

## Gambia publications in the Science Citation Index Expanded: bibliometrics of institutions and subjects

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**Abstract:** Gambia is the smallest country in West Africa and it has contributed to the academic world over the past decades. This study characterized document type, language, publication trend, subject category, international collaboration of Gambia publications during 1900-2016 based on Science Citation Index Expanded in Web of Science. Results showed that Gambia is highly reliant on foreign and international collaboration in research, especially with the UK and USA. International collaboration was responsible for the increasing scientific production and scientific impact of Gambia over the years. Medical Research Council (MRC) contributed the most Gambia publications, and played an important role in conducting international collaboration. Most of Gambia publications focused on tropical medicine, environmental and occupational public health, immunology and infectious diseases. Gambia has attracted increasing attention from the academic world, with improving scientific production and scientific impact, signalling more prestige in the scientific community. With the information and insights provided in this paper, we managed to obtain a quick overview of Gambia publications that can help make strategic decisions for researchers and governors of scientific research.

**Key words:** Gambia; Web of Science; Scientometrics; Citation Impact; collaboration.

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Gambia, a former British colony, is located in the West Coast of Africa and has a population of 1.5 million (Saine, 2003). Before 1999, Gambia had no university. Students intending on higher education were compelled to go overseas, and some who were financially incapable. The first University was established in 1999, 34 years after independence and 29 years after the proclamation of the Republic. However, before the establishment of the University, Yundum Teacher's College which

was founded in 1952 became Yundum College in 1955, when it was foreseen that its scope should be widened for efficient and productive learning. The former Gambia School of Nursing and Midwifery, the School of Agriculture and the School of Public Health, until then separate institutions, were combined with the Teacher Training College into an institution renamed Gambia College, by an Act of Parliament which was passed in 1978. This union led to the College operating from two campuses,

School of Nursing and Midwifery located at Banjul city, whereas the Schools of Agriculture, Education and Public Health are located at Brikama campus (gambiacollege.edu.gm).

To illustrate the research trend in the Gambia, we used a bibliometric analysis to characterize Gambia publications. Bibliometric methods as common research tools have commonly been used to analyse the scientific performance of countries in the world (Glänzel, 2000; Guan & Gao, 2008), research specialties or area of interest with journals (Yamazaki, 1994), subject categories (Pouris, 1989; Moed, de Bruin, & Van Leeuwen, 1995), collaborative countries and institutions (Glänzel, 1996; 2000). Bibliometric analysis is a facilitative technique for depicting scientific research (Fu & Ho, 2013) which can be used to make significant decisions in the modern development of science (Lucio-Arias & Leydesdorff, 2009). Likewise, research trends in certain fields of science such as the research areas of interest, various journals types, scientific conference papers, scientific institutions and countries in the world of science community can be established using bibliometric indicators (Wang, Yu, & Ho, 2010). Similarly, scientific research that was produced by various countries belonging to distinct continents has also been analysed using bibliometric indicators, such as Serbia (Ivanović & Ho, 2015), Morocco (Bouabid & Martin, 2009), Republic of South Africa (Jeenah & Pouris, 2008), Costa Rica (Mongé-Nájera & Ho, 2012), and Taiwan (Chuang & Ho, 2015).

The aim of this publication was to dissect numerous articles that were written by Gambian researchers in the Science Citation Index Expanded (SCI-EXPANDED) database from 1900 to 2016. This study was split into three categories: in the first section, we determined the total scientific performance of Gambia in the SCI-EXPANDED. Secondly, we considered publication activities, with core emphasis on favoured journals and their subject categories, where Gambian high international collaborating and national inter-institutional partners were shown.

## MATERIALS AND METHODS

The information presented in this study was generated from Science Citation Index Expanded (SCI-EXPANDED) online version, the Clarivate Analytics Web of Science Core Collection database (updated on November 28, 2017). An advanced search was carried out to extract documents that had “Gambia” in the country field from the period of 1900 to 2016. The SCI-EXPANDED records and the number of citations in each year per document were downloaded from the database into Microsoft Excel 2013 and the data was later coded manually (Li & Ho, 2008; Ho & Fu, 2016). The impact factors ( $IF_{2016}$ ) of the journals were taken from the Journal Citation Reports (*JCR*) which was published in 2016.

