A Bibliometric Analysis of Biomedical Research Productivity in Africa South of Sahara 2010-2022

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Abstract
The purpose of this study was to analyze biomedical research productivity in Africa South of Sahara indexed in Scopus. Using a retrospective bibliometric analysis with Scopus databases, data covering 2010-2022 from 41 South of Sahara countries was retrieved and analysed using H-Index, webometrics and impact factor. The results show that the biomedical research output by Africa South of Sahara was 2,207 documents, almost half (1,087) from South Africa alone followed by Nigeria (282), Kenya (236) and Uganda (193). The least was Somalia, one (01) document. Overall, the University of Cape Town in South Africa had the highest publications (269) as compared to other researchers. Out of the 193 documents published in Uganda, Makerere University had the highest (93). Bekker, Linda-Gail from the University of Cape Town registered the highest H-index of 82. COVID 19 pandemic as topic, attracted publishing of 1,666 documents. The overall analysis reveals that research productivity was more on cure, treatment and less on prevention measures, diagnosis and drug safety. The practical implications highlight that the study provide valid method of measuring the research productivity trends, gaps for aiding research direction, policy, decision, funds allocation and evaluation. The study identified the biomedical research patterns and brings out the gaps in the discipline for further research.

Keywords: *Biomedical Research Productivity, Africa South of Sahara, Citation, Bibliometrics Analysis Impact Factor, Webometrics,*

Introduction

Biomedical research productivity varies according to countries, regions and economic capabilities. For instance, in developed countries which have strong financial capabilities, research productivity is high compared to developing countries especially Africa, South of Sahara (Rahman, 2003). Research productivity is synonymous to innovation for community development (Owen, Macnaghten & Stilgoe, 2012). Governments, non-governmental organizations and development partners dedicate a lot of funds in research aiming at discovering new ideas for solving human problems, advance knowledge and spur development (Thelwall, Kousha, Dinsmore & Dolby, 2016). The main output of biomedical research is always to bring out evidence based cure, avoidance, investigation of illnesses and death. "It also includes broad investigation of the underlying processes in living organisms; and determination of the effectiveness and safety of drugs, methods and devices used to diagnose, support and maintain individuals during and after treatment of diseases" (European Medical Research Councils 2011) as cited by Nwagwu (2016).

Measuring the research output in terms of a country, institutions and organization is crucial. Publication counts and citation analysis through various metrics are used to measure research productivity for decision and policy making (Rowlands, 2003). Shari, Haddow, Genoni (2012); Karanatsiou, Misirlis &Vlachopoulou (2017); Aliguliyev and Adigozalova (2018) agree that measuring of research productivity is done using tools such as bibliometrics, scientometrics, informetrics, webometrics and altmetrics. These tools evaluate the research output for quality and impact (Thelwall, Kousha, Dinsmore & Dolby, 2016). More so bibliometric are useful indicators for scientific productivity, trends and researchers' contributions (Androl, 2016).

Bibliometrics studies are useful in determining the quality of research and providing direct and indirect types of evidence. The indirect metrics that denote research quality include "number of publications in high-impact journals," h-index and citation frequency (Nazmus Saquib, 2018).

The term 'bibliometrics' emerged in 1960s and was introduced by Pritchard in 1969 (Yand & Yuan, 2017). According to the Institute for Scientific Information (ISI) and Science Citation Index (SCI), bibliometrics is a special field of study in library science and can be used to evaluate research output in many disciplines (Karanatsiou, Misirlis & Vlachopoulou, 2017). Although bibliometric studies flourished in the twenty first century, this technique has not been embraced in a majority of countries in Africa. Therefore, this study makes a contribution to the academic community as it investigates patterns of authorship in biomedical research in Africa.

Governments and development partners are engaging funds in biomedical research aiming at discovering new ideas for solving human health related problems, advance the medical field and generate more innovations (International Development Research Centre, 2022 & WHO 2022). The main output of biomedical research is always to bring out evidence based cure, avoidance, investigation of illnesses and death. "It also includes broad investigation of the underlying processes in living organisms; and determination of the effectiveness and safety of drugs, methods and devices used to diagnose, support and maintain individuals during and after treatment of diseases" (European Medical Research Councils, 2011) as cited by Nwagwu

(2016). However, to evaluate the extent of the research productivity in this field, to establish the gaps and the research impact is important to foster direction of research and aid policy making.

General Objective: To analyze biomedical research productivity including authors impact in Africa South of Sahara that is indexed in Scopus.

Specific Objectives

- To quantify biomedical research worldwide in relation to Africa South of Sahara
- To analyze biomedical research production in Africa South of Sahara according to various bibliographic patterns.
- To compare biomedical research productivity within countries and institutions of affiliation
- To carry out citation analysis of biomedical research and the impact of scholars from Africa
- To recommend areas of further research in biomedical studies

Review of related literature

The main output of biomedical research is always to bring out evidence based cure, avoidance, investigation of illnesses and death. This area of study also includes broad investigation of the underlying processes in living organisms; and determination of the effectiveness and safety of drugs, methods and devices used to diagnose, support and maintain individuals during and after treatment of diseases (European Medical Research Councils 2011) as cited by Nwagwu (2016 p 44). Additionally biomedical research examines the prevention and cure of diseases in human and animals involving variety of scientists such as biologists and chemists where their experiments go through sufficient evaluation before approval (California Biomedical Research Association, 2018).

