this, collaborative research in Africa has been relatively high in volume compared to other regions: in many African countries more than 90 percent of international peer-reviewed articles result from collaborations with scholars from the Global North (Olechnicka et al. 2019). However, the focus of international collaborative research in Africa has largely been on science, medical sciences, and natural resources, which are either easier to accomplish with resources from partners in the Global North or more useful to these partners. Other academic fields and research-based knowledge have received much less support, limiting the potential for broader knowledge-based economies and societies in Africa (Pouris and Ho 2014).

The centre–periphery division in research collaborations resulting in international coauthored publications is a complex issue that cannot be fully understood using a simplistic approach. While scholars and universities in the Global North possess more resources, not all of them are in the same position, and the same applies to scholars and universities in the Global South (see also Marginson and Xu 2023). Hautala and Jauhiainen (2019) developed a more nuanced model of knowledge creation that can be used to better understand research cooperations resulting in international peer-reviewed scientific articles (Figure 1).

The model suggests that scientific development in the Global North is characterized by impactful cores (*core-in-centre*) that define the key scientific paradigms. There are also critical edges (*edge-in-centre*) that provide alternative novel viewpoints for scientific development. Additionally, there are less significant peripheries (*periphery-in-centre*) in the centre that make very small contributions to global scientific development. In the periphery (broadly defined as the Global South), there are centres (*centre-in-periphery*) that perform relatively better than other universities in the region and that meet international scientific

standards in certain academic fields. There are also critical edges (*edge-in-periphery*) that rely more on indigenous knowledge. However, most scientific institutes in the periphery are peripheries (*periphery-in-periphery*) that hardly meet any international academic standards and that barely feature in international university rankings (ShanghaiRanking Consultancy 2021; hereafter cited as ARWU).

The *core-in-centre* is where solid scientific paradigms and knowledge are created and maintained, fitting well with the peer-review processes of international scientific journals. In the traditional division of academic labor, scholars in leading universities in the Global North (such as top-level ones in the United States, the United Kingdom, and the EU) are at the core, while scholars in the universities in the Global South (such as those in Africa) are in the periphery. However, it is important to note that not all disciplines in these universities are necessarily at the core. For example, of the 100 top-ranked universities in the Academic Ranking of World Universities, 40 are from the United States, 20 are from the EU (including three from Sweden and one from Finland), eight are from the United Kingdom, seven are from China, four from Switzerland, and 21 are from elsewhere – but none are from Africa (ARWU 2021). For a more global reach, these universities collaborate with partners in the Global South, including in Africa. Nevertheless, scholars and universities in the Global South are not homogeneous, as some are in the centre-in-periphery and edge-in-periphery, which perform relatively better and which rely more on indigenous knowledge, respectively, while others are in the periphery-in-periphery, hardly meeting any international standards and not appearing in international university rankings (Hautala and Jauhiainen 2019; ARWU 2021).

In addition to the core-in-centre, there are also edges (*edge-in-centre*) in the Global North where scholars challenge existing scientific paradigms and create novel knowledge (Figure 1). However, this process can be challenging, and scholars may seek collaborative partners in the Global South who share their perspectives and can provide critical research support. In these reciprocal edge-to-edge relations, it is important to incorporate decolonized research methodologies that consider power dynamics, trust, cultural competence, respectful and legitimate research practices, and individual and community assets (Keikelame and Swartz 2019). Collaborative practices should embrace diverse epistemic and epistemological perspectives to foster heterogeneous knowledge production (Santos 2014; Mbembe 2016).

The scientific performance of universities, disciplines, and scholars in the Global North is not uniform. Some institutions and individuals perform better than others, and those that perform poorly do not rank highly in the world map of scientific performance (Figure 1). Many universities in the Global North fall into the *periphery-in-centre*, particularly those with a strong national or regional focus or those that give little priority to international research and publishing peer-reviewed articles. These universities rarely engage in any research collaboration with African universities, and when they do, their goals, resources, skills, and outputs in research cooperation are usually less significant than those of leading universities.

The model suggests that most universities in the Global South can be considered to be peripheral (*periphery-in-periphery*) in terms of their scientific contributions and engagement in international research collaborations (Figure 1). Out of the world's top 1,000 universities, only 16 universities are from Africa, indicating that over 99% of the 3,000–4,000 African universities and higher education institutes can be considered peripheral from a global scientific perspective (Jauhiainen and Hooli 2020; ARWU 2021). Due to the importance of international peer-reviewed articles for national and global university rankings, peripheral universities may be interested in any kind of collaboration to produce such arti-

cles. However, scholars from these peripheral universities rarely take significant leadership in collaborations with higher-performing universities in the Global North.

It is important to note that not all universities in the Global South are peripheral, even from the perspective of global rankings. For example, four universities in South Africa and one in Egypt are listed among the top 500 universities globally (ARWU 2021), making them centres in the Global South (*centre-in-periphery*). These institutions follow mainstream paradigms and are highly sought-after partners for core universities in the Global North. Nevertheless, research collaborations in Africa driven by the Global North are vulnerable to changing priorities and donor interests, as highlighted by Samoff and Bidemi (2004) in their work on Africa. The leading universities in the Global South dominate in South–South collaborations and serve as centres within their respective territories (Fahey and Kenway 2010) (Figure 1).

Particularly interesting for novel knowledge creation are universities, disciplines, and scholars that challenge the mainstream knowledge of the Global North's centres. These institutions and individuals are located at the edges of the scientific paradigm in the Global South (*edge-in-periphery*), and international cooperation with their scholars may provide opportunities for "subaltern cosmopolitanism" (see Santos 2014). They criticize the Global North's perceived superiority in knowledge creation processes and may decline to collaborate if potential partners fail to consider perspectives emerging from African contexts, such as rooted indigenous knowledge (Santos 2014; Nhemachena et al. 2016; Khupe and Keane 2017; Seehawer 2018). Such scholars and universities often position themselves critically within a postcolonial framework and conduct strong indigenous research, as seen, for example, in Ethiopia, Nigeria, and Kenya (see Chilisa 2020; Figure 1).

