Journal of Health Promotion and Behavior (2024), 09(04): 329-346
Masters Program in Public Health, Universitas Sebelas Maret
Systematic review
Open Access

# COVID-19 Research in Africa: A Bibliometric Analysis (2019-2021)

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*Received:11 August 2024; Accepted: 23 August 2024; Available online: 16 October 2024*

## ABSTRACT

**Background:** The COVID-19 pandemic has generated an unprecedented volume of research globally, with a significant but varied focus on Africa. Given the unique socio-economic and healthcare challenges faced by the continent, understanding the landscape of COVID-19-related research in Africa is crucial. This study aimed to analyse the body of literature focused on Africa, identifying patterns, trends, and the conceptual, intellectual, and social structures underlying the research. By uncovering these elements, the study provides insights into the strengths and gaps within the existing body of work, offering a foundation for future research and policy formulation.
**Subjects and Method:** A quantitative approach was employed to examine 4,290 documents related to COVID-19 research focused on Africa, sourced from the Web of Science (WoS) database between November 1, 2019 to February 1, 2022. The Bibliometrix R-package was utilized for data processing and visualization, enabling the identification of patterns, trends, and underlying structures within the literature.
**Results:** The analysis revealed significant local and international collaboration in COVID-19 research focused on Africa. Four major themes emerged: (1) Health Systems, Policy, Workers, and Public Health; (2) Mental Health, Depression, and Anxiety; (3) COVID-19's impact on HIV, Poverty, and Children; and (4) its impact on Education. Institutional collaborations were particularly strong among the top five South African universities, highlighting a robust social structure. The productivity of authors conformed to Lotka's Law, while periodical distribution followed Bradford's Law of Scattering. Keywords Plus and Abstract Words offered a comprehensive description of the research domain.
**Conclusion:** The findings highlight the collaborative nature and thematic focus of COVID-19 research in Africa, emphasizing the importance of international collaboration. Future research should address identified gaps to deepen and enhance the impact of studies in this area.

**Keywords:** Africa COVID-19; COVID-19 research; bibliometrics; citation analysis.

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**Cite this as:**
Sanni SA, Yusuf AO, Tsabedze VW, Mathabele NN (2024). COVID-19 Research in Africa: A Bibliometric Analysis (2019-2021). J Health Promot Behav. 09(04): 329-3346. https://doi.org/10.26911/thejhpb.2024.09.04.05.

## BACKGROUND

Applying bibliometric methods to disciplines, domains, and subject areas is crucial for scientific development, assessment, appraisal, and tracking. Bibliometric analysis is particularly useful for science mapping and visualisation, especially when examining trending and voluminous research streams. Bibliometrics offers a more objective and reliable analysis of scientific literature (Aria and Cuccurullo, 2017; Sanni et al., 2014). The rate of scientific publication related to COVID-19 during the pandemic was immense, and increased at a record pace, with significant implications for scientific productivity and tracking (Aviv-Reuven and Rosenfeld, 2021; Else, 2020; Fonkou et al., 2021). The pandemic period altered the publication patterns of authors worldwide. Most papers were preprint articles posted online before peer review and open-access publications (Lee and Haupt, 2021), with over 100,000 articles on COVID-19 published before December 2020 (Else, 2020). Aviv-Reuven and Rosenfeld (2021) observed a notably faster mean time to acceptance for COVID-19 papers compared to non-COVID-19 papers, as well as a significant reduction in international collaboration for COVID-19 papers.

Lee and Haupt (2021) observed an increase in international collaborations between countries significantly affected by the COVID-19 pandemic and less developed nations. This trend indicates a slowdown in research in non-COVID-19 biomedical fields as the pandemic persists, leading to a lower rate of international collaboration. Across all subject areas, studies have also noted a decline in paper submissions from female authors compared to their male counterparts. This decline has been attributed to the additional burden of childcare and home-schooling those women undertook during the pandemic lockdowns, a factor that should be considered in future promotion and hiring decisions (Else, 2020).

Research endeavours focusing on the COVID-19 pandemic are crucial for assessing pathogenic characteristics, therapeutic strategies, and novel treatment options for combating the disease (Chahrour et al., 2020). The World Health Organization (WHO) declared COVID-19 a Public Health Emergency of International Concern on 30 January 2020. It was initially classified as very high risk in China and high risk in other WHO regions, indicating a global threat. The first case of COVID-19 in Africa was identified on 14 February 2020 in Egypt, and the disease was declared a global pandemic on 12 March 2020. This was followed by the implementation of lockdown measures in many African countries, including South Africa, Nigeria, Egypt, Ethiopia, Cameroon, Republic of the Congo, Ghana, Zimbabwe, Uganda, Ivory Coast, Eswatini, Sudan, Gambia, Madagascar, Namibia, and Tunisia, among others (Reuters, 2021).

By May 2020, COVID-19 had spread to nearly every country in Africa through various entry points and community transmission (Cilliers et al., 2020; Reuters, 2021; WHO, 20210). The COVID-19 pandemic has impacted the entire world, including Africa, in numerous ways, resulting in overburdened healthcare systems, delayed medical treatments, mental health issues, economic recession, unemployment and business closures, supply chain disruptions, and educational interruptions. Although mortality rates in Africa are significantly lower compared to other regions, COVID-19 has nonetheless had a substantial and damaging effect on Africa's economic growth, per capita income, poverty levels, and progress towards selected Sustainable

Development Goals (SDGs) (Cilliers et al., 2020).

Fonkou et al. (2021) examined COVID-19 research patterns among African researchers between 2019 and 2021 to assess the strength of collaborations and partnerships between African scholars and those from the rest of the world. Using data from Web of Science (WoS), PubMed or MEDLINE, and African Journals Online (AJOL), the authors found that collaboration patterns differed across African regions. South Africa and Egypt emerged among the most productive countries, with collaborations outside Africa predominantly with European or North American scholars. Additionally, scholars from North Africa primarily collaborated with the Kingdom of Saudi Arabia. Similarly, Guleid et al. (2021) conducted a bibliometric study on COVID-19 research publications in Africa. Their focus was on study design, research themes, and author affiliation, revealing that 20.3% of the research was based in Africa, with South Africa being the most productive, contributing 15.4% of the research settings. Most bibliometric studies on COVID-19 in Africa have concentrated on publication productivity and collaboration networks. Therefore, this current study extends previous research by not only examining publication productivity and collaboration networks but also exploring the conceptual and social structure of COVID-19 literature in Africa. Furthermore, this study aims to evaluate whether the models that explain scientific communication patterns remain applicable during the unprecedented COVID-19 pandemic and to determine if this disruptive period adheres to major bibliometric laws and patterns.

Science mapping has become a crucial activity for scholars across all scientific disciplines. Consequently, numerous bibliometric studies have focused on COVID-19 research (Oh and Kim, 2020). Notable studies include those addressing the future agenda for COVID-19 research in pandemic and epidemic contexts (Mahi et al., 2021), methods for mapping the state of the art in COVID-19 scientific production (Mohadab et al., 2020), and how COVID-19 is influencing research in Africa (Fonkou et al., 2021). Älgå et al. (2020) analysed 16,670 COVID-19-related articles in the PubMed database from 14 February 2020 to 1 June 2020. Their findings indicated that the most prominent topics were health care responses (2812/16,670, 16.86%) and clinical manifestations (1828/16,670, 10.91%). The authors identified an increasing trend in research on clinical manifestations and protective measures, alongside a decreasing trend in research on disease transmission, epidemiology, health care responses, and radiology. Furthermore, the leading countries producing COVID-19 research were found to be the United States, China, Italy, and the United Kingdom.

While scholars typically rely on systematic and critical review processes to manage, synthesise, and understand previous research findings, a substantial compilation of scientific knowledge also heavily depends on bibliometric analysis (Sanni and Zainab, 2010, 2011; Yusuf and Nur Leyni Nilam Putri Junurham, 2021). By applying bibliometric methods to a body of literature, it is possible to identify trends over time or within a specific period, uncover new concepts and themes, detect shifts in research boundaries, and evaluate the sustainability of the research field. Therefore this study aimed to examine the growth, patterns, and trends of COVID-19 research in Africa from 2019 to 2021 using the Clarivate Analytics Web of Science Database; analyse the research front or

conceptual structure of COVID-19 research in Africa; identify the knowledge base and intellectual structure of COVID-19 research related to Africa; Map the social network structure of COVID-19 research concerning Africa. The results of this study will have implications for scientific research productivity in Africa.