Kokwaro & Kariuki (2001) and Zofou [et al] (2011) agree that biomedical research in Africa South of Saharah lack sufficient support though it is a solution to human health. Lack of research facilities, funds and government support has been highlighted as some of the major hindrances. However the international collaborations and public-private partnerships have made attempts in addressing the identified challenges (Agnandji.[et al], 2012).

Bibliometrics Studies

The growth of science and technology has made it easy the production of articles, books and other information materials. This has thus brought the need to evaluate the information materials for quality assurance and impact (Karanatsiou, Misirlis & Vlachopoulou, 2017). The justification for research funds and the societal impact has also contributed to the use of metrics (Reed, Ferré, Martin-Ortega, Blanche, Lawford-Rolfe, Dallimer & Holden 2021). Libraries and research institutions use bibliometrics for aiding decision making and service quality in various ways such as evaluating journal articles for relevancy in research and identification of high impact journals (Ashiq, Ur Rehman, Muneeb, & Ahmad 2022). Thomson Reuters (2008);

Diem and Wolter (2013) agree that bibliometrics evaluate research performance in any discipline for the benefit of libraries and research bodies. Researchers also get to know the areas of research in a specific discipline which has not been well researched and would hence be in need of more research.

There are a number of techniques for measuring metrics. These are such as bibliometrics, scientometrics, informetrics, webometrics and altmetrics (Shari, Haddow, Genoni 2012; Siluo & Qingli, 2017).

According to Jacobs (2010), there are three types of bibliometrics analysis:

(i) Descriptive bibliometrics – analyzing documents using simple indicators such as counting the documents according to authors.
(ii) Evaluative bibliometrics – Using citation techniques to assess the impact of scholarly works such as h-index and journal index.
(iii) Relational bibliometrics - using co-authorship and co-citation to measure similarity and patterns.

Bibliometrics Laws

Various authors (Hood and Wilson, 2001; Ingwersen, 2011; Qiu et al, 2017) ascertain that bibliometrics has theoretical background in three laws as proposed by Bradford in 1934, Latka in 1929 and Zipf in 1949.

Bradford's law

The Bradford's law proposed by Bradford in 1934 provide guidelines to librarians to determine core journals that are most useful in a certain discipline (IFLA, 2010). The law says that scatter articles in a given subject over journals in a nuclear way in form of 1: b: b2 which can be interpreted as 1= database, b= Journals devoted to a specific discipline and b2 number of articles in those specific journals that are useful.

Lotka's law

The Lotka's law proposed by Lotka In 1926 is useful in measuring scientific productivity (IFLA, 2010). Further, it provide a theory of authorship characteristics in research. Librarians and institutions should be aware of a given discipline and the areas that have been frequently researched. An institution or a country research productivity can as well be established through frequency measurements. Lotka's law concentrates on inverse squire law. The relationship between the number of publications(X) and the number of authors(Y).

Zipf's law

Zipf's law proposed by Zipf in 1949 looks at the frequency of words used within a text, in a language and in a collection of words. In order to calculate the frequency, words are ranked in a descending order to get the frequency (Sorell, nd).

Journal ranking studies

Journals are ranked using the number of citations received after a certain period of time, the Impact Factor (IF) and immediacy index. A highly cited journal would be highly ranked which means that there would be a possibility of many authors wishing to publish is such a journal.

Impact factor was introduced by the founder of the Institute for Scientific Information, Eugene Garfield in 1955 (Karanatsiou, Misirlis & Vlachopoulou, 2017). Journal Impact Factor (JIF) is calculated as follows:

$$\frac{\text{Number of citations of the journal in the last two years}}{\text{Number of citable articles}}$$

Publication or article usage is measured using SCImago Journal Rank, Eigen factor and Citation analysis. SCImago Journal Rank measures scientific influence of scholarly journals in relation to the citations and its importance. Eigenfactor measures citation impact from one journal to another.

Another metric is H-index which was proposed by Hirsch in 2005. It is used to statistically measure researcher's productivity and the finding can be used to advice career development for researchers, access to research funding and make promotion decisions (Karanatsiou, Misirlis & Vlachopoulou, 2017).

Methodology

A retrospective bibliometric analysis with Scopus database was used to identify all publications in 41 countries of Africa South of Sahara from 2010 to 2022. Documents by authors were captured. Scopus databases were found suitable for this study because they capture the widely published research and high impact. Therefore it provides the necessary data for the bibliometric study.

Limitations

- The following countries were not included in the study: - Seychelles, South Sudan, Togo, Comoros, Mayotte, Central Africa Republic, Sao Tome and Principe, Congo Brazzavile, Djibouti, Eritrea, Guinea-Bissau, South Sudan, Western Sahara, and Reunion.

Sources of data

BMC medical ethics, health research policy and system, Plos one, BMJ Open and South African medical Journal. The bibliometric techniques used in the study were: - H-Index, webometrics, impact factor.