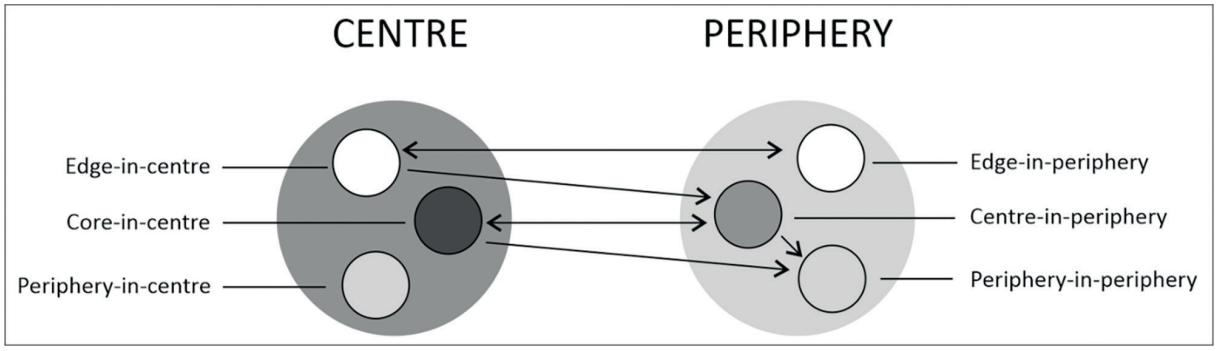


Figure 1. Research collaboration directions between the Global North and the Global South (modified from Hautala and Jauhiainen 2019).

Material and methods

Successful scientific international collaborations lead to scientific outputs published in appropriate venues. The main standard for an international scientific publication is a peer-reviewed article published in a recognized international academic journal. There are hundreds of thousands of scientific journals worldwide, but not all of them are credible. Some journals may appear to be scientific, but they are actually predatory, and authors can pay to get their manuscripts published.

To ensure the validity of the data, specific criteria were established. Firstly, each article needed to have at least two authors, with one author being affiliated with an institution in Africa and the other with an institution in

Sweden or Finland. Secondly, the publication date had to be between 2015 and 2021. Thirdly, only original articles or review articles that had undergone a rigorous peer-review process before publication in an internationally recognized scientific journal were considered. These journals had to have an international scientific editorial board and regular publication schedules. If an international peer-reviewed coauthored article was published and indexed in the Web of Science database (as explained in the Introduction), it was considered evidence of a research collaboration with verifiable scientific outcomes between scholars in Africa and Sweden or Finland.

The main objective of the study was to analyse the research collaboration outputs between Africa and Sweden or Finland, irrespective of the topic of the articles. However, an additional issue was to determine whether the articles had Africa as their key topic. For this purpose, an article was considered to have Africa as its key topic if its title, author's keywords, or Web of Science generated keywords or summary (the Web of Science category "Topic") included the word *Africa* or *African,* but not *African American*. These articles provided insights into Africa as their primary context. Some articles contained keywords related to locations or objects within Africa but did not mention the word "Africa". In this case, they were not examined here as articles with Africa as a specific topic. Nevertheless, they were included in the overall analysis of collaborative articles between scholars from African countries and from Sweden or Finland.

After conducting a thorough screening (as of 19 January 2022) of all Africa–Sweden and Africa–Finland coauthored articles in the Web of Science database from 2015 to 2021, two main data sets were generated, which were then divided into four subsets each. The first dataset was comprised of (1a) all 10,378 coauthored articles by scholars with affiliations in Africa and Sweden, (1b) 2,397 coauthored articles exclusively featuring scholars with affiliations in Africa and Sweden (and not having scholars from any other countries), (1c) 4,092 coauthored articles with a key topic about Africa, and (1d) 1,196 coauthored articles exclusively featuring scholars affiliated with Sweden and Africa and with a key topic about Africa. The second dataset was comprised of (2a) all 4,567 coauthored articles by scholars with affiliations in Africa and Finland, (2b) 707 coauthored articles exclusively featuring scholars affiliated with institutions in Finland and Africa (and not having scholars from any other countries), (2c) 1,455 coauthored articles with a key topic about Africa, and (2d) 625 coauthored articles exclusively featuring scholars affiliated with Finland and Africa and with a key topic about Africa.

After compiling the datasets, I conducted a descriptive statistical analysis to compare the research outputs arising from collaborations with scholars affiliated with Africa and Sweden or Finland. I analysed the annual quantity of articles from 2015 to 2021 and the share of all international peer-reviewed articles in Sweden, Finland, and Africa. Additionally, I identified the most common research topics (areas) in these Sweden–Africa and Finland–Africa coauthored articles. To identify connections between the articles' main topics, research areas, countries, and organizations, I used the visualization of similarities program (VOSviewer) and clustering based on its algorithms. Furthermore, I considered the scientific impact of the articles by examining their accessibility, publication venues, and citations. Finally, I identified the backgrounds of the most prolific scholars, including their current affiliations and countries, the countries in which they earned their PhDs, the countries in which they were born, and whether they were men or women. Overall, these analyses provided a comprehensive overview of the research collaboration outputs between Africa, Sweden, and Finland, as well as the scholarly contributions of individual researchers.

Results

Quantity of Africa–Sweden and Africa–Finland coauthored scientific articles

Coauthored international peer-reviewed scientific articles result from knowledge creation processes between scholars, organizations, and networks involved in research collaborations. From 2015 to 2021, scholars affiliated with institutions in Africa contributed to approximately 485,000 scientific peer-reviewed articles in international journals indexed in the Web of Science database (2.1% of all its articles). Half (50.7%) of these articles were the result of international collaborations between scholars in Africa and scholars outside the continent, while the other half (49.3%) involved only scholars affiliated with one or more African countries. Globally, only 1.1 percent of all international peer-reviewed scientific articles resulted from collaborations between researchers both in and out of Africa. It is noteworthy that non-African organizations were significantly involved in producing scientific knowledge in Africa. Kwiek (2021) observed that scholars from (quantitatively) leading publishing countries were increasingly contributing to international scientific publications. In Africa, the top research collaborations (in terms of coauthored articles in the Web of Science database) occurred with scholars affiliated with the United States (14.1%), the United Kingdom (9.5%), France (8.5%), and Germany (5.5%).