## SUBJECTS AND METHOD

### 1. Study Design

The primary objective of this study is to perform a bibliometric analysis of COVID-19 research publications specifically related to Africa. By utilising the Web of Science (WoS) database as the primary data source and the Bibliometrix R-package for analysis, the study seeks to provide a comprehensive overview of the contributions and impact of African researchers in the global COVID-19 research landscape. The Web of Science database was chosen due to its extensive coverage of high-quality peer-reviewed journals across various disciplines. It is recognized as one of the most reliable sources for bibliometric analysis.

### 2. Data Collection

Data collection involved three sub-stages, and the first was data retrieval from the Clarivate Analytics Web of Science (http://www.webofknowledge.com) database covers the top scientific publications in any field. Data was extracted through a query which is a combination of terms linked by Boolean operators as follows: (COVID19 AND Africa) OR (COVID-19 AND Africa) OR (COVID 19 AND Africa) OR (COVID AND Africa) OR (Corona Virus AND Africa) OR (Coronavirus AND Africa) and returns a total of 4,290 documents between 1st of November, 2019 and 1st of February, 2022. The second sub-stage was data loading and converting, where data collected from WoS in Plaintext format was converted for use in the Bibliometrix R-package (http://www.bibliometrix.org) environment. The Web of Science database is preferred over other scientific databases for its data quality, completeness, and standardisation.

### 3. Inclusion Criteria

Inclusion criteria were all documents written in English, excluding editorials and letters and notes. The file formats were Plaintext and .txt. Several preprocessing methods were applied to detect duplicates, errors, and misspelt or unreadable character elements. The data was managed and merged in Notepad before being exported to Bibliometrix for analysis. Bibliometrix software (Aria and Cuccurullo, 2017) was used—a flexible and user-friendly open-source tool for conducting comprehensive bibliometric, citation, and science mapping analyses. Bibliometrix supports the main stages of the recommended science mapping workflow (Figure 1).

### 4. Search Strategy

A targeted search query was developed to capture research publications related to COVID-19 that have a specific focus on Africa. The query combined keywords related to COVID-19 (e.g., "COVID-19", "Coronavirus", "SARS-CoV-2", "2019-nCoV", "pandemic") with geographical identifiers related to Africa (e.g., "Africa", "Sub-Saharan Africa", names of specific African countries). The search was conducted across titles, abstracts, and keywords to maximize the retrieval of relevant publications. The search was restricted to publications from the 1st of November, 2019 to the 1st of February, 2022. The study focused on research articles, reviews, and conference papers, excluding editorials, letters, and notes to maintain data relevance. The results from the search were exported from the Web of Science database in Plaintext format, compatible with the Bibliometrix R-package. The data extracted included essen-

tial bibliographic information such as authors, titles, publication years, journals, keywords, abstracts, cited references, and citation counts.

### 5. Data analysis

The Bibliometrix R-package was used for a comprehensive bibliometric analysis. Data preprocessing was carried out which involved the identification and removal of duplicate records were identified and removed. Records with missing crucial information were excluded from the analysis. Descriptive Analysis involved identifying publication trends which is the annual growth rate of COVID-19-related publications in Africa. Citation networks analysis was carried out to identify influential research papers and their interconnections. Collaboration network analysis was examined to identify co-authorship networks through the visualization and analysis of collaboration patterns among African researchers, institutions, and international partners.

The examination of cross-continental collaborations involving African researchers, and identifying key global partnerships leads to international collaboration network pattern. The study analysed keyword co-occurrence to identify dominant and emerging research themes within African COVID-19 research; clustering related themes to visualize the structure and evolution of research topics over time. The Bibliometrix R-package provided several tools for this purpose: Trend Plots - Visualization of publication trends, including the growth of COVID-19-related research in Africa over time; Word Clouds - Visualization of the most frequently occurring keywords related to COVID-19 research in Africa; Network Graphs – Visualization of co-authorship networks, citation relationships, and collaboration patterns; Thematic Maps - Graphical representation of thematic clusters, showing the evolution of research topics and areas of focus.

## RESULTS

### 1. Characteristics of Data

A total of 4,290 documents were retrieved during the study period, authored by 32,846 unique authors, with an average of 7.66 authors per document. Single-authored documents accounted for 498, compared to multi-authored documents which totalled 32,348. This indicates a high rate of collaboration in COVID-19 research related to Africa. The average number of citations per document was 9.11, while the average number of citations per year was 3.9 (Table 1). This reflects a high citation rate for COVID-19-related publications within a short timeframe. (Table 1).

**Table 1. Characteristics of data on COVID-19 literature on Africa in WoS database**

| Characteristics | Result |
|---|---|
| Documents | 4,290 |
| Sources (Journals, Books, etc) | 1,719 |
| Average citations per document | 9,11 |
| Average citations per year per doc | 3,934 |
| Keywords Plus (ID) | 4,704 |
| Author's Keywords (DE) | 9,404 |
| Authors | 32,846 |
| Authors of single-authored documents | 498 |
| Authors of multi-authored documents | 32,348 |
| Single-authored documents | 545 |
| Documents per Author | 0.131 |
| Documents | 7.66 |

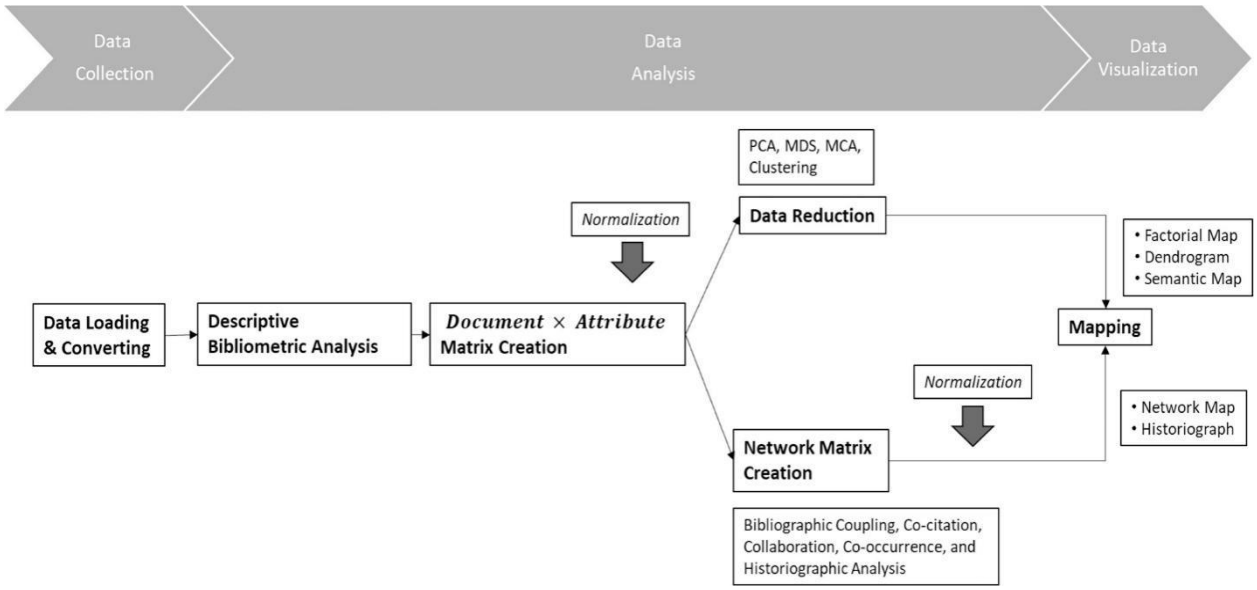



**Figure 1. Bibliometrix Workflow (Aria & Cuccurullo, 2017)**

## 2. Most relevant source

The most relevant sources in the analysis are shown in Figure 2. The most relevant sources include the South African Medical Journal (SAMJ), published by the South African Medical Association; the Pan African Medical Journal (PAMJ), published by the Centre for Public Health Research and Information, Nairobi, Kenya; and the International Journal of Environmental Research and Public Health, published by the Multidisciplinary Digital Publishing Institute (MDPI), Basel, Switzerland. Other significant sources are PLOS ONE, published by the Public Library of Science based in the USA and UK, and HTS Teologiese Studies-Theological Studies, published by African Online Scientific Information Systems, Cape Town, South Africa.