Search strategy

Biomedical Research Worldwide:

TITLE-ABS-KEY (biomedical AND research) AND PUBYEAR > 2009 AND PUBYEAR < 2023

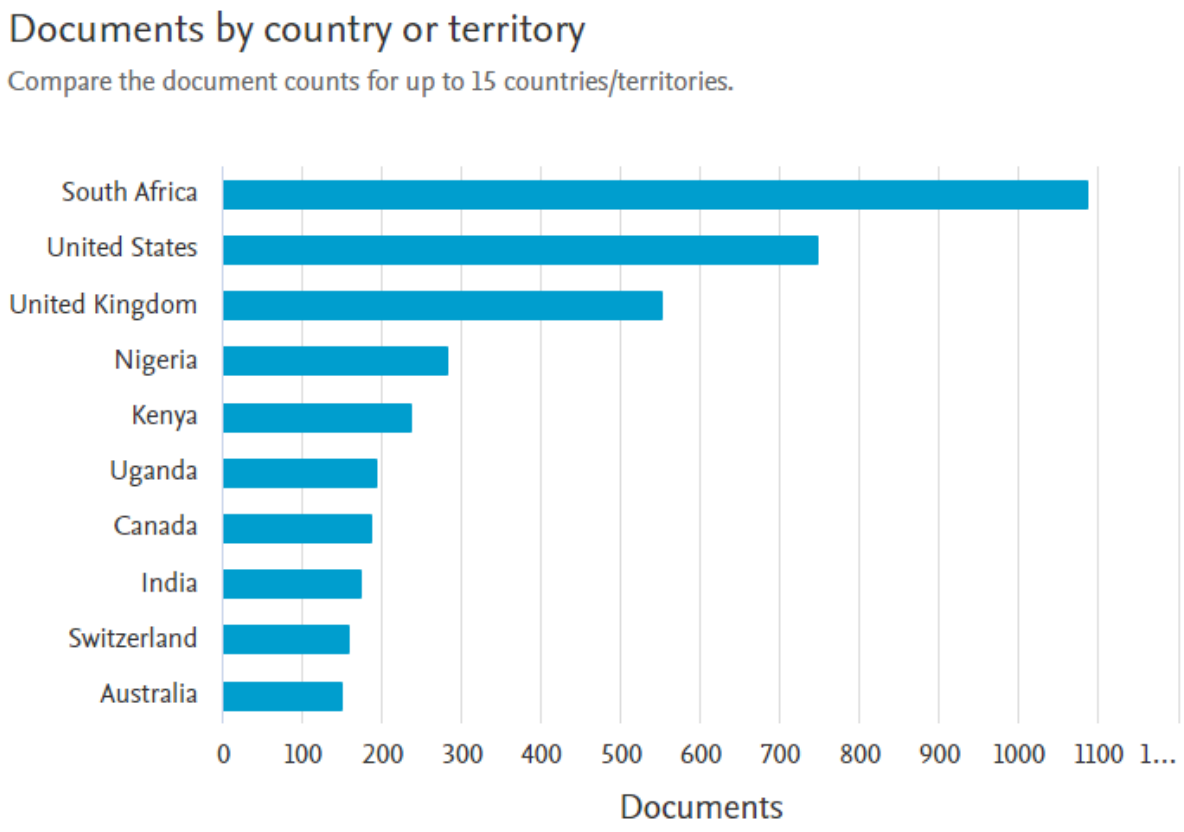
Biomedical Research Africa South of Saharah:

TITLE-ABS-KEY (biomedical AND research) AND PUBYEAR > 2009 AND PUBYEAR < 2023 AND (LIMIT-TO (AFFILCOUNTRY , "Angola") OR LIMIT-TO (AFFILCOUNTRY , "Benin") OR LIMIT-TO (AFFILCOUNTRY , "Botswana") OR LIMIT-TO (AFFILCOUNTRY , "Burkina Faso") OR LIMIT-TO (AFFILCOUNTRY , "Burundi") OR LIMIT-TO (AFFILCOUNTRY , "Cameroon") OR LIMIT-TO (AFFILCOUNTRY , "Chad") OR LIMIT-TO (AFFILCOUNTRY , "Congo") OR LIMIT-TO (AFFILCOUNTRY , "Cote d'Ivoire") OR LIMIT-TO (AFFILCOUNTRY , "Democratic Republic Congo") OR LIMIT-TO (AFFILCOUNTRY , "Ethiopia") OR LIMIT-TO (AFFILCOUNTRY , "Gabon") OR LIMIT-TO (AFFILCOUNTRY , "Gambia") OR LIMIT-TO (AFFILCOUNTRY , "Ghana") OR LIMIT-TO (AFFILCOUNTRY , "Guinea") OR LIMIT-TO (AFFILCOUNTRY , "Guinea-Bissau") OR LIMIT-TO (AFFILCOUNTRY , "Kenya") OR LIMIT-TO (AFFILCOUNTRY , "Liberia") OR LIMIT-TO (AFFILCOUNTRY , "Madagascar") OR LIMIT-TO (AFFILCOUNTRY , "Malawi") OR LIMIT-TO (AFFILCOUNTRY , "Mali") OR LIMIT-TO (AFFILCOUNTRY , "Mauritania") OR LIMIT-TO (AFFILCOUNTRY , "Mauritius") OR LIMIT-TO (AFFILCOUNTRY , "Mozambique") OR LIMIT-TO (AFFILCOUNTRY , "Namibia") OR LIMIT-TO (AFFILCOUNTRY , "Niger") OR LIMIT-TO (AFFILCOUNTRY , "Nigeria") OR LIMIT-TO (AFFILCOUNTRY , "Rwanda") OR LIMIT-TO (AFFILCOUNTRY , "Senegal") OR LIMIT-TO (AFFILCOUNTRY , "Sierra Leone") OR LIMIT-TO (AFFILCOUNTRY , "South Africa") OR LIMIT-TO (AFFILCOUNTRY , "Sudan") OR LIMIT-TO (AFFILCOUNTRY , "Swaziland") OR LIMIT-TO (AFFILCOUNTRY , "Tanzania") OR LIMIT-TO (AFFILCOUNTRY , "Uganda") OR LIMIT-TO (AFFILCOUNTRY , "Zambia") OR LIMIT-TO (AFFILCOUNTRY , "Zimbabwe"))

