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How Authorship Position, Journal Prestige and Author Processing Charges Impact Inequalities in COVID-19 Research with Authors from Sub-Saharan African Countries

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Abstract

COVID-19 has exacerbated research inequality because of the changes in workplace settings. This study presents an insight into the extent of inequalities during the first year of COVID-19 using Sub-Saharan African countries' COVID-19 publication data from Web of Science, MEDLINE and Scopus. The analysis included the publisher's address, CiteScore of the journals and author processing charges (APC) of open access journal articles. Only 13.4% of the journal publishers were in Sub-Saharan African countries, and 21.14% of the articles were published in Sub-Saharan African journals. Publishers from the Netherlands (30.72%), the UK (24.23%) and USA (14.81%) published the highest number of journals. Authors from the Sub-Saharan African region were underrepresented in the first and last author positions. Mega journals published outside Sub-Saharan Africa were twenty-five times more prestigious than those published in the region. Sub-Saharan Africa paid more author processing fees than it received. More equitable global research practices may reduce the imbalances as observed in this study.

Keywords: *COVID-19, Sub-Saharan Africa, Research Collaboration, International Collaboration, Research Funding.*

Introduction

Sub-Saharan Africa is one of the under-represented regions in the global research community. While Sub-Saharan Africa accounted for 17.5% of the world's population in 2020, it produced only 2.6% of the world's science on COVID-19 (Asubiaro and Shaik, 2021). Though research productivity to the gross domestic product ratio of Africa has continued to increase faster than the world's average since 2003 (Pouris and Ho, 2014; Confraria and Godinho, 2015), there is a continuous dearth of research resources in the region. Researchers in Sub-Saharan Africa collaborate with peers in high-income countries to attract funding, which has led to the dominance of research by foreign authors. For instance, researchers in Ghana were found to be motivated to collaborate with peers outside Africa by the prospect of funding (Owusu-Nimo and Boshoff, 2017). Collaboration with foreign countries usually accounts for about 50% of research in Africa, while less than 5% of the publications are products of collaboration between Sub-Saharan African countries; more emphasis has been placed on collaborating with foreign countries with little intra-Sub-Saharan African collaboration (Asubiaro 2019; Asubiaro and Badmus 2020; Onyancha 2020; Onyancha and Maluleka 2011).

Sub-Saharan African countries rely mainly on funding from foreign countries, with many foreign-funded research projects failing because Sub-Saharan African governments cannot pay counterpart funding which is usually a fraction of the funds provided by funding agencies (Bendana, 2019). Also, international collaboration, which ordinarily is a measure of development, has led to "research neo-colonialism" in Africa because of inequality in authorship positions occupied by foreign and local African authors (Boshoff, 2009; Hedt-Gauthier *et al.*, 2019).

Inequality against African research is amplified by the under-representation of African journals in the most authoritative citation indexes leading to less global visibility. For example, Asubiaro (2022) revealed Scopus, Web of Science, and PubMed covered less than 10% of biomedical journals in Sub-Saharan Africa. Africa. In a follow-up study, Asubiaro and Onaolapo (2022) revealed Web of Science and Scopus covered less than 8% of all the journals that are published in Africa.

The increase in the number of Gold Open Access (OA) articles (Laakso *et al.*, 2011; Philipp *et al.*, 2021) and journals is a good development because it helps build global equality in access to science. The development brought by OA comes at a cost because of the introduction of the authors' processing charge (APC), which is very expensive and not affordable for researchers in developing countries and young researchers. The OA's APC has caused a barrier to entrance into publishing in the elite journals by the young researchers and researchers from poor countries, thereby potentially increasing inequality among researchers

Research has shown that the challenges facing research development in Sub-Saharan Africa subsist in the COVID-19 research from the region. For instance, research in Sub-Saharan Africa is bogged down by poor funding and heavily relies on collaboration with authors outside the region, with little intra-pan-African collaboration before and during (Asubiaro and Badmus, 2020; Asubiaro and Shaik, 2021) the pandemic. Similar to the situation before the pandemic (Tiedeu, Para-Mallam and Nyambi, 2019), gender inequality against women in research was more pronounced in Africa than in other parts of the world during the COVID-19 pandemic (Pinho-Gomes *et al.*, 2020). Similarly, studies have reported the inequality in authorship positions in research from Africa before (Schneider and Maleka, 2018) and during (Hedt-Gauthier *et al.*, 2019) COVID-19, where authors from the region are underrepresented in the prestigious first and last authorship positions. Though inequality in authorship has been explored as a metric for measuring research inequality in Africa before and during the pandemic, factors influencing inequality in the region have not been investigated.