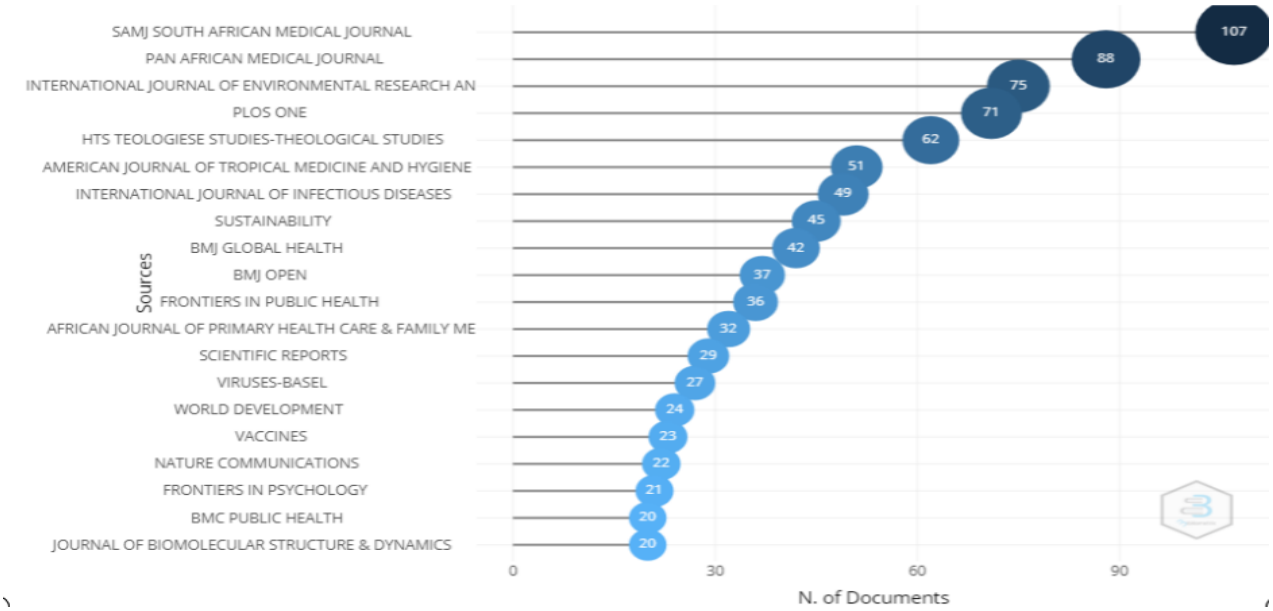



**Table 2. Most Relevant Source on COVID-19 Literature about Africa in WoS Database**

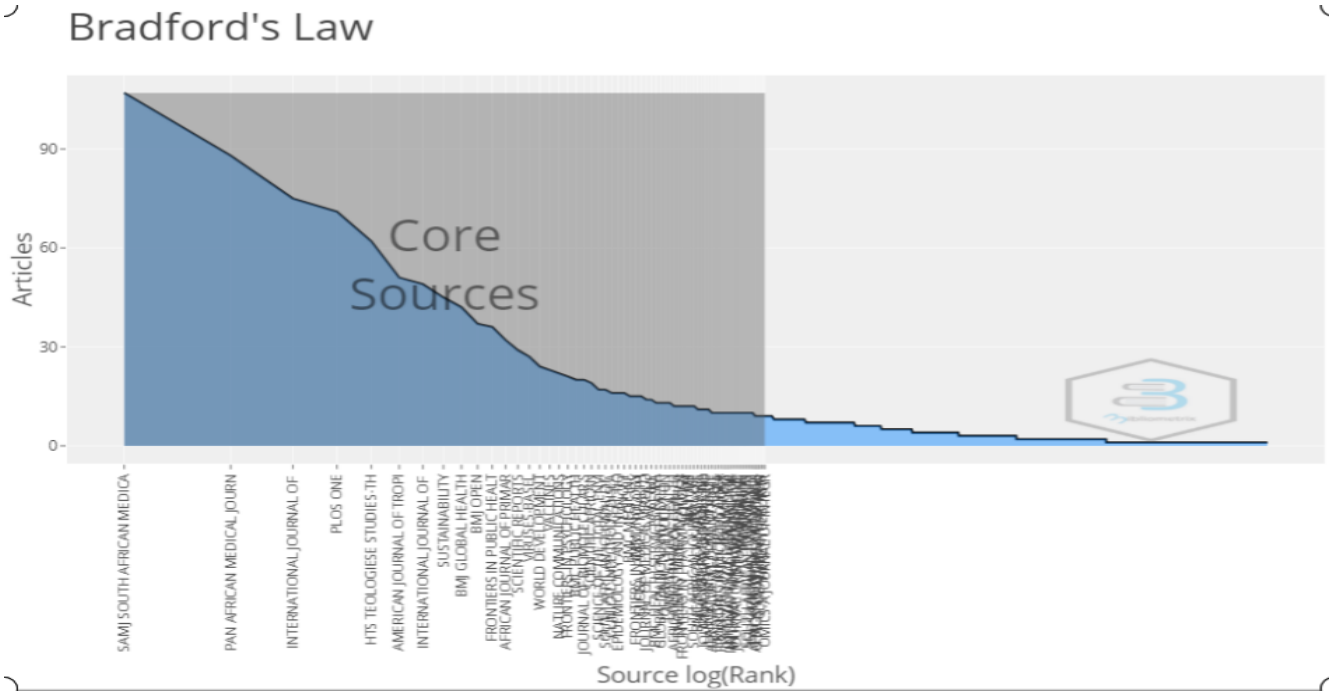



**Figure 3. Bradford's Law of Scattering in COVID-19 Literature on Africa**

The results align with Bradford's Law of Scattering (Bradford, 1948), as illustrated in figure 3, according to Bradford's Law, if journals in a field are sorted by the number of articles into three groups, each containing approximately one-third of all articles, then the number of journals in each group will be proportional to $1:n:n^2$. This theory estimates the exponentially diminishing returns of searching for references in scientific journals. Bradford's Law also helps to identify the "core" journals in COVID-19 literature related to Africa.

### 3. Most relevant keywords (author keywords and keywords plus)

Keyword Plus are words or phrases that frequently appear in the titles of an article's references but not necessarily in the article's title or as author keywords, and can capture an article's content with greater depth and variety. In contrast, Author Keywords consist of terms that authors believe best represent the content of their paper. Zhang et al. (2016) observed that keywords Plus are as effective as author keywords in bibliometric analysis when investigating the knowledge structure of scientific fields. According to figure 4, the most relevant Author Keywords are COVID-19, SARS-CoV-2, Africa, Pandemic, Coronavirus, South Africa, Public Health, and Sub-Saharan Africa. The most relevant countries in these keywords are South Africa, Nigeria, Ethiopia, and Ghana. This was expected since South Africa was the epicentre of COVID-19-related infections and deaths in Africa. South Africa, Morocco, Tunisia, and Ethiopia were among the countries with the most cases on the African continent.

In terms of caseloads, Southern Africa was the most affected region, followed by the northern and eastern parts of the continent, while Central Africa was the least affected (Africa CDC, 2021). The most notable keywords, aside from those identifying the virus and related medical terms, are HIV, Lockdown, Mental Health, Education, Children, Food Security, Health Policy, Health Systems, and Poverty. This indi-

cates that researchers were concerned about the impact of the pandemic on HIV patients, mental health, education, children, food security, and poverty.