Results and Discussions

The bibliometrics analysis of document search and counts from 2010 to 2022 shows that out of 96,740 biomedical research documents listed in SCOPUS worldwide, only 2,207 are from Africa South of Sahara. The 2,207 documents from Africa South of Saharah were analysed further by country and the results as presented in figure 1 below:

Figure 1: Documents by country or teritory

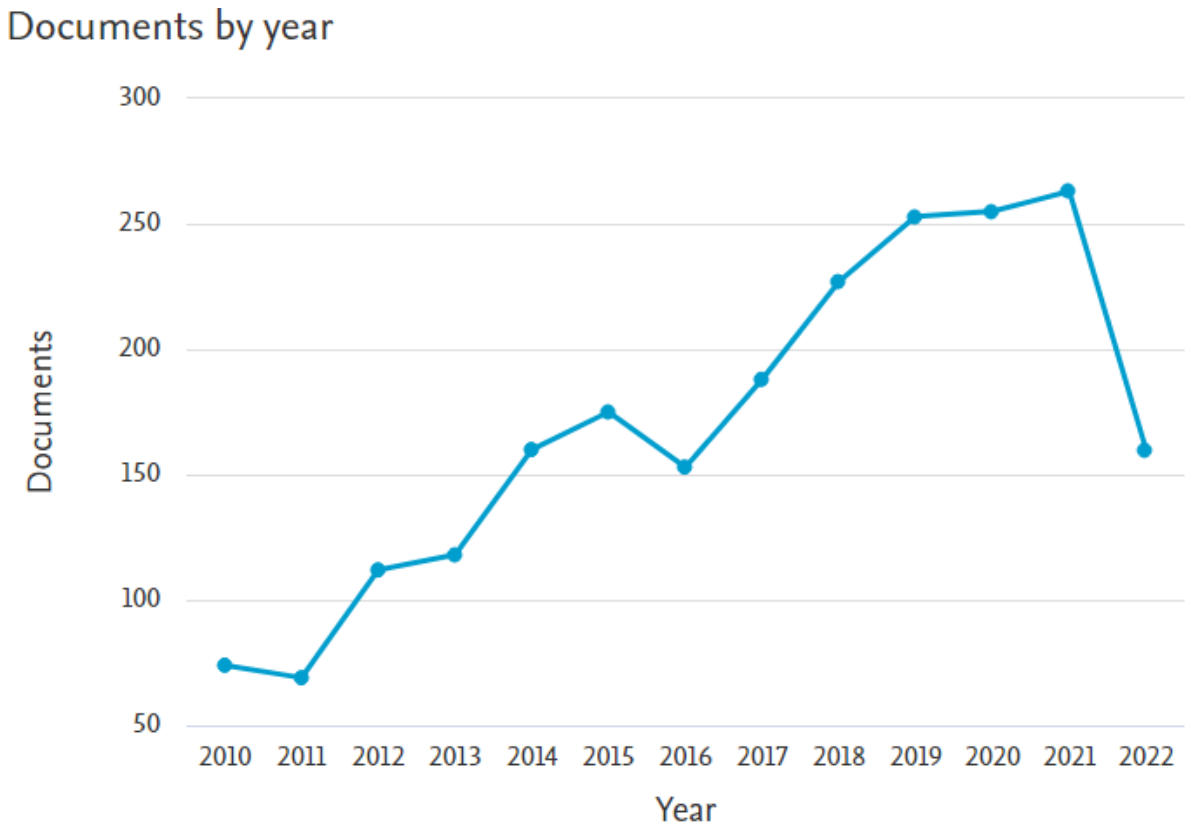


From above figure, it is evident that in the field of biomedical research South Africa published the highest number of documents (1,087) while Somalia published the lowest number of documents (1). Nigeria published most documents in West Africa (282), while Kenya published the most documents in East Africa (236) and was followed by Uganda (193) documents.

Biomedical research productivity in Africa South of Sahara according to various bibliographic patterns

Bibliometrics analysis of biomedical research documents in Africa South of Sahara was done in relation to various bibliographic patterns such as year, source, affiliation, type of document and subject in relation to Lokta's law. The results are presented in figure 2 below:

Figure 2: Year of Publication



As indicated in figure 2, the biomedical research productivity grew steadily between 2018 and 2021 during the peak of COVID 19 pandemic where 1,666 publication were specifically published on COVID 19 related issues as further presented in table 1 below:-

Table 1: COVID 19 publication by year

1,666 document results

Year ↓	Documents ↑
2022	280
2021	781
2020	604
2019	1

The following analysis can be used to find out the kind of documents where the biomedical research findings were communicated.