The contribution of Nordic countries to scientific knowledge production in partnership with Africa was relatively modest on a global scale. Scholars affiliated with Sweden were involved in 2.1 percent (10,378) of articles featuring scholars affiliated with Africa, while those affiliated with Finland were involved in 0.8 percent (4,567) (Figure 2). Although the annual number of Africa–Sweden and Africa–Finland coauthored articles increased during the study period, their global share decreased. Overall, scholars affiliated with Swedish institutions published 2.3 times more coauthored articles with scholars affiliated with African institutions than did scholars in Finland, and had 3.4 times more coauthored articles in collaborations exclusively with African scholars.

Considering scientific research that has Africa as a key topic, the situation differed slightly. In the period 2015–2021, approximately 226,000 articles with Africa as a key topic appeared in the Web of Science database. Out of these articles, almost half (46.2%, 104,668) did not have any scholars affiliated with Africa. Among articles with Africa as the key topic, one in four (24.7%; 55,875) was coauthored by scholars with affiliations in Africa and elsewhere, including scholars from Sweden (0.5%; 1,196) and Finland (0.3%; 625). The remaining articles (29.0%; 65,743) were produced solely by scholars affiliated with organizations in Africa. When comparing Sweden and Finland, scholars affiliated with Swedish institutions published 2.8 times more coauthored articles focused on Africa and 1.9 times more in collaboration only with a partner in Africa than was the case in Finland. The number of coauthored articles with Africa as a key topic between Africa, Sweden, and Finland almost doubled annually from 2015 to 2021. Coauthored articles between Africa and Sweden increased by 96.7 percent to 984 articles, while between Africa and Finland they increased by 97.1 percent to 440 articles (Figure 2).

Geography of Africa–Sweden and Africa–Finland coauthored scientific articles

Research collaborations with scholars affiliated with Africa have a distinctive geographic pattern, with a focus on areas where English is the dominant academic language rather than those where French is more prevalent. The hegemony of the English language relates to the neo-imperialistic Anglo-American efforts to promote internationalization, which perpetuates the disparities between the world's wealthy and less privileged populations (Phillipson 2017; Ezechukwu 2022).

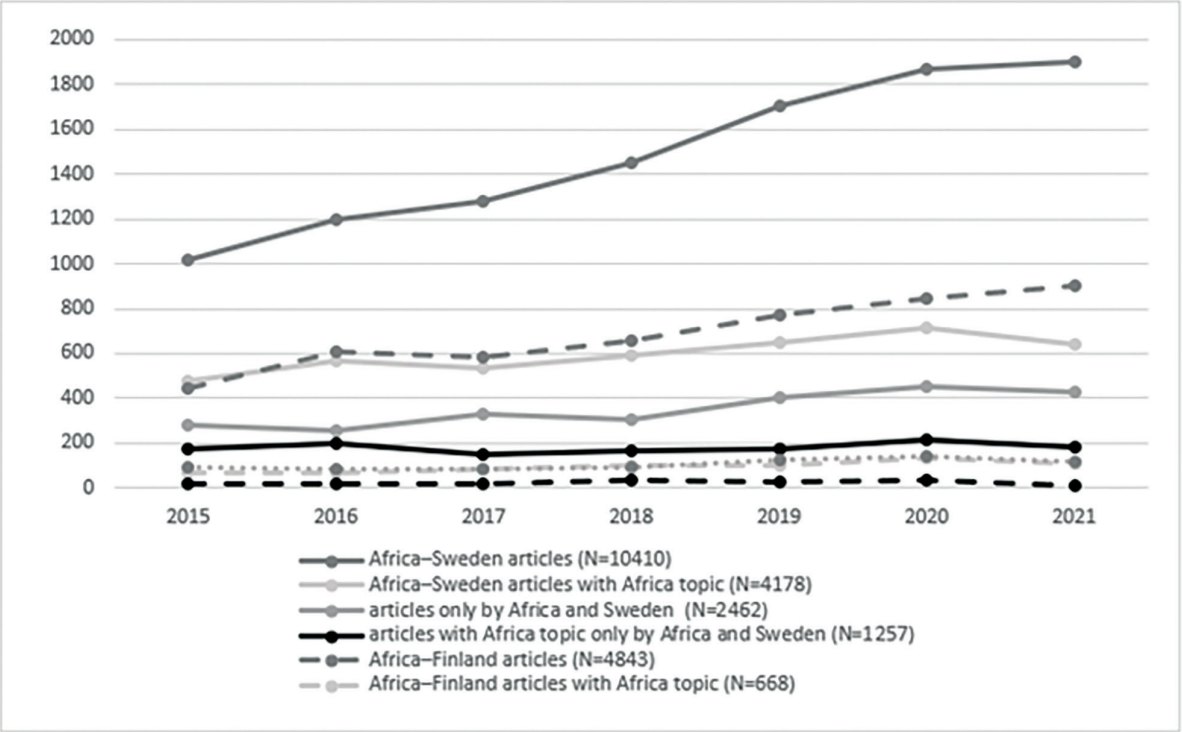


Figure 2. International peer-reviewed scientific articles in Africa–Sweden and Africa–Finland collaboration, 2015–2021. Source: Calculated from the Web of Science database (2022).