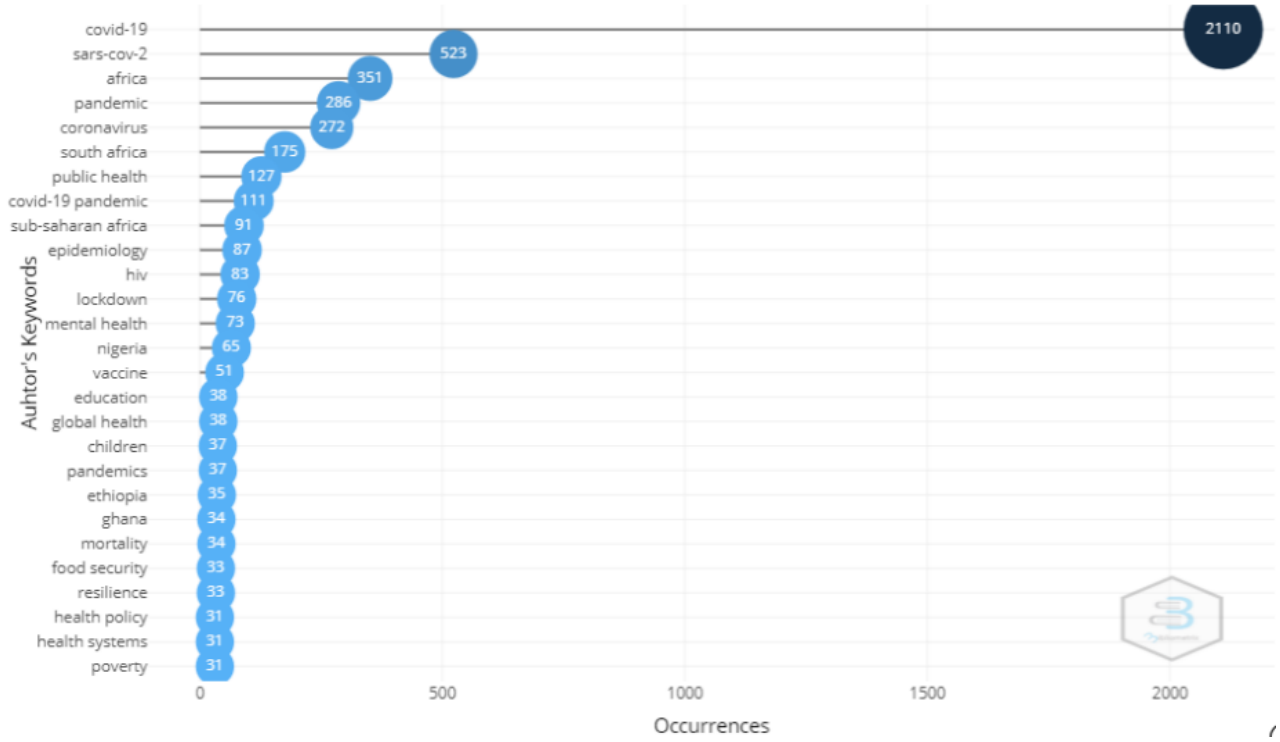



**Figure 4. Most Relevant Author Keywords on COVID-19 in WoS, 2019-2021**

## 4. World Cloud

A tag cloud or word cloud is a weighted list in visual design, or a visual representation of text data, typically used to depict keyword metadata tags on websites or to visualise free-form text. They are usually single words displayed with font size or colour indicating their importance.

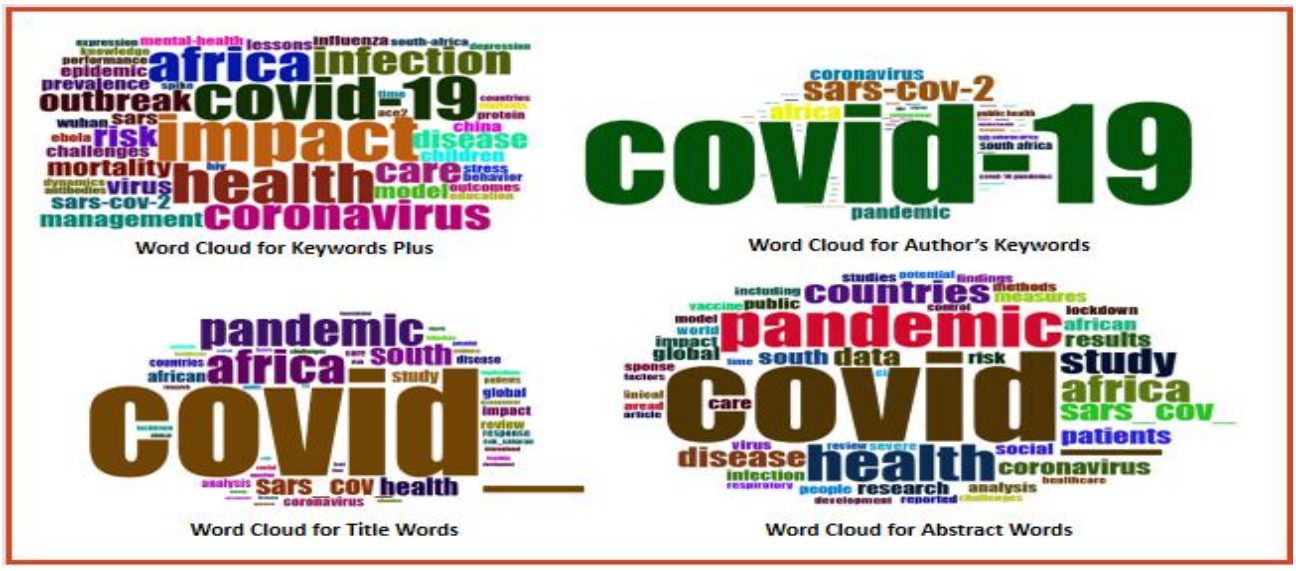



**Figure 5. Word cloud for keywords plus, author's keywords, title words and abstract words**

Figure 5 represents the word cloud for Keywords Plus, Author Keywords, Title Words, and Abstract Words. The results indicate that Keywords Plus and Abstract Words provide a better description of the research domain than Author Keywords and Title Words. Both Keywords Plus and Abstract Words highlight important topics of interest in the research area. While terms related to 'COVID-19' and the pandemic are common in the word cloud, other associated issues such as HIV, Mental Health, Depression, Stress, and Education, which are consequences of the pandemic, are more prominently reflected in both Keywords Plus and Abstract Words.

## 5. World Cloud

A total of 3,846 distinct authors were identified during the study period. More than 80% of these authors published only once, while 12% published twice. Less than 1% of the authors published more than two papers (Figure 6).

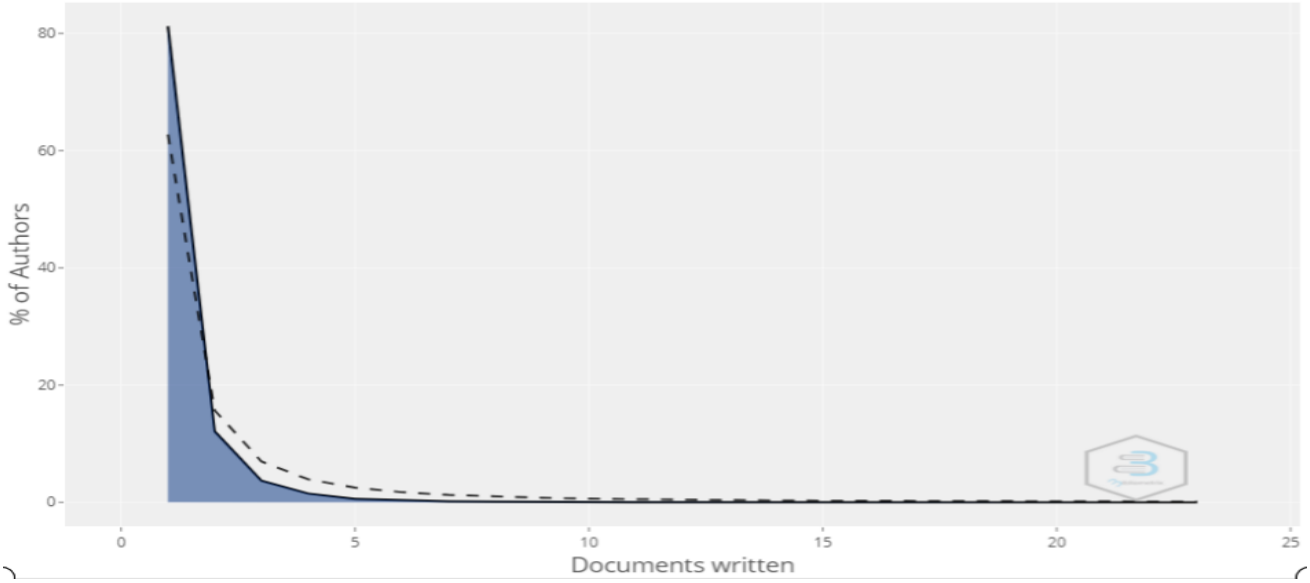



**Figure 6. Frequency Distribution of scientific productivity (lotka's law) during 2019-2021**

This result aligns with Lotka's (1926) Law, which describes the frequency of publication by authors in any given field. The law states that the number of authors making xxx contributions in a given period is a fraction of the number making a single contribution, following the formula 1/xa where a nearly always equals two. This means the number of authors publishing a certain number of articles is a fixed ratio to the number of authors publishing a single article. As the number of articles published increases, the frequency of authors producing that many publications decreases, as confirmed in Figure 5. The most relevant authors are those who have published at least 12 papers during the period under study, with only 20 authors meeting this criterion.