Figure 3: Documents by Source

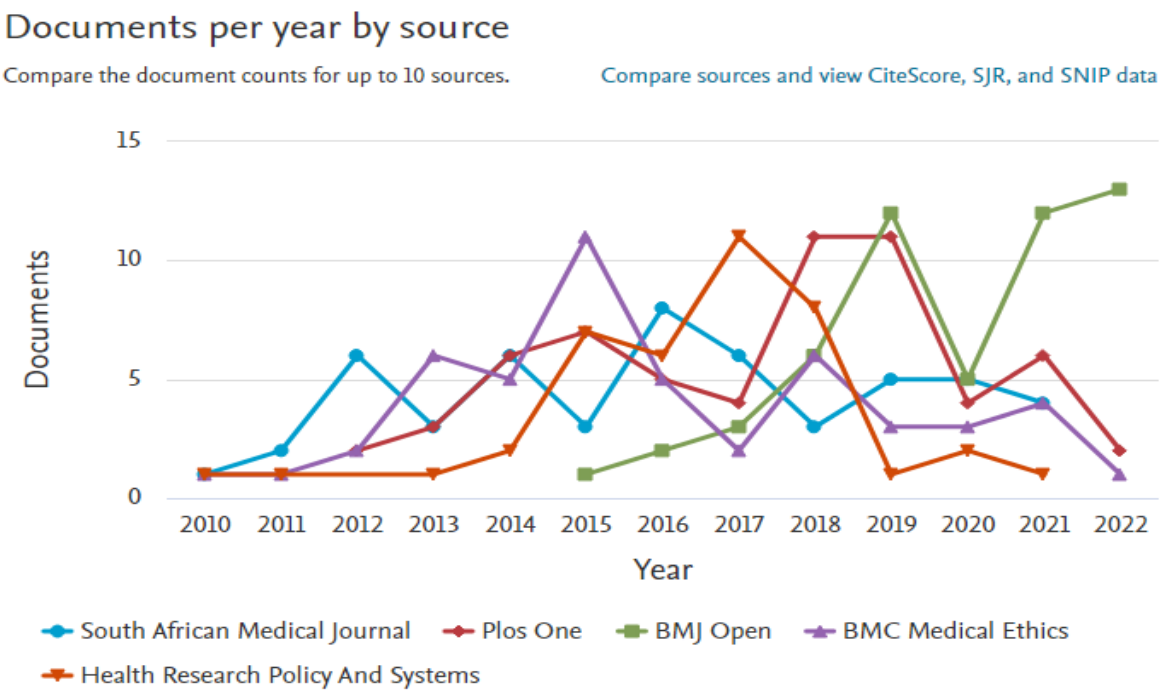


Figure 3 above shows that Plos One had the highest number of publications (61), followed by BMJ Open with 54 publications though it started publishing in 2015.

Bibliometrics analysis can also be used to measure the research productivity according to