Article classification was done to ascertain the authentic origin of all the publications. Articles that were published from England, Scotland, Northern Ireland, and Wales were recategorized as originated from the United Kingdom (UK), while articles from USSR (the Union of Soviet Socialist Republics) were checked and reclassified as being from Russia (Ho, Siu, & Chuang, 2016). Articles that were published from Congo were examined and recategorized as articles from Dem Rep Congo, likewise articles from Rep of Congo were reviewed and reordered as from Rep of Congo (Republic of the Congo). Similarly, articles from London School of Hygiene and Tropical Medicine and University of London School of Hygiene and Tropical Medicine were reclassified as originated from London School of Hygiene and Tropical Medicine. A potential bias in analysis of institutions might occur when authors use different spelling of associations for the same institution (Fu, Long, & Ho, 2014). Therefore, we merged these institutions, for example MRC Labs, MRC Unit, MRC, and Med Res Council were merged to be MRC.

Different countries and institutions that have contributed to the article were estimated by the affiliation of at least one author to the publications (Wang et al., 2010). Collaboration was established by the affiliations of the

authors, where ‘single country article’ and ‘single institute article’ was assigned if the researchers’ affiliations were from the same country and institute respectively, whereas ‘internationally collaborative articles’ was classified to those articles that were coauthored by researchers from distinct countries, while ‘inter-institutionally collaborative article’ was assigned if authors originated from diverse institutions. As for the author, if one author was assigned as the first author of one publication, the publication was considered as “first author publication” of the author; and if one author was assigned as the corresponding author of one publication, the publication was considered as “corresponding author publication” of the author. In terms of country/territory or institution, the term “first author publication” was assigned if the first author was from the country/territory or institution for analysis; and the term “corresponding author publication” was assigned if the corresponding author was from the country/territory or institution for analysis (Fu & Ho, 2014).

To determine the total citations since publication to the end of a specific year, the idea of  $TC_{year}$  was proposed by Ho and his fellow workers (Wang, Fu, & Ho, 2011; Chuang, Wang, & Ho, 2011). This indicator makes total

citations to be a constant as a scientific result which can be recurrent and checked (Ho & Fu, 2016). To explore the citation rate in a publication, indicators such as  $C_{2016}$ ,  $TC_{2016}$ , and  $CPP_{2016}$  were used. The influence of articles in the current year was considered as the number of citations from Web of Science Core Collection of a paper in that year only ( $C_{year}$ ), for example  $C_{2016}$  (Ho, 2012),  $TC_{2016}$  was defined as the total number of citations since publication to the end of 2016 (Wang et al., 2011; Chuang et al., 2011). Therefore, number of citations per publication  $CPP_{2016}$  ( $CPP_{2016} = TC_{2016}/TP$ ) was developed based on  $TC_{2016}$  (Ho, 2012; Elango & Ho, 2017).

## RESULTS

**Document type and language of publication:** A total of 2509 documents were published by at least one author from the Gambia which represented 11 document types in SCI-EXPANDED. Out of total journal articles, 99.9 % were published in English, two in French and one in German.

Table 1 shows the features of the 11 document types, including 1867 articles (74 % of 2509 documents) with 12 different authors per publication ( $APP$ ) which was higher than

TABLE 1  
Characteristics of document type

Document type	TP	%	AU	APP	$TC_{2016}$	$CPP_{2016}$
Review	52	1.6	169	3.3	2 722	52
Proceedings paper	370	12	1 357	3.7	7 055	19
Article	2 846	90	11 889	4.2	38 276	13
Note	4	0.13	13	3.3	34	8.5
Reprint	35	1.1	78	2.2	170	4.9
Correction	12	0.38	44	3.7	9	0.75
Editorial material	58	1.8	102	1.8	42	0.72
Meeting abstract	141	4.5	184	4.3	1	0.0071
Letter	4	0.13	5	1.3	0	0
Biographical-item	3	0.095	3	1.0	0	0
Addition correction	3	0.095	3	1.0	0	0
Item about an individual	3	0.095	3	1.0	0	0

$TP$ : number of publications;  $AU$ : number of authors;  $APP$ : number of authors per publication;  $TC_{2016}$ : the total number of citations from Web of Science Core Collection since publication to the end of 2016;  $CPP_{2016}$ : number of citations ( $TC_{2016}$ ) per publication ( $TP$ ).