## 6. Corresponding authors countries

Figure 7 presents the most relevant countries of corresponding authors, highlighting that South Africa, the USA, the UK, Nigeria, and China are the top five. This indicates that publications originate from multiple countries and reflect high international collaboration in COVID-19-related research on Africa.

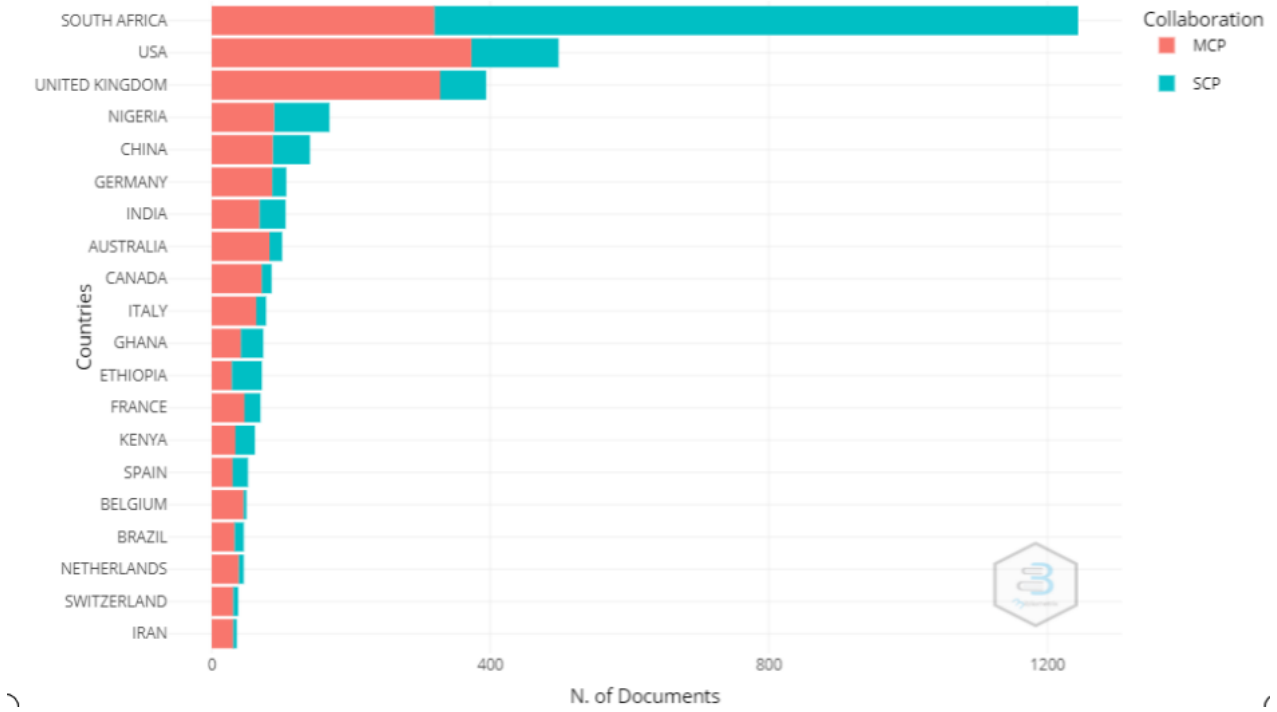



**Figure 7. Most relevant countries by corresponding authors. intra-country (scp) and inter-country (mcp) collaboration during 2019-2021**

## 7. Citation analysis

The most common analysis in bibliometrics is citation analysis, which assesses the impact or quality of a document by counting the number of times other documents refer to it in their work. Figure 8 show the most cited countries, indicating that the USA, UK, South Africa, Germany, and China are the most frequently cited.

The most cited documents are presented in figure 9. The most cited paper was by Polack et al. (2020), which discussed the safety and efficacy of the BNT162b2 mRNA Covid-19 Vaccine. It reported that a two-dose regimen of BNT162b2 conferred 95% protection against Covid-19 in persons 16 years of age or older. This research was significant in the battle against COVID-19 and was funded by BioNTech and Pfizer. The second most cited paper was by Voysey et al. (2021), which evaluated the safety and efficacy of the ChAdOx1 nCoV-19 vaccine in a pooled interim analysis of four trials among persons aged 18 years and older. The study was funded by UK Research and Innovation, National Institutes for Health Research (NIHR), Coalition for Epidemic Preparedness Innovations, Bill and Melinda Gates Foundation, Lemann Foundation, Rede D'Or, Brava and Telles Foundation, NIHR Oxford Biomedical Research Centre, Thames Valley and South Midlands NIHR Clinical Research Network, and Astra-Zeneca. The third most cited paper was by Ziegler et al. (2020), which explained the pathogenesis of the severe acute respiratory syndrome coronavirus clade 2 (SARS-CoV-2), which causes COVID-19.

## 8. Most prolific affiliation

Figure 10 show the top five most prolific institutions, all from South Africa, are the University of Cape Town, the University of the Witwatersrand, Stellenbosch University, the University of KwaZulu-Natal, and the University of Pretoria). According to the Times Higher Education university ranking

(Best Universities in Africa 2022), these universities are among the top in Africa.