In the period 2015–2021, scholars from Sweden or Finland collaborated on coauthored articles with scholars in almost all African countries (52 out of 54 for Sweden; 50 out of 54 for Finland). However, the collaborations were concentrated in only a few countries and universities. On average, scholars in Sweden coauthored more than 10 articles per year with less than half of African countries (46.3%; 25), while scholars in Finland collaborated with substantially fewer African countries (27.7%, 15). The proportion of scholars affiliated with Sweden or Finland was modest, usually less than two percent, regarding all individual African countries' Web of Science articles. Typically, Sweden or Finland was one of many international partners in wider research networks.

The primary hub of Swedish and Finnish research collaboration in Africa was South Africa. South African universities have a high ranking in Africa, and very often collaborate with scholars from the Global North. During the study period, South Africa was clearly the most frequent partner in joint Africa–Sweden articles (5,113 articles; 48.6%) and Africa–Finland articles (2,013 articles; 44.1%). However, there was little collaboration exclusively between South Africa and Sweden (6.9%) or Finland (10.7%) (Table 1). Instead, the top-ranked universities from the Global North engaged in functional collaborations with the leading African universities in multilateral international networks, with the core-in-centre collaborating with the centre-in-periphery (see Figure 1). Scholars affiliated with Sweden or Finland tended to collaborate more with scholars in countries where Sweden and Finland implemented development aid. For example, Uganda has been significant in Sweden's development policy, especially for academic training and collaborations. Scholars with affiliations in Sweden were present in 6.3 percent of Ugandan publications in the Web of

Table 1. Most frequent Sweden–Africa and Finland–Africa research partners in co-authored scientific articles.

Sweden–Africa Co-Authored Articles			**Finland–Africa Co-Authored Articles**		
South Africa	5,113	48.6%	South Africa	2,013	44,1%
Egypt	1,279	12.1%	Egypt	1,396	36,3%
Morocco	1,040	9.9%	Kenya	330	7,2%
Kenya	923	8.7%	Nigeria	299	6,5%
Uganda	737	7.0%	Ghana	275	6,0%
Tanzania	728	6.9%	Morocco	218	4,8%
Ethiopia	693	6.5%	Ethiopia	206	4,5%
Nigeria	601	5.7%	Algeria	197	4,3%
Ghana	527	5.0%	Tunisia	164	3,6%
Rwanda	277	2.6%	Tanzania	161	3,5%
Total	10,378	100%	Total	4,567	100%

Source: Calculated from the Web of Science database.

Science database. Similarly, in 3.4 percent of Namibia's Web of Science articles, scholars affiliated with Finland were present. Finland has been involved for a long time in Namibian society, including in the education sector, and Namibia has been an important target country for Finland's development policy (Jauhiainen and Hooli 2020).

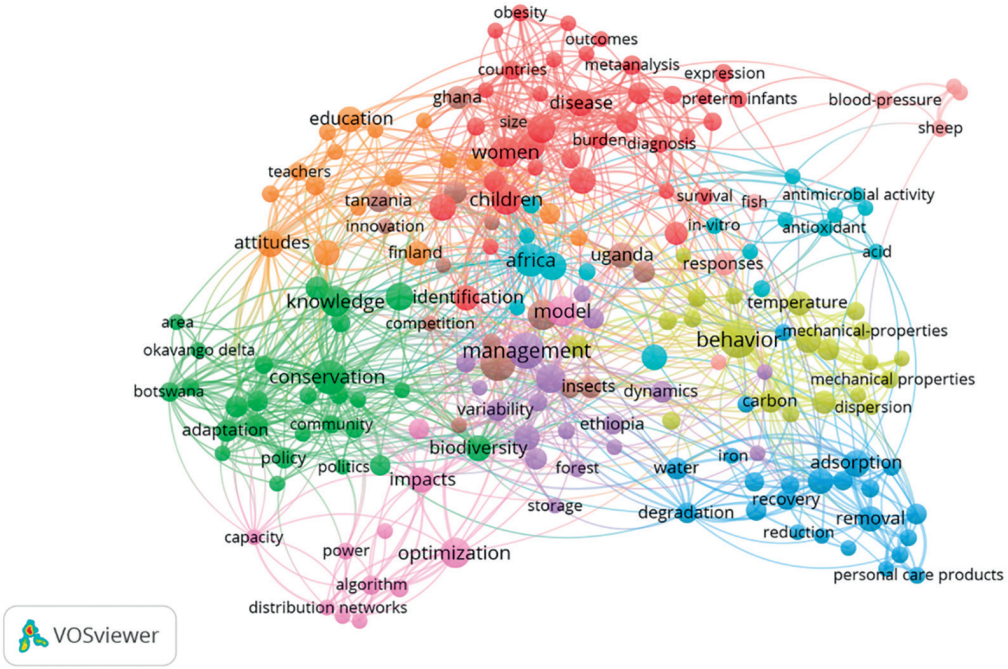
Although most coauthored articles did not focus exclusively on Africa, when they did, almost half of the Africa–Sweden (49.6%) and Africa–Finland (47.6%) articles studied the entire continent or its macro-regions. When specific African countries were mentioned, South Africa was the most common research target (15.6% of the Africa–Sweden articles and 13.2% of the Africa–Finland articles). Other countries were studied to a lesser extent, including Uganda (4.0%), Kenya (3.5%), and Tanzania (2.9%) in Africa–Sweden articles, and Kenya (3.0%), Ghana (2.8%), and Tanzania (2.3%) in Africa–Finland articles. These differences may be related to variations in Swedish and Finnish development policies towards different target countries (Figure 3).

Collaboration networks in Africa–Sweden and Africa–Finland coauthored scientific articles

The internationalization of research collaboration often results in peer-reviewed articles with several or even dozens of authors from various countries. External funding plays a crucial role in promoting and guiding such collaborations. Within Africa, there are various collaboration patterns, including those between science-oriented and applied-sciences-oriented universities, those with greater external funding from Global North countries, and those in which English or French is the academic language (Doh et al. 2021).