32 documents and their citations per publication ( $CPP_{2016}$ ) (Table 1). An article entitled “Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death, 1990-2013: A systematic analysis for the Global Burden of Disease Study 2013” (Naghavi et al., 2015) had the highest number (89) of countries per publication where the total of 713 authors originated. Another definitive article entitled “A global reference for human genetic variation” (Auton et al., 2015) had 774 authors from 25 distinct countries, this article was similar to a study by Wang et al. (2016), Forouzanfar et al. (2015), and Vos et al. (2015) where a single publication had a multiple number of authors such as 786, 722, and 679, respectively. Documents of reviews had the highest  $CPP_{2016}$  which can be attributed to the classic review entitled “Genome-wide association study of 14 000 cases of seven common diseases and 3 000 shared controls” (Burton et al., 2007) with  $TC_{2016} > 4\ 282$  by 194 authors.

**Characteristics of publication outputs and citation impact:** A total of 1 867 Gambia

articles were published in SCI-EXPANDED over years and their citations per publication ( $CPP_{2016}$ ) is shown in figure 1, while the citation life cycles of Gambia’s publications are shown in figure 2 (Fig. 1 and Fig. 2). No Gambia articles were found before 1972. After 1993 and 2011, a sharp increase of publications occurred. The variability in life span of the total Gambian articles cited per publication shows that  $CPP$  increased more rapidly in the first year after publication and reached a peak in the 3<sup>rd</sup> year (Fig. 2). In 1986, only four articles had the highest  $CPP_{2016}$  of 79.

**Web of Science categories and journals:**

As shown in figure 3 (Fig. 3 see Appendix 1), 52 % of all articles were published in leading four categories including immunology with 429 articles (23.0 % of 1 867 articles), infectious diseases 421 (22.5 %) articles, public, environmental and occupational health 332 (18 %) articles, and tropical medicine with 329 (18 %) articles. According to Journal Citation Reports (JCR) in 2016, there were 177 Web of Science categories in SCI-EXPANDED. Based on the classification of various categories in

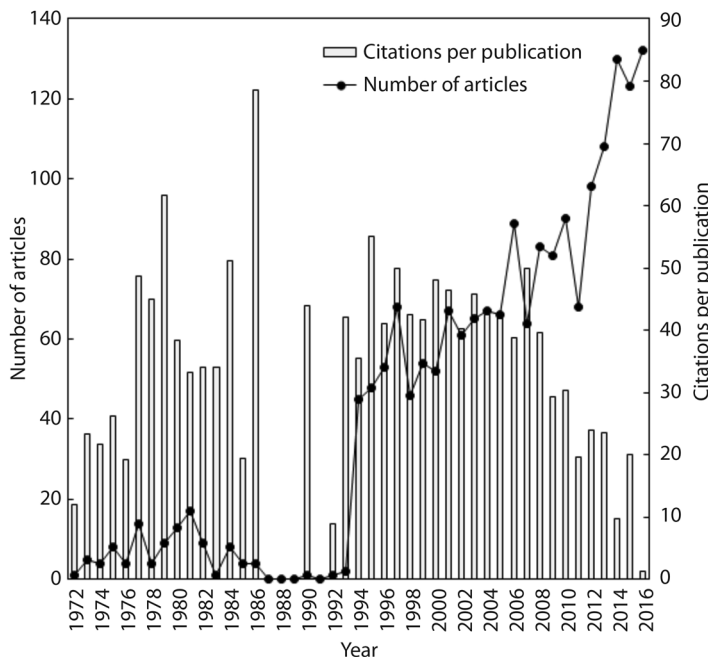
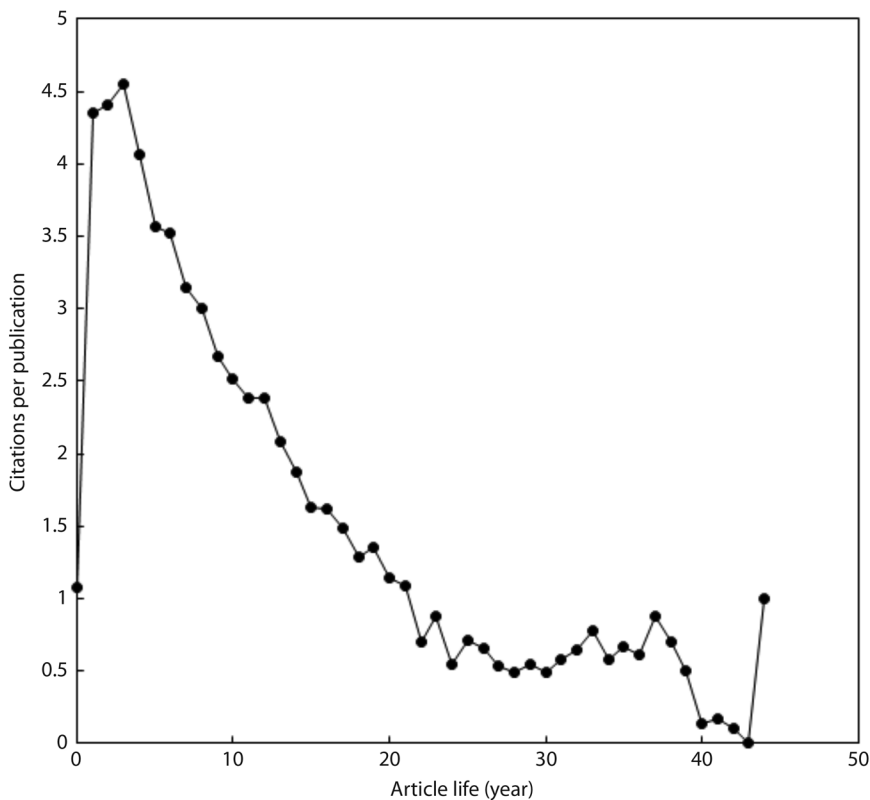