This study investigates the factors influencing inequalities in COVID-19 research focussing on authors from Sub-Saharan Africa and using authorship positions and journal prestige metrics. OA articles' APC were investigated as a factor that could affect the authorship position of researchers from Sub-Saharan Africa in COVID-19 research stemming from the problem of poor research funding, which has led to a heavy reliance on funding from outside the region for COVID-19 research (Asubiaro and Shaik, 2021). Secondly, publishers' location (in and outside Africa) and collaboration types were included as potential factors because previous studies have shown that both factors are important in determining the prestige of articles from the region (Asubiaro, 2019). This study also investigates the representation of authors from Sub-Saharan Africa in the first and last author positions in international collaboration publications that were published in prestigious journals. This study was aimed at answering the following questions:

1. How were authors from Sub-Saharan Africa represented in first and last author positions during international collaboration?
2. Which authorship role did authors from Sub-Saharan Africa play in studies that were published in prestigious journals?
3. What is the difference between the prestige of journals in which intra-African and international collaboration articles were published?

Significance of the Study

Inequality in science, a growing challenge, has been exacerbated during the COVID-19 pandemic in developing countries, especially in Sub-Saharan Africa, where resources to mount an effective response are limited (Vieira et al., 2020). While there is ample evidence in the literature on gender inequality (Bendels *et al.*, 2017; Broderick and Casadevall, 2019; Huang *et al.*, 2020), there is a dearth of research on inequality against researchers that are affiliated with universities in Sub-Saharan Africa. Understanding inequality against Sub-Saharan African researchers is important to inform decision-making and planning, especially during infectious disease outbreaks when quick and unhindered research dissemination is needed to understand aetiology, epidemiology, diagnosis, treatment,

prevention, and control is important. Inequality in science negatively affects research discovery, dissemination and ownership and hampers accurate evidence gathering to mount robust local and global responses during infectious disease outbreaks. Infectious and neglected diseases continue to affect the Sub-Saharan Africa region. The COVID-19 pandemic and the Ebola Virus Disease (EVD) are infectious disease outbreaks that have significantly affected the Sub-Saharan African region in the last two decades. There are other diseases such as malaria, which is an epidemy affecting the Sub-Saharan Africa region. HIV also continues to take a huge economic toll on the continent since its outbreak in the early 1980s, as Africa accounts for about two-thirds of the global burden of HIV (World Health Organisation, 2018). Understanding the inequality pattern among researchers affiliated with Sub-Saharan African countries is important for health and research policymaking.

Methodology

COVID-19 research records of all 46 Sub-Saharan African countries were retrieved from Scopus, MEDLINE and Web of Science databases. The search was done on the 1st of January, 2021, to capture publications in 2020, with an update in April 2021, having noticed an increment in the number of publications in 2020. The search query was composed to retrieve publications on COVID-19 that were published by authors who are affiliated with institutions in Sub-Saharan Africa. The search query included the names of all 46 countries in Sub-Saharan Africa. Variants of the Sub-Saharan African countries' names (e.g. Cameroun and Cameroon) were also included so that indexes with their variant names would be captured. All the variant names of COVID-19, as specified in peer-reviewed search strings of the Medical Library Association for bibliographic database retrieval of COVID-19 publications, were also included in the search query (LaLonde, 2020). At the early stage of the COVID-19 pandemic, before the World Health Organisation (WHO) assigned a globally recognized name, COVID-19 disease was called different names such as Wuhan coronavirus, Hubei coronavirus, China coronavirus, 2019 novel coronavirus disease, 2019-nCoV disease and Chinese Coronavirus, these names were included in our search query so that scientific publications that used such names were retrieved. Some of the names that were given to COVID-19 disease were later regarded as unethical because of their discriminatory tendencies. The search query implementation for retrieving Sub-Saharan Africa's publication from Scopus is as follows:

AFFILCOUNTRY ("South Africa" OR "Nigeria" OR "Angola" OR "Benin" OR "Burkina Faso" OR "Burundi" OR "Cameroon" OR "Cameroun" OR "Canary Islands" OR "Cape Verde" OR "Central African Republic" OR "Chad" OR "Comoros" OR "Congo" OR "Democratic Republic of Congo" OR "DR Congo" OR "Cote D'ivoire" OR "ivory coast" OR "Kenya" OR "Lesotho" OR "Liberia" OR "Madagascar" OR "Malawi" OR "Mali" OR "Mauritius" OR "Mozambique" OR "Mocambique" OR "Namibia" OR "Niger" OR "Principe" OR "Reunion" OR "Rwanda" OR "Sao Tome" OR "Senegal" OR "Seychelles" OR "Sierra Leone" OR "Somalia" OR "Sudan" OR "Swaziland" OR "Tanzania" OR "Togo" OR "Uganda" OR "Zaire" OR "Zambia" OR "Zimbabwe" OR "South Sudan" OR "Ghana" OR "Ethiopia" OR "Eritrea" OR "Gambia" OR "Botswana" OR "Guinea" OR "Djibouti" OR "Gabon" OR "Papua and Guinea" OR "Guinea-Bissau" OR "Equatorial Guinea") AND TITLE-ABS-KEY ("2019 novel coronavirus disease" OR "COVID19" OR "COVID-19 pandemic" OR "SARS-CoV-2 infection" OR "COVID-19 virus disease" OR "2019 novel coronavirus infection" OR "2019-nCoV infection" OR "coronavirus disease 2019" OR "coronavirus disease-19" OR "2019-nCoV disease" OR "COVID-19 virus infection" OR "severe acute