Over three out of four (76.5%) coauthored Africa–Sweden articles and five out of six (84.5%) coauthored Africa–Finland articles also involved authors from outside of Africa, Sweden, and Finland. These collaborations were predominantly based on multilateral international networks, typically originating from the core-in-centre of the Global North, such as leading universities in the United States, the United Kingdom, or Germany. This

Finland



Sweden

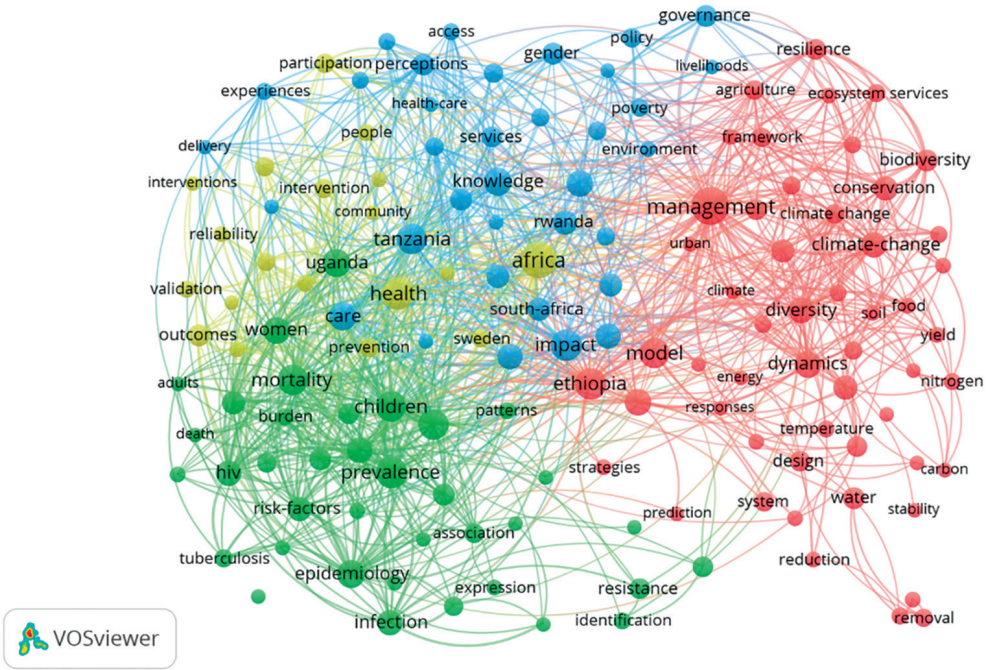


Figure 3. Topics of international scientific Africa–Sweden and Africa–Finland articles, 2015–2021. The material is derived from articles in the Web of Science database in which t organizations exclusively from Africa and Sweden (2,397) or Africa and Finland (707) were involved. Source: Calculated with VOSviewer from the Web of Science database (2022).

type of collaboration was more common in science, medical science, and climate change research. In such collaborations, individual African universities played a less prominent role compared to those from countries outside Africa, even when the article focused on Africa as a topic. More Africa-topic research was conducted by scholars from universities and research institutes outside Africa than by those within Africa.

The research collaborations between Sweden, Finland and Africa largely followed the core-in-centre with centre-in-periphery pattern (see Figure 1). The most common collaborations involved the globally highest ranked universities in Sweden, Finland, and Africa (ARWU 2021). In articles published through collaborations exclusively between scholars in Africa and those in Sweden or Finland, the ten most common African universities included seven from South Africa and three from Egypt. Regarding coauthored articles with at least one affiliation to Africa and Sweden, the Karolinska Institute had the highest share (21.6%), followed by the University of Lund (20.9%) and the University of Uppsala (19.7%). In Finland, Africa–Finland coauthored research was much more concentrated in the country's single university in the top 100 global ranking. The University of Helsinki was involved in almost half (46.1%) of the Finland–Africa coauthored articles. Lappeenranta University of Technology (16.9%) and the University of Turku (12.1%) were the next most common affiliations in Finland. In coauthored articles where the key topic was about Africa, the most common affiliations in Sweden were the University of Gothenburg, the University of Lund, and the Karolinska Institute. In Finland, the University of Helsinki, the University of Eastern Finland, and the University of Turku were the most common affiliations. In Africa, scholars affiliated with Stellenbosch, Cape Town, and Witwatersrand Universities, all in South Africa, were the most frequently present.

Research cooperation means connections and collaborations between universities and other organizations, but it ultimately occurs among the researchers affiliated with them. Among the most prolific researchers in coauthored articles exclusively written by scholars in Sweden and Africa, 12 were men and eight were women. Of these researchers, 10 were born in Sweden, six in South Africa, and four in other countries. 10 held PhDs from Sweden, three from South Africa, three from the United Kingdom, and four from other non-African countries. Eight researchers had worked only in a university in Sweden, three had worked only in South Africa, six had affiliations with institutions in both Sweden and South Africa, and three had other combinations of affiliations.

Among the most prolific researchers in coauthored articles exclusively from scholars in Finland and Africa, 17 were men and three were women. Nine of the researchers were born in Finland, three in South Africa, five in other African countries, and three in other non-African countries. Among them, nine researchers had obtained their PhDs from Finland, three from South Africa, one from the United Kingdom, and seven from other countries. Eight researchers had worked only in a university in Finland, three had worked only in South Africa, three had affiliations in both Finland and South Africa, and six had other combinations of affiliations.

Thus, the most prolific authors in international coauthored articles between Africa and Sweden or Finland were mainly not African and not affiliated with institutions in Africa, although in the case of Finland–Africa collaborations, more researchers of direct African origins were involved. Earlier studies have indicated that scientifically productive researchers in Africa, i.e., those who produce many scientific publications and highly cited articles, often obtained their highest academic qualifications from high-ranking English-speaking universities (in the United States, Canada, the United Kingdom, or Australia), and they most frequently collaborate with

Table 2. Research areas in Sweden–Africa and Finland–Africa co-authored international scientific articles in 2015–2021.