Fig. 1. Number of articles and citations per publication by year.



**Fig. 2.** Citation life span for Gambia articles.

JCR in 2016, Gambia articles were distributed in 94 Web of Science categories in SCI-EXPANDED. The top 20 productive Web of Science categories are shown in figure 3 (Fig. 3). A total of 19 journals were listed in Web of Science category of tropical medicine, and 18 % of Gambia articles were published in this category because Gambia is a tropical country where infectious diseases such as malaria, leishmaniasis, schistosomiasis, African trypanosomiasis, Dengue fever, etc. thrive well by hot and humid conditions.

Consequently, total articles were published in 393 journals in SCI-EXPANDED. The top 10 most productive journals are listed in table 2 (Table 2 see Appendix 2). *PLoS One* with  $IF_{2016}$  of 2 806 in category of multidisciplinary sciences, published the most Gambia articles (111; 5.9 % of 1867 articles), followed by *Transactions of the Royal Society of Tropical*

*Medicine and Hygiene* with  $IF_{2016}$  of 2279 in categories of public, environmental and occupational health and tropical medicine (72; 2.3%), and *Journal of Infectious Diseases* with  $IF_{2016}$  of 6 273 in categories of immunology, infectious diseases, and microbiology (72; 2.3%). Surprisingly, 53 Gambian articles were published in *Lancet* with  $IF_{2016}$  of 47 831 ranked 2<sup>nd</sup> in category of general and internal medicine. Articles published in *Lancet* by Naghavi et al. (2015), Kotloff et al. (2013), Cutts et al. (2005), Vos et al. (2015), Snow et al. (1997) and Bojang et al. (2001) with  $TC_{2016}$  of 842 (rank 1<sup>st</sup>), 576 (3<sup>rd</sup>), 537 (4<sup>th</sup>), 465 (6<sup>th</sup>), 429 (7<sup>th</sup>), and 355 (8<sup>th</sup>), were the main highly cited articles in the Gambia.

#### **Collaborating countries and institutes:**

In general, 154 (8.2 % of 1867) were Gambia independent articles and 1713 (92 %)

were internationally collaborative articles with authors from 157 different countries.

Table 3 (Table 3 see Appendix 3) displays the 10 commonest countries that collaborated with Gambia in research publications including the first and the corresponding authors as well as their  $CPP_{2016}$ . The Gambia articles that collaborated with Kenya and Germany had the highest  $CPP_{2016}$  of 55. Furthermore, a total of 136 (7.3 % of 1 867 Gambia's articles) were independent institution articles, while 1 731 (93 %) articles were institutionally collaborative. Of 1867 Gambia articles, the first authors of 210 internationally collaborative articles were from UK. Also, 213 (12 % of 1 728 articles with corresponding affiliations) with the UK corresponding authors were from London School of Hygiene and Tropical Medicine in UK. A total of 54 internationally collaborative articles had the highest  $CPP_{2016}$  but their corresponding authors were from Kenya. In addition, 54 internationally collaborative articles had the highest  $CPP_{2016}$  when the first authors were from USA and the lowest  $CPP_{2016}$  of 23 when the first authors were from Belgium.