respiratory syndrome coronavirus 2" OR "COVID-19" OR "COVID19" OR "COVID2019" OR "SARSCoV2" OR "SARS coronavirus 2" OR "2019-nCoV" OR "2019nCoV" OR "nCoV2019" OR "nCoV-2019" OR "Wuhan coronavirus" OR "Hubei coronavirus" OR "chin coronavirus")*

A total of 2310 citations were retrieved from MEDLINE, 2400 citations were retrieved from Web of Science core collections, and 2830 citations were retrieved from Scopus. There were 3867 articles after data cleaning -removal of duplicates and errors (records with no Sub-Saharan African author).

Collaboration Types

Four collaboration types were coded: single author, national, Sub-Saharan African, and international collaborations. Single-author papers were classified as "no collaboration" papers. Papers by multiple authors who were affiliated with one or more institutions in a Sub-Saharan country were classified as *national collaboration.* Papers written by more than one author, affiliated with multiple institutions, where the institutions are located in multiple Sub-Saharan African countries and no author from institutions outside Sub-Saharan Africa were classified as *Sub-Saharan African collaboration.* National and international collaborations were regarded as internal collaborations. Papers that have multiple authors wrote with multiple affiliated institutions, where the institutions are located in at least one country within and one country outside of Sub-Saharan Africa, were classified as *international collaboration.*

Journal Information

Journal CiteScores

Two types of journals were identified in the collection-ordinary journals (sometimes referred to as journals) and mega journals. Mega journals are different from ordinary journals because they publish "larger than an average journal in a particular field" (Zhang, 2006, p. 68). This study classified journals that published more than 1,000 articles per year as mega journals. In contrast, others with less than 1,000 articles per year were classified as ordinary journals.

CiteScores for all the journals were obtained using data from Publish or Perish (PoP) software (Harzing, 2007), while the CiteScores for mega journals were collected from the Scopus Citescore report for 2021. Citescore was the choice for measuring prestige because of its simplicity, and it is an alternative to the journal impact factor. Citescore was calculated as the number of citations received from 2018 to 2020 to publications(articles, reviews, conference papers, and data papers) by a journal in the same period, divided by the number of publications in the journal within the same period[1]. We decided not to use CiteScore from journal websites because many of the journals did not have them, and we could not verify the accuracy of CiteScores for journals that included them on their websites. We also decided not to use CiteScore from Scopus for all the journals because many of the journals were not indexed in Scopus (publication data was collected from Scopus, Web of Science and PubMed). The Crossref database was queried through the PoP interface to obtain the number of articles published in a journal in the years 2018 to 2020 and the number of citations received by the publications in the journal during the 2018 to 2020 period. Crossref was chosen as the source of journal citation information because of its authoritativeness, as it is used by reputable citation data sources such as Scopus and Web of Science for the collection of citation information. A combination of the journal title, years of publication (2018-2020) and ISSN were posed as queries on the PoP software interface. One of the limitations of the PoP is that a maximum of 1000 articles can only be retrieved per journal in a given year. Since 114/121 (94.21%) of all the mega journals were captured in the 2020 Scopus CiteScore report, the CiteScores of the mega journals were obtained from Scopus 2020 Citescore report. We did not compare the CiteScores for the journals and mega journals because they were obtained from different sources.

Journal OA Status and Author Processing Charge

Conference papers, corrections, erratum, book reviews, news and preprints were excluded from the OA data collection. OA status of the retrieved publication took five values: gold, green, hybrid, bronze, and closed. APCs for only gold and hybrid

articles were collected because these OA models require the payment of APCs. APCs for the articles were obtained from available publishers' APC lists for 2020. In cases where such lists are unavailable, Way Back Machine (archive.org/web/) was consulted to retrieve relevant web pages on 2020 APC from the journal websites. Different pricing for different publication types and economic country categories through waivers were considered.