All Sweden–Africa Articles (n=10,378)			**All Finland–Africa Articles (n=4,567)**		
Research Area	n	%	Research area	n	%
Physics	1217	11.7	Physics	1049	22.9
Environmental Sciences and Ecology	1187	11.4	Astronomy and Astrophysics	581	12.7
Science and Technology, Other Topics	907	8.7	Environmental Sciences and Ecology	460	10.0
Public, Environmental and Occupational Health	832	8.0	Science and Technology, Other Topics	315	6.3
Astronomy and Astrophysics	652	6.2	Engineering	290	6.3
Infectious Diseases	489	4.7	Chemistry	239	5.2
Chemistry	444	4.2	Public, Environmental and Occupational Health	151	3.3
General and Internal Medicine	405	3.9	Materials Science	141	3.0
Pharmacology and Pharmacy	349	3.3	General and Internal Medicine	134	2.9
Engineering	337	3.2	Computer Science	121	2.6

Articles with only Africa and Sweden (n=2,397)			**Articles with only Africa and Finland (n=707)**		
Research area	n	%	Research area	n	%
Environmental Sciences and Ecology	297	12.3	Environmental Sciences and Ecology	93	13.1
Public, Environmental and Occupational Health	267	11.1	Engineering	89	12.5
Science and Technology, Other Topics	203	8.4	Chemistry	56	7.9
Chemistry	147	6.1	Science and Technology, Other Topics	53	7.4
Engineering	131	5.4	Materials Science	45	6.3
Agriculture	123	5.1	Education and Educational Research	43	6.0
Business and Economics	102	4.2	Agriculture	29	4.0
Infectious Diseases	93	3.8	Computer Science	29	4.0
Education and Educational Research	79	3.2	Physics	29	4.0
Mathematics	71	2.9	Public, Environmental and Occupational Health	29	4.0

Source: Calculated from the Web of Science database (2022).

non-African partners at and beyond their alma maters (Confraria et al. 2018).

Topics of the Africa–Sweden and Africa–Finland coauthored scientific articles

It should be noted that the inclusion of a scholar affiliated with an organization from Africa in a coauthored article does not necessarily mean that the article's content is related to Africa. Each article in the Web of Science database is assigned to at least one subcategory, often multiple. According to the Web of Science categories (which consists of 20 main categories and 256 subcategories), Africa–Sweden coauthored articles covered 199 (77.7%) subcategories at least once between 2015 and 2021, while Africa–Finland coauthored articles covered noticeably fewer (148, 58.3%) subcategories. Articles coauthored exclusively between scholars affiliated with Africa and Sweden had fewer (136, 53.1%) subcategories again, as did those between Africa and Finland (65, 25.3%). In articles where the key topic was about Africa and which were coauthored exclusively by scholars affiliated with Africa and Sweden, the number of subcategories was even lower (86, 33.5%), as was also the case in the Africa–Finland articles (54, 21.0%).

The field of science was the most frequent in articles where scholars in Africa and Sweden or Finland collaborated (Table 3). The most common subfields included physics, astronomy, astrophysics, environmental sciences, and ecology, and the collaborations were part of large and established global international research networks. These collaborations were often led by scholars and universities from the Global North (core-in-centre), with scholars from African universities (centre-in-periphery or even periphery-in-periphery) merely providing empirical data from Africa.

It was found that the most common research areas differed between Africa–Sweden research collaborations and Africa–Finland collaborations. Universal research themes of medical sciences and ecology, and more generally, of biology, were evident here but more applied themes emerged as well. In articles coauthored by scholars in Africa and Sweden, the most common themes were environmental sciences and ecology, health, science, chemistry, and engineering. Conversely, in articles coauthored by scholars in Africa and Finland, the common themes were somewhat different: evolution, health, nature conservation, management, health risks, morbidity, biodiversity, models, and climate change.

Even in articles where Africa was a key topic, Africa (or part of it) was often only mentioned as a regional reference for international comparison, or the article simply discussed health, flora, or fauna located in Africa. Overall, the most common themes in Africa–Sweden and Africa–Finland articles were related to nature conservation, management, health risks, biodiversity, and climate change. In the collaboration articles in the fields of education, educational research, meteorology, and agriculture, the topics tended to be more case-oriented, with an applied orientation (Figure 4).

Scientific impact of Africa–Sweden and Africa–Finland coauthored articles

Measuring the exact scientific impact of Africa–Sweden and Africa–Finland research collaborations through coauthored articles is challenging. However, a general overview can be obtained by examining the number of citations that the articles receive, the prestige of the journals in which they are published, and their accessibility. Overall, articles related to medical sciences and science tend to receive higher citation counts more quickly than those in social sciences or humanities. As many of the articles analysed in this study were published recently, they have not yet garnered a significant number of citations. Mirzenami and Beaudry (2022) concluded that international collaboration positively influences African scholars' research output in terms of

Table 3. Frequently appearing organizations in co-authored Sweden–Africa and Finland–Africa peer-reviewed international articles.

Sweden			**Africa**			**Global**		
Name	NR Articles	ARWU rank	Name	NR Articles	ARWU rank	Name	NR Articles	ARWU rank
Karolinska inst.	2245	42	U of Cape Town	1912	201–300	U of London	1896	-
U of Lund	2166	151–200	U of Witwatersrand	1672	301–400	U of Calif. System	1655	5
U of Uppsala	2041	78	EKB	1199	-	CNRS	1612	-
U of Stockholm	1683	74	U of Johannesb.	1032	601–700	U of Copenhagen	1455	30
Royal Inst. of T.	1075	201–300	Moh. V U Rabat	719	>1000	Helmholtz Ass.	1440	-
U of Gothenburg	1021	101–150	Cadi Ayyad U	708	>1000	R. Karls U. Heidelberg	1373	57
U of Agricul. Sci.	948	201–300	Stellenbosch U	675	401–500	U of Harvard	1346	1
Karol. U. Hosp	786	-	Moh. 1. U Oujda	664	>1000	U College London	1340	17
U of Umeå	709	401–500	U of KwaZulu-Natal	504	601–700	U of Oslo	1338	61
U of Linköping	463	301–400	Makerere U	473	>1000	U Paris Saclay	1319	13