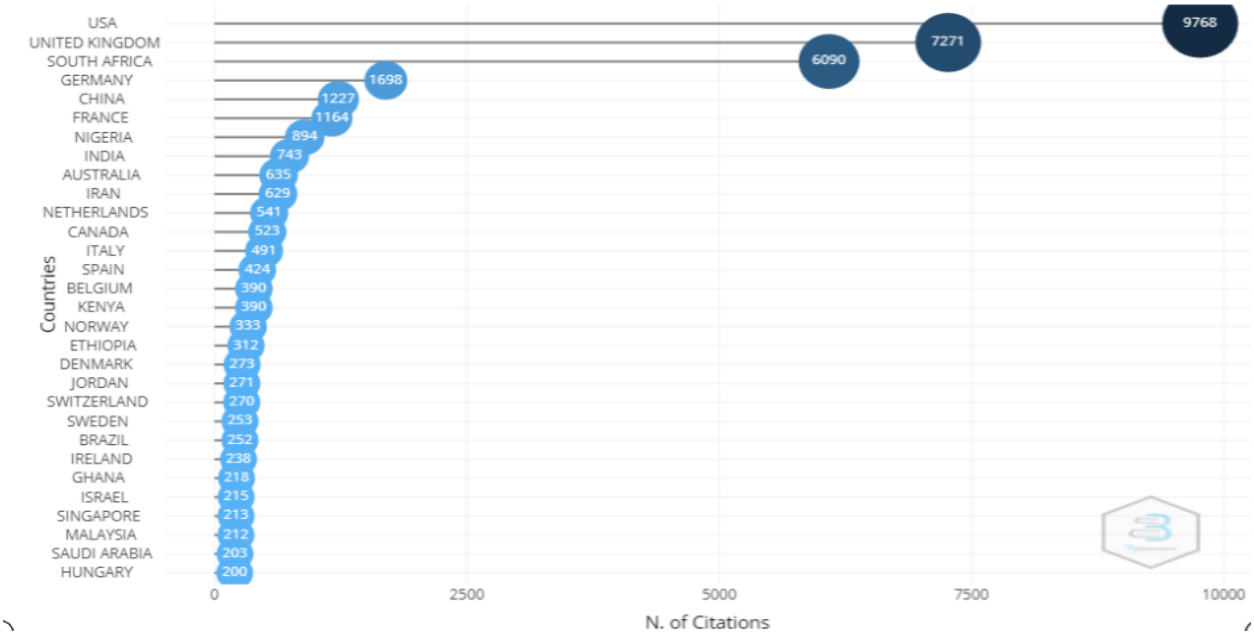



**Figure 8. Most Cited Countries during 2019-2021**

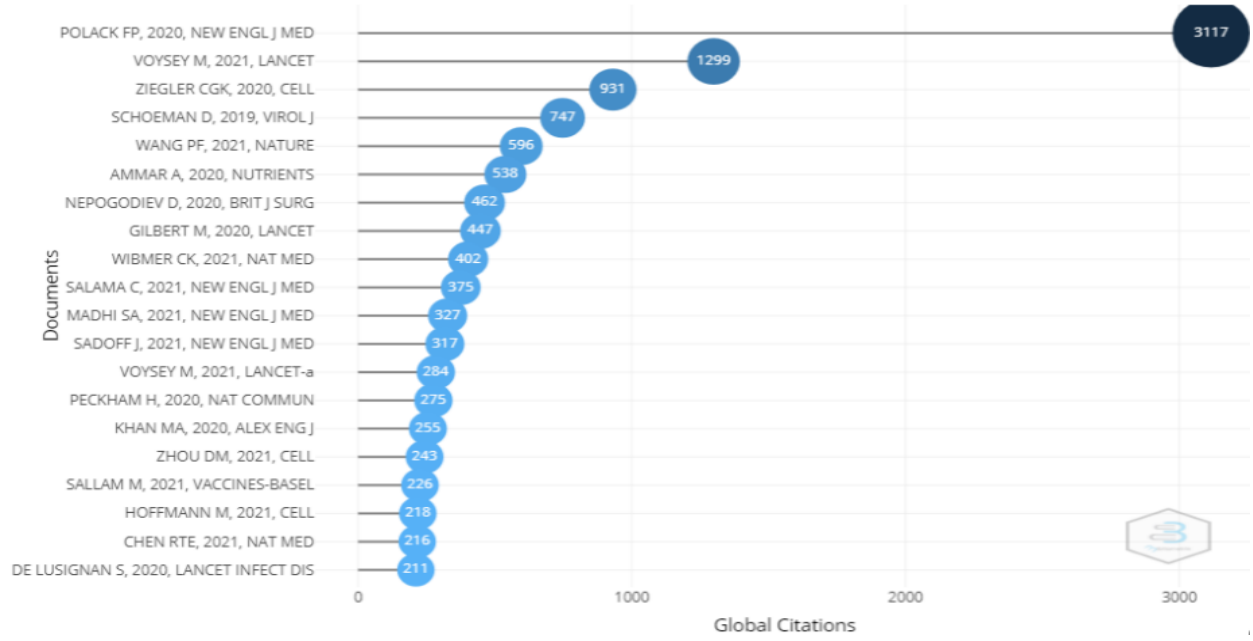



**Figure 9. Most Cited Documents during 2019-2021**

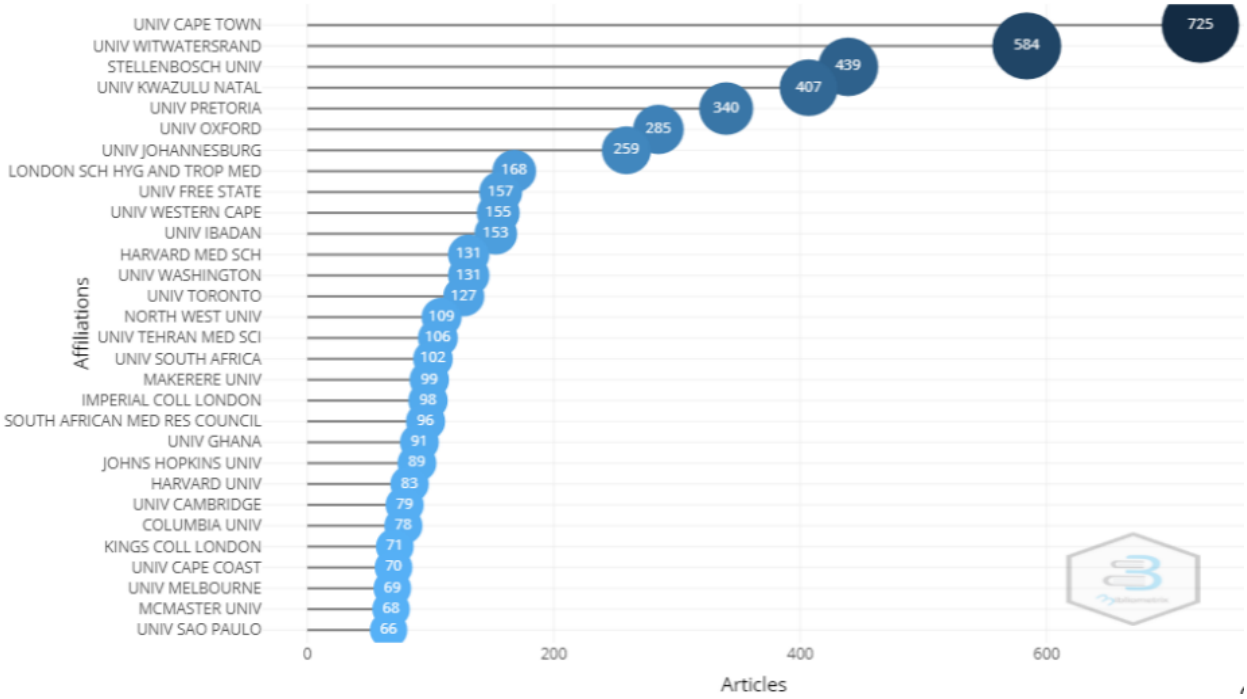



**Figure 10. Most Prolific Affiliation during 2019-2021**

## 9. Conceptual structure

The conceptual structure illustrates the framework within a subject area, presenting the knowledge synthesis of the domain. It depicts the relationships among concepts or words in a set of publications, helping to understand the topics covered by a research field and identify the most important and current discussions. This structure is essential for studying and monitoring the evolution of subjects over time. Figure 11 presents the conceptual structure of COVID-19 literature on Africa.

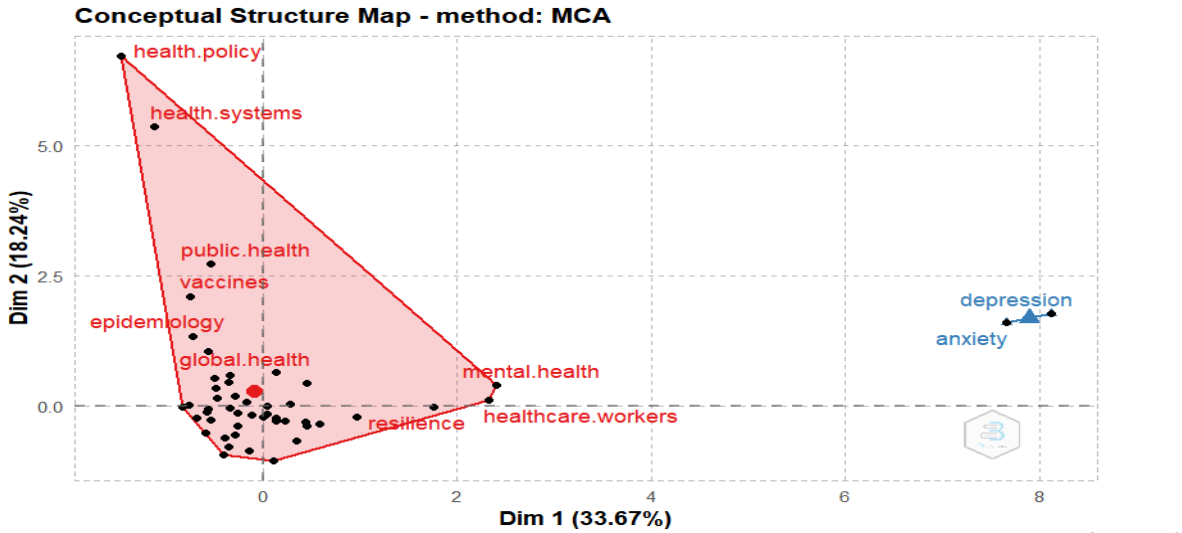



**Figure 11. Conceptual Structure Map of COVID-19 Literature on Africa: 2019-2021**

Each colour represents a cluster of words—a topic. Clusters are identified through hierarchical clustering. Two clusters can be identified in the collection: 1. Red: Health Systems and Policies; 2. Blue: Anxiety and Depression. The conceptual structure reveals the main themes and trends in the field. The main themes in the COVID-19 literature on Africa are organised into two separate clusters: one focusing on Health Policy, Health Systems, Public Health, Vaccines, and Healthcare Workers, and the other on Mental Health, Depression, and Anxiety (Figure 11).

## 10. Intelectual structure

The intellectual structure reveals the influence or impact of an author's work within a scientific community. It shows the relationships between nodes, which represent references. The network edges in the intellectual structure can have different interpretations depending on the citation type (co-citation or direct citations). Citation analysis is a common approach in bibliometrics, typically involving co-citation between authors or documents (Sanni et al., 2013). Examining co-citation (Small, 1997) over time helps to detect shifts in paradigms and schools of thought.