APCs listed in currencies other than the United States dollar were converted using data from www.exchangerates.org.uk/. The cost of APCs was attributed to the corresponding authors' country since the convention in most journals is the payment of APCs by the corresponding author. This method also agrees with Simard, Asubiaro and Mongeon (2021), where APCs costs were attributed to the corresponding authors' institution.

Results

From the result, a majority (55%) of all Sub-Saharan African publications on COVID-19 were produced through international collaboration. In comparison, there was a negligible research synergy among the Sub-Saharan African countries as publications from intra-Sub-Saharan African collaboration accounted for only 3% of the papers. Single authored papers constituted 13% of all the publications, and 29% of the publications were written through national collaboration. The productivity of Sub-Saharan African countries and the contribution of countries from outside Sub-Saharan Africa to COVID-19 research from the region is presented in Table 1. As usual, South Africa, Nigeria, Kenya, Ghana, Ethiopia and Ghana are the most productive countries in Africa. Usual top collaborating countries (e.g. USA, United Kingdom, Australia, India and Canada) with Sub-Saharan Africa before the pandemic ranked among the countries that contributed most to COVID-19 research in Sub-Saharan Africa.

Table 1: Productivity of Countries in and Outside Sub-Saharan Africa

Sub-Saharan African countries				Countries outside Sub-Saharan African		
Rank	**Country**	**Documents (%)**	**total link strength**	**country**	**Documents (%)**	**total link strength**
1	South Africa	1616 (41.79)	3789	USA	879 (22.73)	4628
2	Nigeria	789 (20.40)	1867	United Kingdom	712 (18.41)	4011
3	Kenya	284 (7.34)	1246	Australia	272 (7.03)	2064
4	Ghana	268 (6.93)	1044	India	256 (6.62)	2241
5	Ethiopia	261 (6.75)	510	Canada	255 (6.59)	2045
6	Uganda	181 (4.68)	806	Italy	232 (6.00)	2433
7	Cameroon	156 (4.03)	535	Germany	218 (5.63)	1967
8	Sudan	125 (3.23)	524	China	209 (5.40)	1600
9	Senegal	104 (2.69)	338	France	205 (5.30)	1445
10	Zimbabwe	104 (2.69)	405	Switzerland	181 (4.68)	1598
11	Tanzania	94 (2.43)	344	Brazil	174 (4.50)	1936
12	Zambia	72 (1.86)	379	Belgium	169 (4.37)	1053
13	Dem. Rep. of Congo	59 (1.53)	187	Spain	150 (3.88)	1608
14	Mozambique	58 (1.50)	350	Saudi Arabia	128 (3.31)	937
15	Malawi	50 (1.29)	250	Netherlands	121 (3.13)	1273
16	Rwanda	49 (1.27)	241	Sweden	106 (2.74)	1068
17	Burkina Faso	44 (1.14)	146	Egypt	102 (2.64)	1046
18	Mali	41 (1.06)	139	Japan	91 (2.35)	1164
19	Benin	36 (0.93)	248	Iran	84 (2.17)	974
20	Botswana	34 (0.88)	155	Turkey	82 (2.12)	915

Inequality in the Geographical Distribution of Journal Publishers

The 3832 publications appeared in 1263 journals and were published by 308 publishers (after removing preprints, papers in conference proceedings, erratum, corrections and news). Letters and editorials were included in the analysis because of their importance in COVID-19 research (Teixeira da Silva, 2021). The twenty most popular journal publishers and their countries/locations are presented in Table 2. Elsevier and Springer, in the Netherlands, published 30.33% of all the journals and 27.69% of all the articles. Pan African Medical Journal is the most popular journal/ publisher in Sub-Saharan Africa and contains 8.43% of all the articles.

Further analysis shows that only 13.4% of the publishers are in Sub-Saharan African countries. This shows that 21.14% of the articles were published in Sub-Saharan African journals. This suggests that most of the journal articles from Sub-Saharan Africa that are indexed in Scopus and Web of Science are not published in Sub-Saharan Africa. South Africa housed the highest number of publishers, journals and journal articles; 8.16% of the publishers in South Africa published 10.75% of the articles in 4.03% of the journals. USA (20.92%) and the UK (13.73%), and India (6.21%) house the highest number of publishers. Publishers from the Netherlands (30.72%), the UK (24.23%) and USA (14.81%) published the highest number of journals. Similarly, publishers from the Netherlands (28.18%), the UK (20.15%) and USA (13.49%) published the highest number of journal articles.