Finland			**Africa**			**Global**		
Name	NR Articles	ARWU rank	Name	NR Articles	ARWU rank	Name	NR Articles	ARWU rank
U of Helsinki	2105	82	Egypt knowl bank	1377	-	U of Calif. System	1395	-
Lappeenranta U Tec	770	>1000	Egyptian HEP netw	687	-	CNRS	1330	-
U of Turku	559	301–400	U of Cape Town	611	201–300	Helmholtz Ass.	1258	-
U of Oulu	494	401–500	U of Witwatersrand	416	301–400	Russian Acad. of Sci	1207	-
U of Jyväskylä	428	701–800	Cairo U	407	401–500	U Paris-Saclay	1163	13
Tampere U	411	501–600	North West U	282	601–700	U of Padua	1120	151–300
Aalto U	360	301–400	Stellenbosch U	233	401–500	United States DoE	1102	-
U of Eastern Finland	276	601–700	U of KwaZulu-Natal	214	601–700	INFN	1092	-
Finn Meteor Inst	108	-	U of Johannesburg	199	601–700	Sapienza U	1092	151–200
Nat Inst Health Welf	106	-	U of Pretoria	180	401–500	U of Bologna	1064	201–300

Source: Calculated from the Web of Science database and from ARWU (2021).

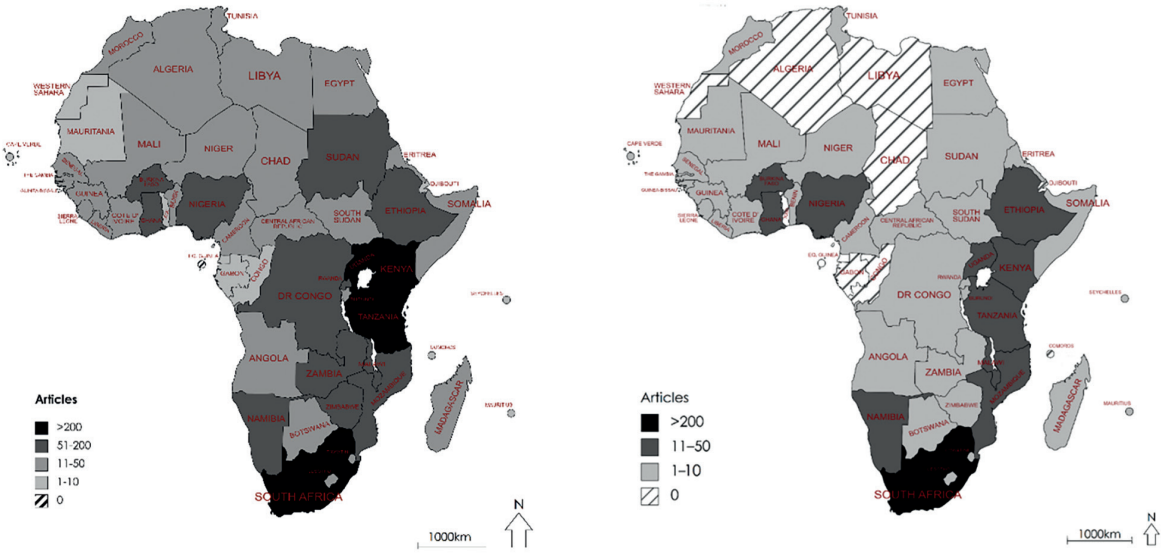


Figure 4. Geographical distribution of international scientific Sweden–Africa coauthored articles (left, n=4,225) and Finland–Africa coauthored articles (right, n=1,455), 2015–2021. Includes Africa-topic Web of Science articles in which at least one Swedish organization (left) or one Finnish organization (right) were involved. Source: Calculated from the Web of Science database (2022).

citation scores, journal scores, and the likelihood of publishing a highly-cited article. Thus, African scholars who collaborate internationally tend to perform better and have a more sustained scientific impact than their peers who do not participate in international collaborations.

One way of measuring the academic impact of articles is by the share of highly cited articles. In the 2015–2021 period, a higher percentage of Africa–Sweden coauthored articles (4.9%) were highly cited compared to all international peer-reviewed articles in the Web of Science database in which a Swedish organization was involved (1.9%). Similarly, of all Africa–Finland coauthored articles, 6.8 percent were highly cited, which is likewise higher compared to all articles affiliated with Finland (1.8%).

Regarding the ten most cited Africa–Sweden coauthored articles, seven were from medical sciences, two from astrophysics, and one from science. For Africa–Finland coauthored articles, eight were from medical sciences and two from astrophysics, including the same top-cited articles. The article that was the 100th most cited Africa–Sweden coauthored article received 428 citations (347 for Africa–Finland), and the median citation number was eight (9 for Africa–Finland). However, the citation numbers were substantially smaller for coauthored articles written exclusively by scholars affiliated with Sweden or Finland and Africa. The 100th most cited Sweden–Africa coauthored article had 36 citations (5 for Africa–Finland), and the median citation number was four (6 for Africa–Finland).

The academic prestige of authors and organizations can be inferred from the publishers they choose. Publishing an article in a high-impact factor journal is a clear indication of merit. On average, at least one international peer-reviewed coauthored article appeared annually in 247 journals for Africa–Sweden collaborations, while substantially

Table 4. Most common international scientific peer-reviewed journals of Sweden–Africa and Finland–Africa.