the institution of affiliation. This type of measurement enables funders to determine which institutions are capable of undertaking research in a given area. The results are plotted in figure 4 below:

Figure 4: publication by affiliation

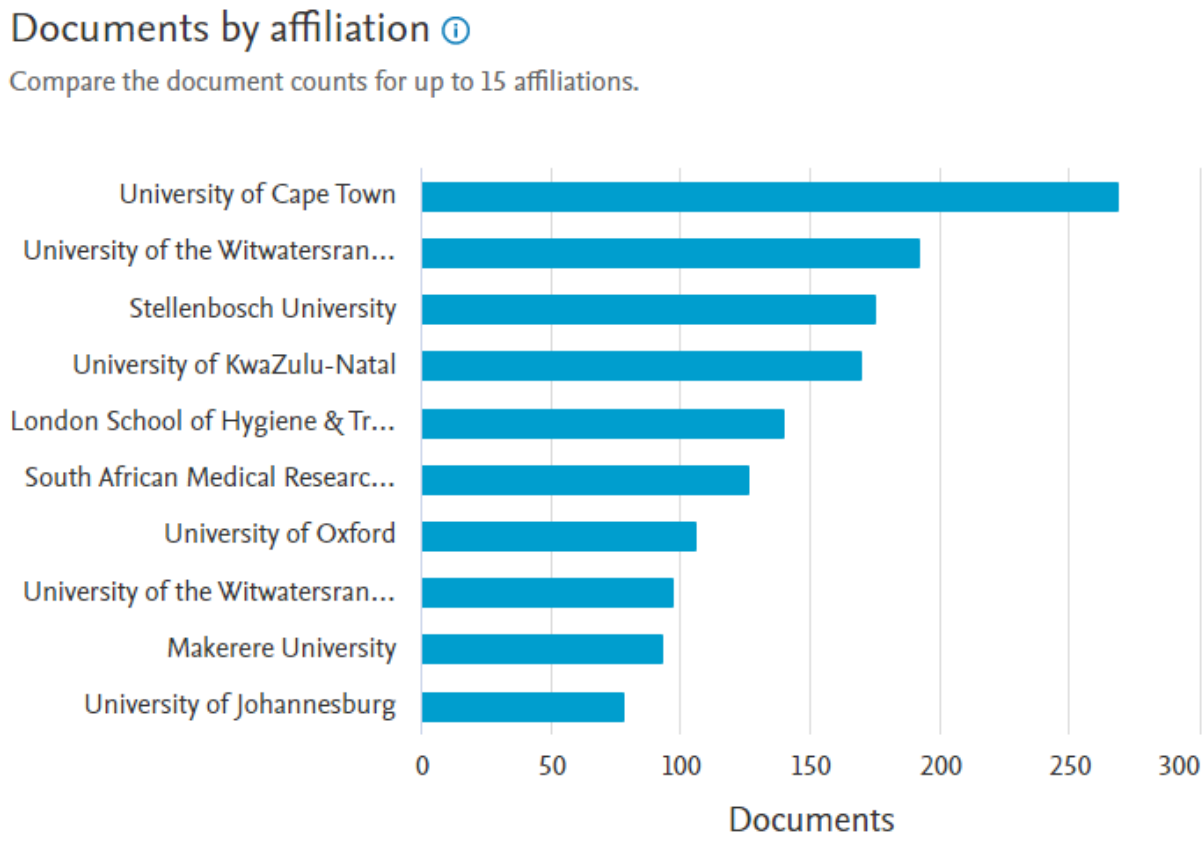
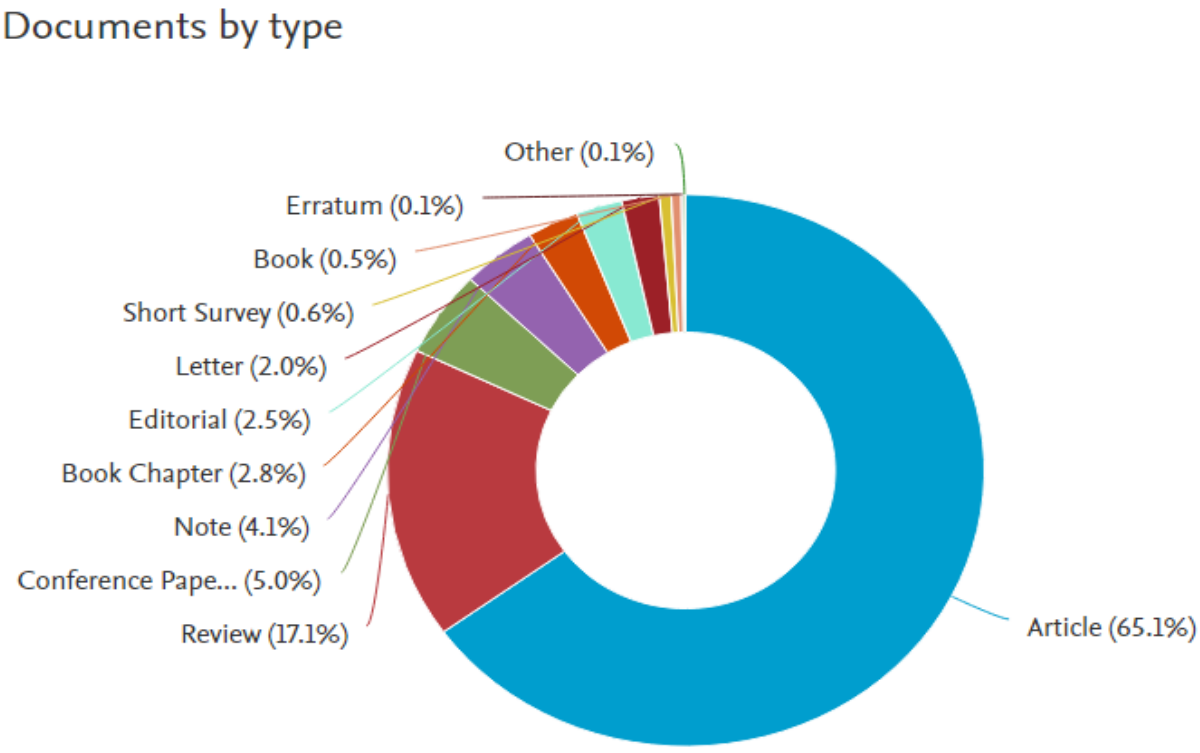