The intellectual structure of the COVID-19 literature on Africa is presented in Figure 12. Five major clusters can be identified in the collection for the intellectual structure: 1. Pink: COVID-19 Impact on Africa; 2. Blue: COVID-19 Lockdown in South Africa; 3. Green: Public Health and Global Health; 4. Purple: COVID-19 Impact on HIV and Children; 5. Orange: COVID-19 Impact on Education.

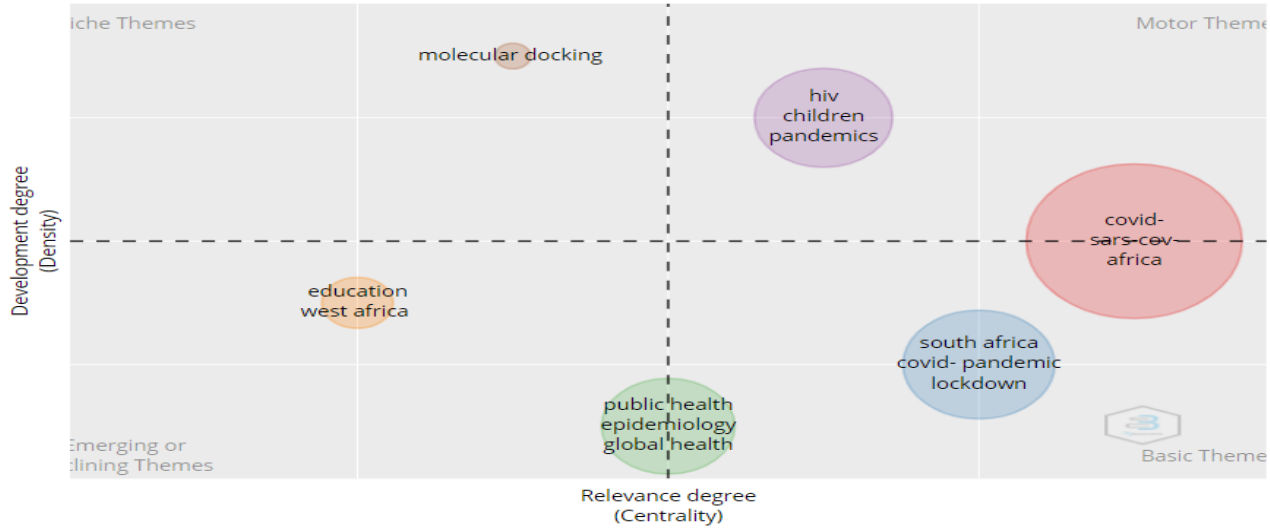


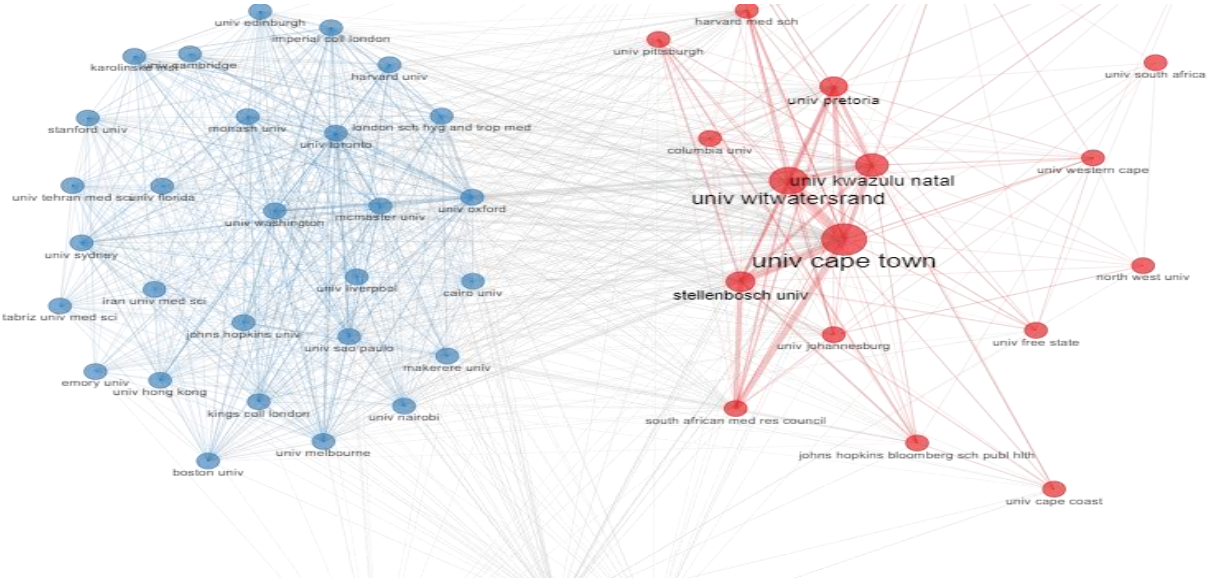

**Figure 12. Thematic**

## 11. Social sctructure

Five major clusters can be identified in the collection for the intellectual structure: 1. Pink: COVID-19 Impact on Africa; 2. Blue: COVID-19 Lockdown in South Africa; 3. Green: Public Health and Global Health; 4. Purple: COVID-19 Impact on HIV and Children; 5. Orange: COVID-19 Impact on Education.

Figure 13 showed the most significant social structure in the collection is the institutional social structure. It shows that the majority of collaborations occur between the University of Cape Town, the University of the Witwatersrand, the University of KwaZulu-Natal, Stellenbosch University, and the University of Pretoria—all from South Africa and top universities in

Africa according to THE university ranking. These five institutions are the most prominent in COVID-19 research in Africa.




**Fu=igure 13. Social structure by Institutional Collaboration**

## DISCUSSION

The COVID-19 pandemic altered publication patterns globally, with research efforts concentrating on controlling, treating, and mitigating the disease. Notably, theories of scholarly communication remained relevant even amid this disruption in the scientific publication process. This study examined scientific literature on COVID-19 in Africa from 2019 to 2021 to identify trends and patterns in publication, as well as the conceptual, intellectual, and social structures of COVID-19 research in the region. The findings revealed a significant increase in international collaboration and a high rate of joint research efforts. These results align with those of Älgå et al. (2020), who observed a substantial surge in COVID-19 research articles published over a short timeframe, Lee and Haupt (2021), who documented a rise in international collaboration during the COVID-19 pandemic. Key sources of COVID-19 research in Africa include the South African Medical Journal (SAMJ), the Pan African Medical Journal (PAMJ), the International Journal of Environmental Research and Public Health, PLOS ONE, and HTS Teologiese Studies-Theological Studies.

The analysis of COVID-19 literature on Africa reveals a well-defined conceptual structure with key clusters focusing on 'Health Systems and Policies' and 'Anxiety and Depression'. The intellectual structure highlights five major research areas, including the impact of COVID-19 on Africa, public health, and education. The study also underscores the significant role of institutional collaboration, with major research contributions from leading South African universities. These five universities are the most relevant institutions for COVID-19 research in Africa, highlighting the leadership of the South African scientific community in this field. This finding aligns with Fonkou et al. (2021), who reported that South Africa and Egypt are among the most productive countries for COVID-19 research, with collaborations outside Africa primarily involving European or North American scholars. Additionally, Guleid et al. (2021) observed that South Africa is the

leading country in Africa for COVID-19 research productivity.

South Africa, being the epicentre of COVID-19-related infections and deaths on the continent, along with countries such as Morocco, Tunisia, and Ethiopia, experienced significant caseloads. Southern Africa was the most affected region, followed by the northern and eastern parts of the continent, while Central Africa saw the least impact. A substantial portion of COVID-19 research funding was directed to South Africa, allowing its researchers to lead the continent in COVID-19 studies. According to the Times Higher Education university ranking, South African universities are the top institutions for research and scholarship in Africa. This research reaffirms South Africa's position as a leader in African scientific research publications

In addition to COVID-19-related terms, key keywords in the literature included HIV, Lockdown, Mental Health, Education, Children, Food Security, Health Policy, Health Systems, and Poverty. This underscores the researchers' focus on mitigating the pandemic's impact on these areas. It was also found that 'Keywords Plus' and 'Abstract Words' offer a more profound understanding of COVID-19 literature, capturing crucial research topics. While the term 'COVID-19' and related words were prevalent, associated issues such as Mental Health, Depression, Stress, and Education were more prominently reflected in both 'Keywords Plus' and 'Abstract Words'. The analysis highlights the leading role of South African universities in COVID-19 research within Africa, reflecting their significant impact and the concentration of research funding in the region. The emphasis on critical areas such as HIV, Mental Health, and Education underscores a comprehensive approach to addressing the broader effects of the pandemic. The use of 'Keywords Plus' and 'Abstract Words' further enriches the understanding of key research themes, revealing the depth of investigation into both COVID-19 and its associated issues.