The MRC (Medical Research Council) ranked top one in five indicators, including 1 534 (82 %) of total Gambia articles, 102 institutional independent articles (75 % of 136 institutional independent articles), 1 432 internationally collaborative articles (92.7 % of 1 731 internationally collaborative articles), 537 first author articles (29 % of 1 867 Gambia articles), and 418 corresponding author articles (24 % of 1 728 articles with corresponding author's affiliations in Web of Science). Figure 4 (Fig. 4 see Appendix 4) exhibits characteristics of publication types and their citations per publication. Publications of the top 10 institutions in the Gambia were compared with the five indicators in table 4 (Table 4 see Appendix 5). As shown in table 4 a total of 1 598 (82 %) of Gambia articles were published by the MRC unit which ranked top among the research institutions in the Gambia (Table 4).

## DISCUSSION

**Document type and language of publication:** The distributions of document types in the Web of Science and language of publication were attached much attention for tropical countries in Central America. For example Costa Rica (Monge-Nájera & Ho, 2012), Nicaragua (Monge-Nájera & Ho, 2017a), and Honduras (Monge-Nájera & Ho, 2017b), likewise countries in tropical regions of Africa such as Republic of Cameroon (Tchui fon Tchui fon, Fu, & Ho, 2017) and Ghana (Boamah & Ho, 2018). The majority of Gambia publications in the SCI-EXPANDED are formal articles, which might be partly explained by the fact that generally, institutions do not offer financial motivations for the publication of comments, letters, and book reviews, and therefore authors focus their efforts in publication of full articles.

Gambia's articles published in SCI-EXPANDED were mostly in English, similar with some Central American countries (Monge-Nájera & Ho, 2015). Nevertheless, Gambia is an Anglophone country that was colonized by the British Empire. There are only two articles written in French, indicated that though Gambia is almost surrounded by a Francophone country Senegal, French education is not highly incorporated in Gambia's education system.

**Characteristics of publication outputs and citation impact:** No Gambia articles before 1972 might be attributed to that the Gambia became an independent member of the Commonwealth in February 1965, and five years later a new Constitution was approved in a referendum in April 1970 to transform the nation into a republic. In addition, it may also have resulted to the general election that was held on 28<sup>th</sup> and 29<sup>th</sup> March 1972. In 1986, only four articles had the highest  $CPP_{2016}$  which can be attributed to the article entitled "Antigens induced on erythrocytes by *P. falciparum*:"

Expression of diverse and conserved determinants” (Marsh & Howard, 1986) with a  $TC_{2016}$  of 278, by Marsh from Gambia and Howard from USA. The peak year of *CPP* (3<sup>rd</sup> year) conformed to some tropical countries in Central America such as El Salvador (Monge-Nájera & Ho, 2017c), but distinguished from other tropical countries such as Honduras with the peak year shifting to the 4<sup>th</sup> year (Monge-Nájera & Ho, 2017b), 2<sup>nd</sup> year in Nicaragua (Monge-Nájera & Ho, 2017a) and likewise Guatemala (Monge-Nájera & Ho, 2018).

#### **Web of Science categories and journals:**

The majority of the Gambia articles were published in tropical medicine. Mortality rate from cerebral malaria still ranges between 20 and 30 % in the eastern part of the Gambia where three-quarters of these deaths occur within 24 hours of admission (Jaffar, 2005). Nevertheless, preventing the spread of infectious tropical diseases is paramount and stringent precautions enabled Gambia to focus on research areas in tropical medicine.