Table 2: Journal Publishers' Location/Country

	Publisher	Country	No of Journals (%)	No of papers (%)
1	Elsevier	Netherlands	243 (19.24)	720 (18.79)
2	Springer	Netherlands	140 (11.09)	341 (8.90)
3	Pan African Medical Journal	Kenya/Cameroun	1 (0.08)	323 (8.43)
4	Informa UK	UK	135 (10.69)	286 (7.46)
6	South African Medical Association	South Africa	7 (0.55)	199 (5.19)
5	Wiley	USA	91 (7.21)	189 (4.93)
7	Oxford Academic	UK	37 (2.93)	104 (2.71)
8	AOSIS	South Africa	17 (1.35)	101 (2.64)
9	Sage	Germany	50 (3.96)	90 (2.35)
10	MDPI	Switzerland	24 (1.90	88 (2.30)
11	British Medical Journals	United Kingdom	12 (0.95	88 (2.30)
12	Frontiers	Switzerland	20 (1.58)	81 (2.11)
13	American Society of Tropical Medicine and Hygiene	USA	1 (0.08)	60 (1.57)
14	PLOS	USA	4 (0.32)	56 (1.46)
15	Emerald	UK	28 (2.22)	54 (1.41)
16	Wolter Kluwers	India	30 (2.38)	53 (1.38)
17	the International Society of Global Health (ISoGH)	UK	1 (0.08)	44 (1.15)
18	Cambridge University Press	UK	15 (1.19)	36 (0.94)
19	Hindawi	United Kingdom	20 (1.58)	35 (0.91)
20	Academy of Science of South Africa	South Africa	3 (0.24)	29 (0.76)

Representation of Journal Publishers from Sub-Saharan Africa across Collaboration Types

The result of the analysis of the addresses of publishers is presented in Table 3. Most of the journals (78.9%) were published outside Sub-Saharan Africa. The proportion of international collaboration articles that were published outside Sub-Saharan Africa is 91.5%. Only 33.3% to 36.3% of papers that were written through single authorship and internal collaboration were published in Sub-Saharan African journals. In contrast, only 8.5% of the articles written through international collaborations were published in journals from Sub-Saharan Africa.

Table 3: Publishers in and outside Sub-Saharan Africa

Collaboration Type	Publishers' location		Total
	Outside Sub-Saharan Africa	In Sub-Saharan Africa	
No collaboration	293 (63.7%)	167 (36.3%)	460
National collaboration	635 (62.6%)	379 (37.4%)	1014
Sub-Saharan Africa	82 (66.7%)	41 (33.3%)	123
International collaboration	1817 (91.5%)	168 (8.5%)	1985
Total	**2827 (78.9%)**	**755 (21.1%)**	**3582**

Inequality in Journals' Prestige (CiteScore) across Collaboration Types and Publishers' Location

The analysis of journal prestige is presented for the two groups of journals-(ordinary and mega journals) in Table 4. Table 4 shows the differences between the CiteScore of journals and mega journals based on publishers' addresses (in and outside Sub-Saharan Africa). The result indicates that the average CiteScore of ordinary journals published outside Sub-Saharan Africa (average cite score=5.75) is five times greater than those published in the Sub-Saharan African region (average cite score-1.11). In comparison, the average CiteScore of the mega journals published outside the Sub-Saharan African region ((average cite score=18.08) is twenty times greater than those published in the region ((average cite score=0.90). This result paints a grim picture of inequality between ordinary journals and mega journals in and outside Sub-Saharan Africa that published COVID-19 articles with authors from Sub-Saharan Africa. The most prestigious ordinary journals from Sub-Saharan Africa received an average CiteScore of 7.52, almost ten times lower than the best journals published outside Sub-Saharan Africa. The gulf widened with mega journals as the most prestigious mega journal from Sub-Saharan Africa received 3.80 CiteScore, 24 times lower than the CiteScore of the most prestigious mega journal from outside Sub-Saharan Africa.

Articles through international collaboration were published in more prestigious journals (Cite score=6.80) and mega journals (Cite score= 16.66) than publications through single-authored papers and internal collaborations. Though mega journals are more prestigious, with a higher average CiteScore of 11.79 compared to ordinary journals with an average CiteScore of 5.01, papers through internal collaboration appeared in mega journals much lower than the average mega journal CiteScores- Sub-Saharan African collaboration-(average cite score=1.85) and national collaboration-(average cite score=3.96). While journal articles from Sub-Saharan Africa collaborations were published in journals with average CiteScores of (5.67), that are high compared to articles from international collaboration with an average Citescore of (6.80), the number of papers through the latter is 17 times higher than the former.