The data were analysed using Lotka's Law of Author Productivity and Bradford's Law of Scattering. The results confirmed that the data align with both laws. The analysis using Lotka's Law revealed a core group of highly productive authors, consistent with the law's suggestion that a small number of authors produce the majority of publications. Similarly, Bradford's Law, which posits that most publications are concentrated in a few core journals, was supported by the observed distribution of research outputs across journals. This alignment with established bibliometric laws underscores the robustness of the data and the effectiveness of these laws in understanding publication patterns within the field (Garfield and Sher, 1993; Lotka, 1926).

These findings have implications for the future of scientific communication, evaluation, and productivity. Bibliometric methods remain a dependable tool for tracking scientific progress and underscore the significance of collaboration for scientific advancement. Furthermore, these methods are instrumental in shaping research policies for academic institutions, funding organisations, and industry partnerships (Sanni and Zainab, 2012). The research highlights that African researchers have made substantial contributions to COVID-19 research, demonstrating their capacity to produce high-quality work when provided with adequate funding and international collaborations. However, the uneven publication trends across African countries may be due to challenges such as limited funding, infrastructure, resources, and collaboration opportunities (Antonio et al., 2020).

Addressing these issues is essential for ensuring Africa's equitable participation in global scholarly communication. Bibliometric researchers should focus on examining the conceptual, intellectual, and social structures of disciplines, as these approaches offer a richer and more nuanced understanding of research content compared to other bibliometric indicators.

Overall, these findings offer valuable insights into the key themes, trends, and collaborative efforts in COVID-19 research across the continent. The results of this research have implications for future scientific communication, evaluation, and productivity.

## AUTHOR CONTRIBUTION

Sanni Shamsudeen Ademola served as the lead researcher, responsible for conceiving the research idea and writing the entire paper.

Aliyu Olugbenga Yusuf contributed to the study design and conducted the literature review.

Vusi Wonderboy Tsabedze played a key role in data analysis.

Ntombikayise N. Mathabele contributed by writing the literature review section.

## FUNDING AND SPONSORSHIP

Not applicable.

## CONFLICT OF INTEREST

None.

## ACKNOWLEDGMENT

Not applicable.

## REFERENCES

Africa CDC (2021). Updates and resources on the continental response to COVID-19. https://africacdc.org/

Älgå A, Eriksson O, Nordberg M (2020). Analysis of scientific publications during the early phase of the COVID-19 pandemic: Topic modeling study. J Med Internet Res, 22(11). Doi: 10.2196/21559

Antonio E, Alobo M, Bayona MT, Marsh K, Norton A (2020). Funding and COVID-19 research priorities-are the research needs for Africa being met?. AAS Open Research, 3: 1-15. Doi: 10.12688/aasopenres.13162.1

Aria M, Cuccurullo C (2017). Bibliometrix: An R-tool for comprehensive science mapping analysis. J. Informetr, 11(4): 959–975. Doi: 10.1016/j.joi.2017.08.-007.

Aviv-Reuven S, Rosenfeld A (2021). Publication patterns' changes due to the COVID-19 pandemic: a longitudinal and short-term scientometric analysis. Scientometrics, 126(8), 6761-6784. Doi: 10.1007/s11192-021-040-59-x

Bradford SC (1948). Documentation. London, UK: Crosby Lockwood and Son Ltd.

Chahrour M, Assi S, Bejjani M, Nasrallah AA, Salhab H, Fares M, Khachfe HH (2020). A bibliometric analysis of COVID-19 research activity: a call for increased output. Cureus. Doi: 10.-7759/cureus.7357

Cilliers J, Pooe TK, Alexander K, Oosthuizen M, Moyer JD (2020). Impact of COVID-19 in Africa: a scenario analysis to 2030. ISS Africa Report. 2020 (24): 1-40. Doi: 10.2139/ssrn.36608-66.

Else H (2020). How a torrent of COVID science changed research publishing - in seven charts. Nature. 588(7839): 553. DOI: 10.1038/d41586-020-03564-y

Fonkou MDM, Bragazzi NL, Tsinda EK, Bouba Y, Mmbando GS, Kong JD (2021). Covid-19 pandemic related

research in Africa: Bibliometric analysis of scholarly output, collaborations and scientific leadership. Int. J. Environ. Res. Public Health, 18(14): 1–16. Doi: 10.3390/ijerph18147273

Garfield E, Sher IH (1993). Keywords plus [TM]-algorithmic derivative indexing. Am. J. Sci. 44: 298–298.

Guleid FH, Oyando R, Kabia E, Mumbi A, Akech S, Barasa E (2021). A bibliometric analysis of COVID-19 research in Africa. BMJ Global Health, 6(5): 1–7. Doi: 10.1136/bmjgh-2021-00569

Harzing AW (2007). Publish or Perish. Bibliometrix.

Lee JJ, Haupt JP (2021). Scientific globalism during a global crisis: research collaboration and open access publications on COVID-19. Higher Education. 2021. Doi: 10.1007/s10734-020-00589-0

Loktka A (1926). The frequency distribution of scientific distribution. J. Wash. Acad. Sci, 16: 317–323.

Mahi M, Mobin MA, Habib M, Akter S (2021). A bibliometric analysis of pandemic and epidemic studies in economics: future agenda for COVID-19 research. Soc. Sci. Humanit. Open, 4(1): 100165. Doi: 10.1016/j.ssaho.-2021.100165

Mohadab M, Bouikhalene B, Safi S (2020). Bibliometric method for mapping the state of the art of scientific production in COVID-19. Chaos, Solitons and Fractals, 139: 110052. Doi: 10.1016/-j.chaos.2020.110052

Oh J, Kim A (2020). A bibliometric analysis of COVID-19 research published in nursing journals. Science Editing, 7(2): 118–124. Doi: 10.6087/KC-SE.205

Polack FP, Thomas SJ, Kitchin N, Absalon J, Gurtman A, Lockhart S, Perez JL, et al. (2020). Safety and efficacy of the BNT162b2 mRNA COVID-19 vaccine. New England journal of medicine. 383(27):2603-15. Doi: 10.1056/NEJ-Moa2034577.

Sanni SA, Zainab AN (2010). Google Scholar as a source for citation and impact analysis for a non-ISI indexed medical journal. Malays. J. Lib. Inform. Sci. 15(3).

Sanni SA, Zainab AN (2011). Measuring the influence of a journal using impact and diffusion factors. Malays. J. Lib. Inform. Sci, 16(2).

Sanni SA, Zainab AN (2012). Publication productivity and citation analysis of the Med. J Malays. 2004-2008, 67(1).

Sanni, SA, Zainab AN, Raj RG, Abrizah A, Zaina AN, Abrizah A (2014). Measuring journal diffusion using periodic citation counts. Malays J Lib Inform Sci, 19(1).

Small (1997). Update on science mapping: Creating large document spaces. Scientometrics. 38:275-93.

Times Higher Education (THE) (2022). World University Rankings 2022.

Voysey M, Clemens SA, Madhi SA, Weckx LY, Folegatti PM, Aley PK, Angus B, et al. (2021). Safety and efficacy of the ChAdOx1 nCoV-19 vaccine (AZD1222) against SARS-CoV-2: an interim analysis of four randomised controlled trials in Brazil, South Africa, and the UK. The Lancet. 397(10269):99-111. Doi: 10.1016/S0140-6736(20)32661-1

World Health Organization (WHO) (2020). COVID-19 cases top 10 000 in Africa.

Yusuf AO, Nur LNP, Junurham UAA (2021). Bibliometric Assessment of Scholarly Publications on Waqf J. Iium. Edu. My, 29(1): 223–241.

Zhang J, Yu Q, Zheng F, Long C, Lu Z, Duan Z (2016). Comparing keywords plus of WOS and author keywords: A case study of patient adherence rese-

arch. JASIST. 67(4):967-72. Doi: 10.-1002/asi.23437

Ziegler CG, Allon SJ, Nyquist SK, Mbano IM, Miao VN, Tzouanas CN, Cao Y, et al. (2020). SARS-CoV-2 receptor ACE2 is an interferon-stimulated gene in human airway epithelial cells and is detected in specific cell subsets across tissues. Cell. 181(5):1016-35. Doi: 10.-1016/j.cell.2020.04.035.