Figure 4 above shows that the University of Cape Town had the highest number of publications (269) in comparison to the other institutions. In East Africa, Makerere University had the highest number of publications (93). In the context of webometric ranking, University of Cape Town was number 1 and Makerere University was number 09. In the impact rank, the University of Cape Town maintained the top position while Makerere University dropped to number 18 while Kampala International University rose significantly to the sixth position.

Analysis of document types was carried out inorder to measure the prefered mode of communicating biomedical findings. The results are presented in figure 5 below:

Figure 5: Publications by Type



Through the use of bibliographic coupling technique, the publications were grouped according to type. The majority were journal articles with 65.1%, followed by reviews with 17.1%. These findings indicate that biomedical researchers prefer to communicate their findings through journal articles as compared to other publications type. These findings agree with Subramanyam (2013) who pointed out that journal articles are the preferred source of scientific information.

The analysis of the subfields was done through as indicated in figure 6 below:-

Figure 6: Publications by Subject

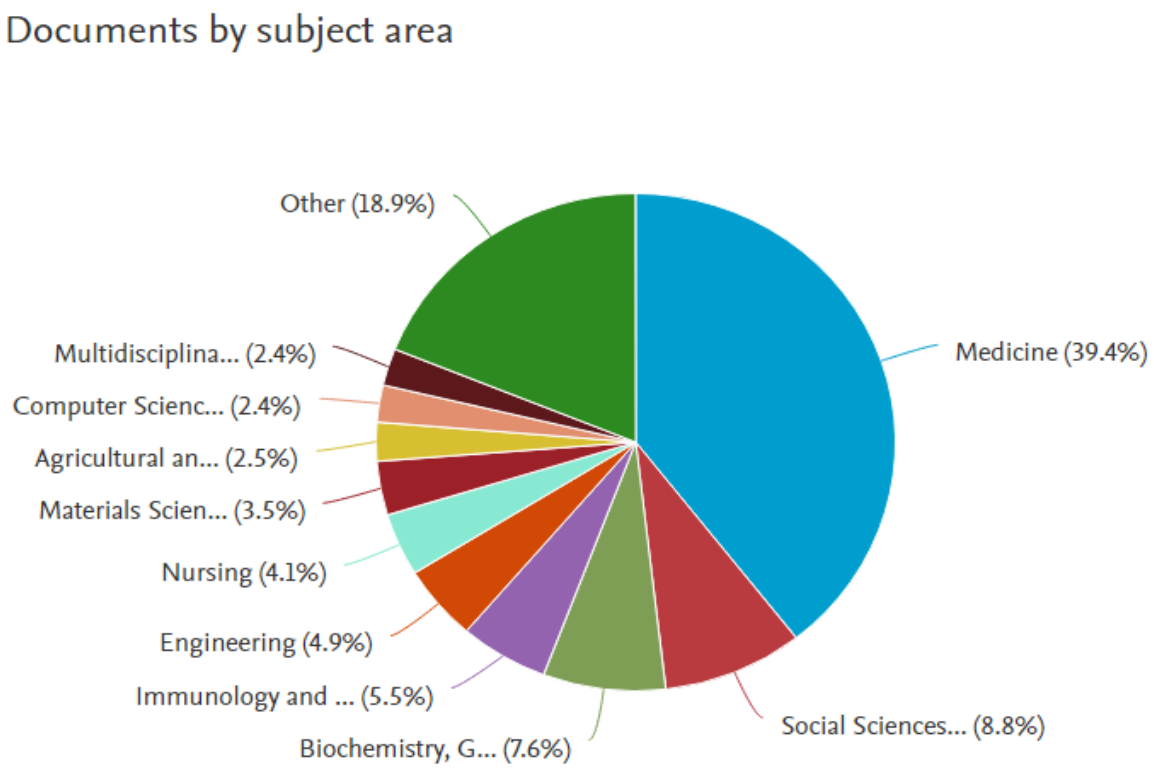


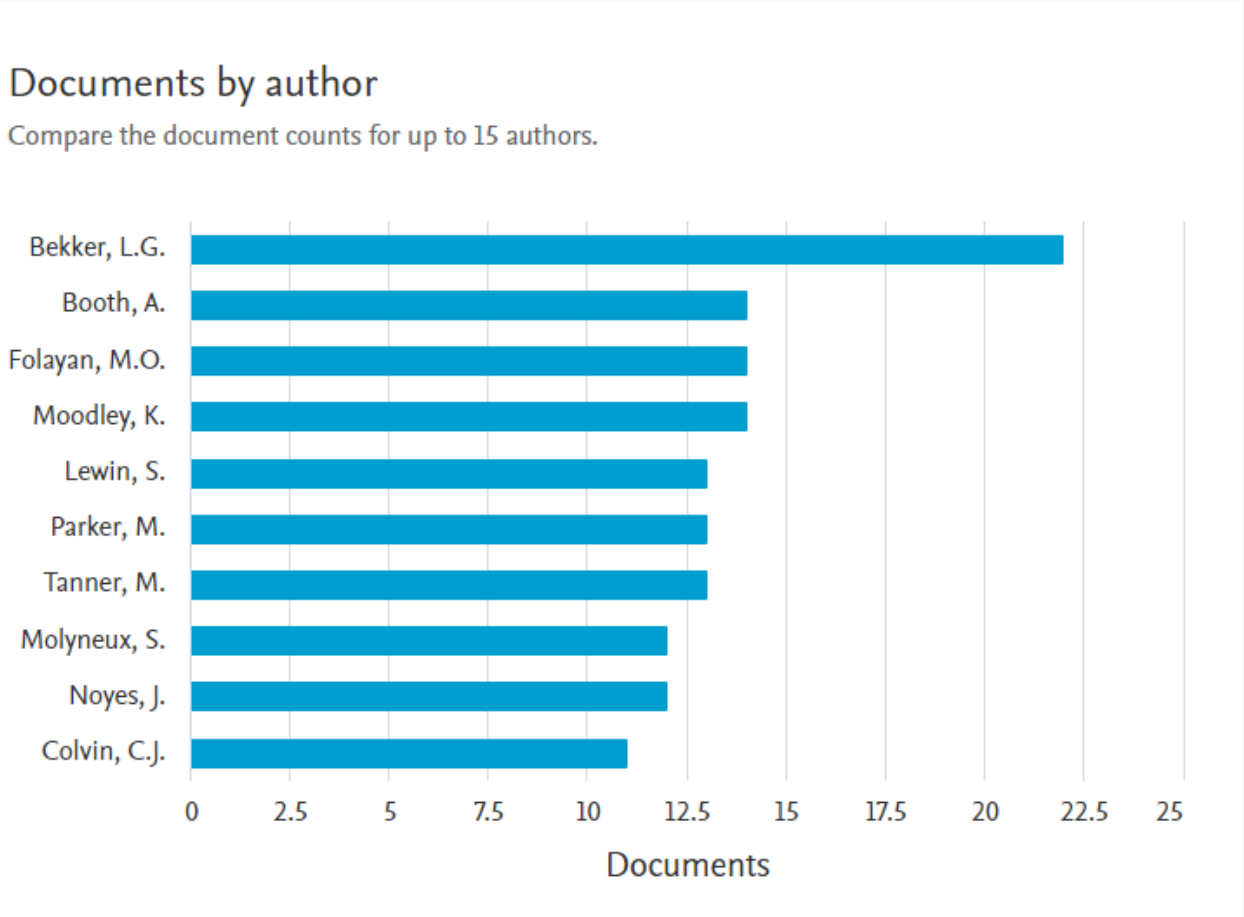
Figure 6 above indicates that the majority of the biomedical research productivity was done in medicine with 39.4%. Other subjects covered in the data include:- social sciences, biochemistry, Immunology, nursing, pharmacology, agriculture, engineering, psychology, arts and humanities.According to the European Medical Research Councils (2011), the main output of biomedical research is to bring out evidence based cure, avoidance, investigation of illnesses and death. In addition, biomedical research also includes broad investigation of the underlying processes in living organisms; and determination of the effectiveness and safety of drugs, methods and devices used to diagnose, support and maintain individuals during and after treatment of diseases. This implies that the biomedical research productivity in Africa South of Sahara is mainly done in treatment leaving out prevention, diagnosis and drug safety.