Table 4: Journals and Mega Journals' CiteScore based on Publishers' location (In or outside Sub-Saharan Africa) and Collaboration Type

			N	Mean	Std. Deviation	Min	Max
Publishers' Location	Ordinary Journals	Outside Sub-Saharan Africa	2268	5.75	7.74	0.00	74.57
	Mega Journals	In Sub-Saharan Africa	432	1.11	0.94	0.09	7.52
		Outside Sub-Saharan Africa	559	18.08	28.19	0.21	91.50
		In Sub-Saharan Africa	323	0.90	0.49	0.80	3.80
Collaboration Type	Ordinary Journals	No	412	2.44	4.37	0.03	66.85
		National	750	2.86	4.85	0.01	74.57
		Sub-Saharan Africa	81	5.67	6.93	0.15	27.45
		International	1457	6.80	8.45	0.00	74.57
		Total	**2700**	**5.01**	**7.31**	**0.00**	**74.57**
	Mega Journals	No	49	10.14	18.46	0.80	91.50
		National	265	3.96	9.52	0.21	91.50
		Sub-Saharan Africa	41	1.85	2.32	0.80	11.60
		International	527	16.66	28.61	0.80	91.50
		Total	**882**	**11.79**	**23.92**	**0.21**	**91.50**

Inequality in Author Processing Charges Paid across Collaboration Types and Publishers' Location

Of the journal publications, 1,979 had gold or gold hybrid OA status. The Author Processing Charges and CiteScores of 1870 articles were available (i.e. the APC and CiteScores of 1422 articles in 443 journals and 448 articles in 95 mega journals. Journals published in Sub-Saharan Africa were three times cheaper ($433.36) than those that were published outside the region. Descriptive statistics of the author processing charges paid for OA journal articles are presented in Table 5. Journals published in Sub-Saharan Africa averagely ($225.73), cost seven times less than those published outside Sub-Saharan Africa ($1557.05). Journals published outside Sub-Saharan Africa cost as much as $8536.45, almost ten times more than the most expensive journal from a Sub-Saharan African publisher.

Though most of the journal articles that were published through single-authorship and internal collaborations were published in journals by foreign publishers (see Table 3), it is interesting that the author processing charges paid were much lower than in international collaboration.

Table 5: Descriptive Statistics of Author Processing Charge Paid for OA Journals Articles

		N	Mean ($)	Std. Deviation	Min ($)	Max ($)
Publishers' Location	Outside Sub-Saharan Africa	1354	1557.05	1421.71	.00	8536.45
	In Sub-Saharan Africa	516	225.73	176.14	.00	892.30
	Total	**1870**	**1156.03**	**1338.41**	**.00**	**8536.45**
Collaboration Types	No collaboration	231	583.96	953.68	.00	4052.00
	National collaboration	594	537.04	819.94	.00	5380.00
	Sub-Saharan Africa	56	808.70	1457.57	.00	8536.45
	International collaboration	989	1744.74	1436.11	.00	6000.00
	Total	**1870**	**1189.69**	**1351.33**	**.00**	**8536.45**

Inequalities in Authorship Role during International Collaboration

The geographical distribution of the first and last authors is presented in Table 6. Though South Africa, a country in Sub-Saharan Africa, contributed to the highest number of publications, the highest number of first authors (in the 1985 articles from international collaboration) came from USA (n=336, 16.92%). Other countries that produced the highest number of first authors are South Africa (n=261, 13.15%), the UK (n=251, 12.65%), Nigeria (n=168, 8.46%), and India (n=71, 3.58%). Similarly, USA (15.42%), followed by South Africa (13.1%), the UK (10.78%), Nigeria (5.09%) and China produced the highest number of last authors. There were only three Sub-Saharan African countries in the first ten countries with the highest number of first (South Africa, Nigeria and Ghana) and last authors (South Africa, Nigeria and Kenya).

Apart from the under-representation of authors from Sub-Saharan Africa as first and last authors, differences in journal CiteScores were also explored. Journal publications with local first authors (average Citescore=5.44) and last authors (Citescore=6.26) received average CiteScores lower than those with foreign first authors (average average Citescore=7.33) and last authors (average Citescore=7.11), mega journal publications with local first authors (average Citescore=10.01) and last authors (average Citescore=10.96) received CiteScores and those with foreign first authors (average Citescore= 21.33) and last authors (average Citescore19.66), respectively.