Sweden with also third country organization(s)				**Finland with also third country organization(s)**			
Name	Number	%	IF	Name	Number	%	IF
Plos One	249	2.3	3.240	*Journal of High Energy Physics*	295	6.4	5.810
Journal of High Energy Physics	239	2.3	5.810	*Physical Letters B*	225	4.9	4.771
European Physical Journal C	225	2.1	4.590	*European Physical Journal C*	149	3.2	4.843
Physics Letters B	182	1.7	4.771	*Astronomy Astrophysics*	133	2.9	5.802
Astronomy and Astrophysics	161	1.5	5.802	*Physical Review Letters*	96	2.1	9.227
Scientific Reports	121	1.1	4.379	*Physical Review D*	95	2.0	5.296
Only Sweden–Africa organization(s)				**Only Finland–Africa organization(s)**			
Name	Number	%	IF	Name	Number	%	IF
Plos One	84	3.4	3.204	*Plos One*	16	2.2	3.204
Pan African Medical Journal	50	2.0	0.519	*Minerals Engineering*	8	1.1	4.765
Global Health Action	49	1.9	2.640	*Scientific Reports*	8	1.1	4.379
Int J of Env Res and Public Health	22	0.8	2.468	*Applied Sciences Basel*	7	0.9	2.679
BMC Public Health	21	0.8	3.295	*Forests*	7	0.9	2.633
Malaria Journal	21	0.8	2.979	*IEEE Access*	7	0.9	4.098

Source: Calculated from the Web of Science database (2022).

fewer (82) journals were used for Africa–Finland collaborations. The multiparty international research networks tend to publish more often in prestigious journals with higher impact factors (Table 4). These authors and organizations usually had a greater number of publications and citations. This reinforces the scientific paradigms developed in the academic core-in-centre of the Global North.

Open-access publishing is crucial for increasing the visibility, accessibility, and use of articles. In the case of Africa–Sweden coauthored articles, 77.2 percent (8,011 articles) were published using open-access practices, with 37.1 percent (3,843) fully accessible (Gold Access) on the Internet. The numbers were rather similar for Africa–Finland coauthored articles, with 80.1 percent (3,622) published using open-access practices and 37.5 percent (1,173) fully accessible. However, the percentage of open-access articles was lower for coauthored Africa–Sweden and Africa–Finland articles that exclusively involved organizations from Africa and Sweden or Finland, and for those in which Africa was a key topic (Table 4).

Conclusions

Research collaborations between universities of the Global North and the Global South are increasingly supported by governments and university authorities aiming to foster international research outputs and economic development. The European Commission and the governments of Sweden and Finland aim to promote more equal partnerships with Africa. However, the hierarchies of centre-periphery collaborations and knowledge creation still continue between the Global North and Africa.

To conceptualize knowledge creation processes between scholars and universities in the Global North and the Global South, I developed a nuanced model of centres and peripheries in knowledge production. It included impactful cores (*core-in-centre*), critical edges (*edge-in-centre*), and less significant peripheries (*periphery-in-centre*) in the Global North. In the Global South, there were centres (*centre-in-periphery*), critical edges (*edge-in-periphery*), and weak peripheries (*periphery-in-periphery*).

Coauthored scientific articles between Africa, Sweden, and Finland provide evidence of the connection between research collaboration and knowledge creation processes. The empirical results of this study indicate that most coauthored research outputs are the results of collaborations between scholars affiliated with the core-in-centre in the Global North and those in the centre-in-periphery in Africa. The highest ranked universities in the Global North tend to collaborate most with the highest-ranked universities in Africa. However, in most African countries, 80 to 90 percent of their international peer-reviewed scientific articles are coauthored with scholars from the Global North (Olechnicka et al. 2019). The largest volume and most highly cited articles appear to come from global academic networks in medical sciences and science, many of which have several authors. Notably, in most cases, the primary role of scholars from African universities is to collect local data for these articles, which follow the mainstream epistemologies and themes in knowledge production that have been designed in the Global North.

Between 2015 and 2021, almost 10,500 international peer-reviewed scientific articles coauthored by scholars in Africa and Sweden were indexed in the Web of Science database, and almost 4,600 such articles were indexed by scholars in Africa and Finland. However, these collaborations played only a minor role in the academic performances of African countries and accounted for only 1–2 percent of total international scientific performance in Sweden, Finland, and most African countries. In comparison with Finland–Africa collaborations, the volume of Sweden–Africa scientific outputs was larger, and the topics were more diverse.

Research collaborations were geographically clustered in a few African countries, with South African universities present in almost half of the coauthored articles involving Africa, Sweden, and Finland. Relatively many articles were published with scholars affiliated with African countries where Sweden and Finland conducted development policy initiatives. Scholars from the highest-ranked universities in Sweden and Finland were the most active in producing coauthored articles. As regards the demographic and scholarly backgrounds of the 40 most prolific researchers who coauthored international peer-reviewed scientific articles with affiliations exclusively in Africa and Sweden or Finland, 72.5% were men and 22.5% were women. Among them, 47.5% were born in Sweden or Finland, 35% in Africa (with 22.5% born in South Africa), and 17.5% elsewhere. Furthermore, 47.5% held PhDs from Sweden or Finland, 15% from Africa (all from South Africa), and 37.5% from elsewhere. Of these 40 researchers, 85% were currently affiliated with Sweden or Finland (with 35% exclusively there), 35% in Africa (with 15% exclusively there), and 27.5% had an affiliation outside Africa besides their af-

filiation with Sweden or Finland.

To advance our understanding of research collaborations between Africa and Sweden or Finland, future research could delve into the intricate details of knowledge creation processes and practices, while paying attention to gender themes and exploring the reciprocity (or lack thereof) between partners. An important aspect to consider would be to broaden the scope of investigation beyond international peer-reviewed journals to gain a more comprehensive understanding of collaborations. In addition, it would be worthwhile to investigate to what extent the recent emphasis on more equal partnerships facilitates the science-renewing critical edges of knowledge creation. This would foster epistemological diversity and the integration of scientific and indigenous knowledge, and would contribute to the emancipation of scientific perspectives and practices in research collaboration and its scientific outputs.

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