4.3 Biomedical Productivity Societal Impact

The societal impact of research is measured using citation analysis and h-index in relation to the researcher/author and institution of affiliation. H-index is a bibliometrics index that is statistically used to measure researchers productivity and usage impact. It is measured in relation to the number of publications and the citations they receive in a certain period of time.

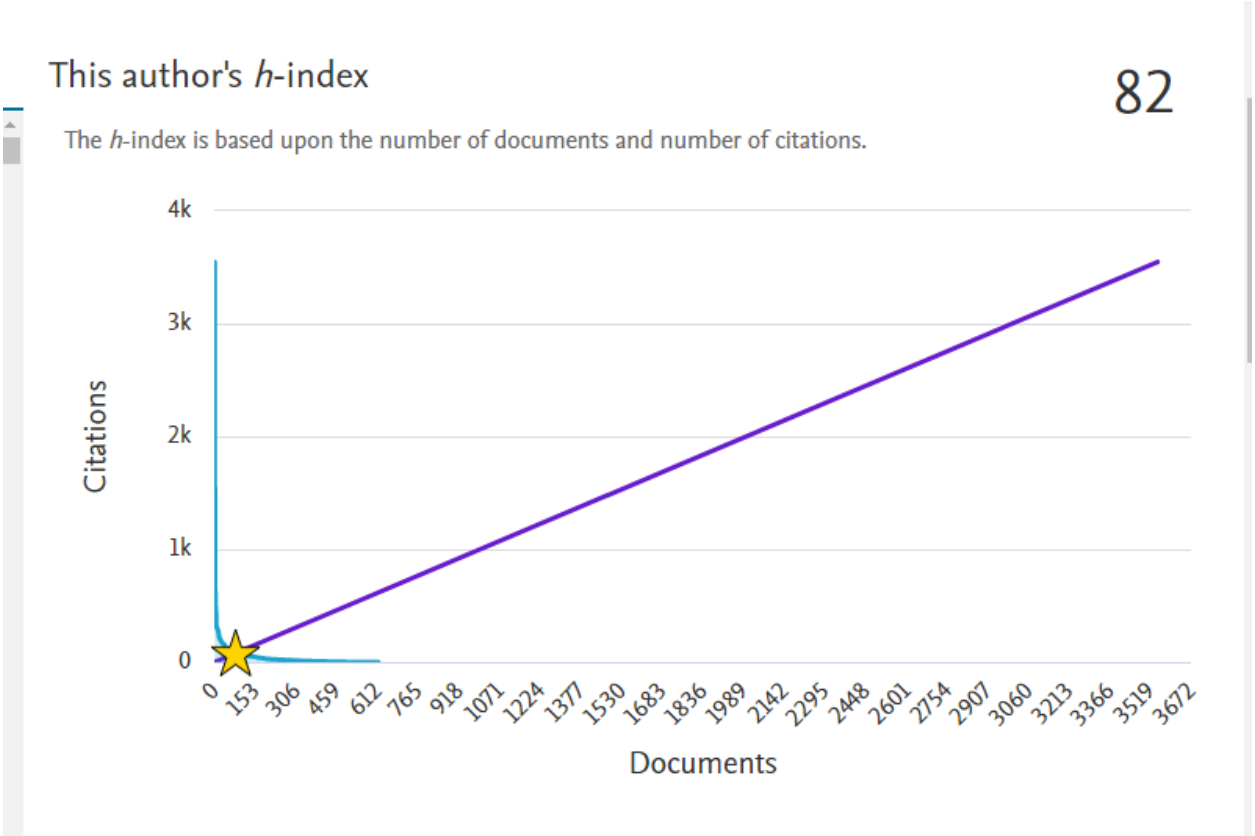
The impact of authors is indicated in figure 7 and more analysis on the h-index results presented as figure 8.

Figure 7: Author Impact Factor



Bekker, Linda-Gail had the highest research productivity with 22 publications. His highest cited article being "Pre-exposure chemoprophylaxis for HIV prevention in men who have sex with men" which was cited 3,547 times by 2010. The second was Booth A, with the highest cited article being "A typology of reviews: an analysis of 14 review types and associated methodologies" which was cited 3,673. These findings show the different level of research productivity and impact between researchers in the same discipline. Bekker was more productive yet less impactful while Booth was less productive but more impactful.

Figure 8: Prof. Bekker, Linda-Gail H-Index



Conclusion

Literature evaluation through bibliometrics provide evidenced based support to decision-making and policy making in research institutions and libraries. Bibliometrics evaluation indicators such as publication counts, citation analysis, and journal impact factor have become effective in directing biomedical research investment, productivity, discipline coverage and international collaboration. For effective and efficient bibliometrics, other literature analysis measurements like webometrics, SCImago Journal Rank and Eigenfactor can be used. Biomedical research productivity in Africa South of Sahara is low compared to other regions. Decision makers and policy makers should direct more funds biomedical research in the region of Africa South of Sahara. The findings of this study implies that biomedical research productivity is more on medicine and cure compared to the other areas of biomedical research such as prevention, diagnosis and drug safety. This means that there is research gap in biomedical research in the areas of prevention, diagnosis and drug safety.

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