Table 6: Top twenty countries of first and last authors in the COVID-19 articles

	First authors			Last authors		
Rank	**Country**	**Number of papers**	**Percentage**	**Country**	**Number of papers**	**Percentage**
1	USA	336	16.93	USA	306	15.42
2	South Africa	261	13.15	South Africa	260	13.10
3	UK	251	12.64	UK	214	10.78
4	Nigeria	168	8.46	Nigeria	101	5.09
5	India	71	3.58	China	54	2.72
6	China	70	3.53	France	53	2.67
7	Australia	61	3.07	Canada	50	2.52
8	France	60	3.02	India	49	2.47
9	Canada	56	2.82	Kenya	49	2.47
10	Ghana	54	2.72	Australia	44	2.22
11	Belgium	50	2.52	Germany	41	2.07
12	Italy	48	2.42	Uganda	38	1.91
13	Germany	45	2.27	Ghana	37	1.86
14	Saudi Arabia	41	2.07	Italy	36	1.81
15	Ethiopia	38	1.91	Cameroon	35	1.76
16	Switzerland	38	1.91	Spain	28	1.41
17	Kenya	37	1.86	Brazil	25	1.26
18	Uganda	36	1.81	Sudan	24	1.21
19	Cameroon	35	1.76	Belgium	22	1.11
20	Congo	32	1.61	Egypt	22	1.11
	Total	**1985**		**Total**	**1985**	

Table 7: Differences in the CiteScores based on the location of the First and Last Authors During International Collaboration

			N	Mean	Std. Deviation	Min	Max
Journals	First Authorship	Foreign					
		author	858 (58.84%)	7.33	8.65	.00	74.57
		Local Author	387 (26.54%)	5.44	7.30	.06	66.85
		Hybrid	213 (14.61%)	7.12	9.27	.00	66.85
		Total	**1458**	**6.80**	**8.45**	**.00**	**74.57**
	Last Authorship	Foreign author	926 (63.51%)	7.11	9.01	.00	74.57
		Local Author	530 (36.35%)	6.26	7.36	.00	66.85
		Hybrid	2 (0.14%)	4.06	3.02	1.92	6.19
		Total	**1458**	**6.80**	**8.45**	**.00**	**74.57**
Mega Journals	First Authorship	Foreign	272 (51.61%)	21.33	31.08	.80	91.50
		author					
		Local Author	194 (36.81%)	10.01	22.59	.80	91.50
		Hybrid	61 (11.58%)	16.96	30.45	.80	91.50
		Total	**527**	**16.66**	**28.61**	**.80**	**91.50**
	Last Authorship	Foreign					
		author	345 (61.67%)	19.66	30.68	.80	91.50
		Local Author	182 (34.54%)	10.96	23.24	.80	91.50
		Total	**527**	**16.66**	**28.61**	**.80**	**91.50**

Discussion

Low Research Integration among Sub-Saharan African countries

Evidence of low research integration among the Sub-Saharan African countries well documented in the literature, before (Asubiaro, 2019; Onyancha and Maluleka, 2011) and during (Asubiaro and Shaik, 2021) the COVID-19 pandemic. Though international collaboration is a positive development, a delineation among in the pan Sub-Saharan African collaboration is a concern. With most publications categorised as international collaboration and only 3% intra-Sub-Saharan African collaboration, it portrays Sub-Saharan African countries on researchers outside the continent. A three-throng collaboration pattern that includes a balanced blend of national, intra-Sub-Saharan African and external collaboration solutions was proffered by Onyancha (2020).

Journals Published in and Outside Sub-Saharan Africa

Foreign publishers are dominant at the expense of local Sub-Saharan African journals as most of the COVID-19 articles with Sub-Saharan African authors were published in foreign journals. This inequality is a result of many years of epistemic bias against the knowledge that is produced in Sub-Saharan Africa as being inferior to those from the West. Only a fraction of research from Africa is indexed in the citation databases because they do not meet the set standard (Nwagwu, 2010). Sub-Saharan Africa's challenges are different from other parts of the world; the same applies to the region's level of development. Researchers from this region, like other regions of the world, work based on this reality. In contrast, the major citation databases only collect data based on the world-view of the researchers from the dominant western countries, thereby favouring knowledge that is produced in the West. Perhaps, the result could have been different

if a fair representation of publications from Sub-Saharan Africa had been indexed in the major citation databases. Because of the bias against publications from indigenous Sub-Saharan African publishers, (Harsh *et al.*, 2021) recommended the inclusion of publications deposited on academic social networking sites of Sub-Suharan Africa's publication data because they contain some of the articles that are not captured in the conventional citation databases.

This study also shows a big inequality in the prestige of journals that are published in and outside Sub-Saharan Africa. This explains why even researchers affiliated with institutions in Sub-Saharan Africa published more than 60% of their journal articles in foreign journals, despite the cheaper author processing charges of journals from publishers in Sub-Saharan Africa. These journals are in a conundrum because while the Sub-Saharan African journals do not have global appeal because they focus on Sub-Saharan African-related themes, researchers from the region want global visibility for their works. Sub-Saharan Africa has an author processing fee deficit because they pay more author processing fees than they receive.

Deficit in Author Processing Fee

Authors in Sub-Saharan Africa pay more author processing fees than the amount received by the publishers in the region. Therefore, author processing fees paid by researchers in Sub-Saharan Africa mostly go to publishers in the UK, Europe and North America.

Foreign authors hardly publish in Sub-Saharan African journals even when collaborating with researchers from Sub-Saharan African countries. Though the journals that are published in Sub-Saharan Africa are much cheaper in author processing charges, they are also not attractive because they rank low in prestige. Besides, journals in Sub-Saharan do not enjoy the robust infrastructure that is available to journals outside the region; these infrastructures support easy retrieval, fast review, easy dissemination and visibility of manuscripts. For instance, authors prefer to publish in foreign journals with infrastructure that have trackable and fast review process.

Inequality in Collaboration Patterns

It is very interesting that most of the publications were produced through international collaboration. By the way, the argument in this study is not against international collaboration in Sub-Saharan Africa's research. International collaboration portrays a level of development in science, and previous studies have shown it benefits Sub-Saharan Africa (Frieden and Damon, 2015; Tesema *et al.*, 2020). However, I argue against the dominance of international collaborators and recommend an increase in synergy among the Sub-Saharan African countries for research partnerships. Sub-Saharan Africa, as a social entity in the research world, has the mandate to create its own research agenda. Right now, research stakeholders have not created research frameworks or infrastructure that facilitate health research collaboration and synergy between Sub-Saharan African countries. The progress that is recorded, if any, is from the auto-pilot mechanism that has been in place for pan-Sub-Saharan African research integration that is past over due. Though each country in the region may have its own research agenda/framework, pan-Sub-Saharan Africa research will strengthen the scientific position of the individual countries and the region as a unit in the global scientific system.

Inequality in Authorship Positions during International Collaboration

It is concerning that foreign authors dominated the first and last author positions. This is a depiction of inequality against authors in Sub-Saharan Africa's COVID-19 research. This result corroborates earlier studies that reported authors from Ghana, a Sub-Saharan African country, participate in international collaboration in fringe roles like data collector (Owusu-Nimo and Boshoff, 2017). Studies have reported that power dynamics shape how authors from low and middle-income countries, like the Sub-Saharan African countries, are represented when they collaborate with authors from high-income countries. Hedt-Gauthier *et al.*, (2019) also revealed that authors from Africa were less likely to feature in the first and last author positions when they engaged in collaboration with foreign authors.

The power dynamics between authors in Sub-Saharan Africa and high-income countries stem from

practices that are associated with epistemic wrongs of pose or positionality and gaze or audience. Epistemic wrongs that are associated with pose or positionality also occur when "knowledge practices limit the extent to which members of marginalised social or epistemic groups have ownership of knowledge production and sensemaking" (Bhakuni and Abimbola, 2021, p. e1466). The power dynamics that relegate Sub-Saharan African authors from the lead authorship position in studies about Sub-Saharan Africa is limiting the extent to which they own knowledge from their locality. Authorship positions mostly reflect the sensemaking or intellectual contribution of authors. It is perceived that the lead and last authorship positions in research are the most prestigious because they mostly theorise, interpret data and lead other researchers on the authorship list, while others that are stuck in the middle may not have contributed in the same magnitude. The practice of not recognising local authors in the lead/last authorship position downplays the sensemaking ability of the local authors, who may better understand the problems because they have first-hand experience and therefore be in the best position to perform the duties of the first and last author.

Conclusion and Recommendations

This study focused on studying inequality in COVID-19 research from Sub-Saharan Africa. The study found that international collaboration accounted for the majority of the studies. While international collaboration is a good development, the synergy between Sub-Saharan African countries which is negligible, is concerning. This study also found the dominance of advanced countries in prominent authorship positions (first and last author). Articles published through internal Sub-Saharan African collaboration appeared less prestigious journals than the those from international collaborations. This study also found that Sub-Saharan African researchers mostly publish in journals outside the region, though the journals that are published in the region are much cheaper but less prestigious.

This study recommends a scientific partnership between Sub-Saharan Africa and the developed countries, one that eradicates the imbalances between researchers from developed countries and the region. There is a need for a more equitable partnership that encourages publishing important research in journals that are published in Sub-Saharan Africa. One of the selling points of the journals from Sub-Saharan Africa is they are very cheap, and they could become more prestigious if more important articles are published in them. The inclusion of local researchers from Africa as lead authors and not as "ordinary field agents" especially in studies about or in Sub-Saharan Africa, is important for creating equity.

There is a need for research stakeholders in Sub-Saharan Africa to design a roadmap for a stronger research partnership between Sub-Saharan African countries.

Limitations of the Study

One of the limitations of the study is that the effect of the number of authors on authorship position was not normalised. For instance, the last authors in two-authored papers may be nominal since the second author is automatically the last author. Secondly, we did not collect data before the COVID-19 pandemic so a comparative study could be made.

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