A total of 286 journals were listed in category of biochemistry and molecular biology but only 1.7 % of Gambia articles were published in this category, since the country’s main target is to combat the occurrences of infectious diseases that cost the lives of many individuals, thus the focus of Gambia research is actively on the tropical medicine and infectious diseases elimination. Furthermore, it should be comprehended that based on the journal type it can be categorized into two or more classifications, for instance *Journal of Infectious Diseases* was listed in categories of immunology, infectious diseases, and microbiology, therefore the total percentage of the journals was higher than 100 % (Ho, 2014). Meanwhile most articles in Costa Rica were published in *Revista de Biología Tropical* (Monge-Nájera & Ho, 2012), and *American Journal of Tropical Medicine and Hygiene* published the most articles for both Nicaragua (Monge-Nájera & Ho, 2017a) and Honduras (Monge-Nájera & Ho, 2017b).

The Gambia independent articles published in *Lancet* by Obaro (2000), Faal (1997),

and Cham (1997) had no citation after their publication. An article entitled “The Gambia: Treated bednets (Cham, 1997) had no citations after its publication. Treated bednet may not be a popular area of research in most countries but in Gambia, due to the high cases of malaria in the past years. At least 25 % of the high mortality rates in Gambia was attributed to malaria killing children (aged 1 - 4 years) (Greenwood et al., 1987). The use of bednets is traditionally high in many Gambian households. A nationwide survey of bednet use in rural Gambia found that 58 % of Gambian beds had bednets (D’Alessandro, Aikins, Langerock, Bennet, & Greenwood, 1994).

#### **Collaborating countries and institutes:**

Majority of the Gambia’s collaboration were from UK, followed by USA and Belgium. This differs from other tropical countries, such as Panama whose top three collaborators are USA, Germany and UK (Monge-Nájera & Ho, 2015), USA and Sweden for Nicaragua (Monge-Nájera & Ho, 2017a), USA, France and Mexico for Costa Rica (Monge-Nájera & Ho, 2012), USA, Mexico and Brazil for Honduras (Monge-Nájera & Ho, 2017b) and France, USA, and UK for Cameroon (Tchuifon Tchuifon et al., 2017).

The outcome illustrates that Gambia’s independent research ability is ineffective and weak. UK establishes the highest collaboration because Medical Research Council (MRC) unit in the Gambia is the UK’s single largest investment in medical research in a developing country. It was established in the Gambia in 1947. The Unit’s research focuses on infectious diseases of immediate concern to the Gambia and the continent of Africa, with the aim of reducing the burden of illness and death in the country and the developing world as a whole. Furthermore, 31 and 34 % of Gambia articles with first and corresponding author information, respectively, were from UK institutions, this indicates that UK had significant collaboration with Gambia.

This analysis of institutions was similar in other tropical countries where the most

productive institutions are: El Salvador; Universidad de El Salvador (Monge-Nájera & Ho, 2017c), Panama; Smithsonian Tropical Research Institute (STRI) (Monge-Nájera & Ho, 2015), Nicaragua; Universidad Nacional Autónoma de Nicaragua-Managua (UNAN) (Monge-Nájera & Ho, 2017a), Honduras; Universidad Nacional Autónoma de Honduras (Monge-Nájera & Ho, 2017b), Costa Rica; Universidad de Costa Rica (Monge-Nájera & Ho, 2012), and Cameroon; University of Yaoundé I (Tchuifon Tchuifon et al., 2017).

MRC unit was far established in 1947 before some of the current institutions were founded. The majority of its publications were from international collaboration, although 76 % of the articles were published by the unit independently. International Trypanotolerance Centre (ITC), top second research institute in the Gambia was founded in 1982 by an Act of Gambian Parliament. The centre aimed to increase the efficiency of livestock-based farming methods through the deployment of improved technological options based on good exploitation of adaptive traits of indigenous livestock. The centre had published 104 articles. Royal Victoria Teaching Hospital (RVTH), now called Edward Francis Small Teaching Hospital (EFSTH), was one of the oldest hospitals in the Gambia and has published 92 articles in the Web of Science. Out of the total publications by RVTH, 4 % of its articles were single institute articles, and 5 % were from inter-institutional collaboration. Gambia Government Department of Health and Social Welfare had also contributed a quota in research development in the Gambia. Most interestingly, the department itself has not published any single articles independently, likewise the National Eye Care Program and the University of the Gambia; their total publications were 99, 21, and 20 respectively, most of the articles published by them were inter-institutionally collaborative articles.

This paper presents a systematic review and bibliometric analysis of Gambian literature, which could serve as a reference for the researchers, administrators, and general

audients. While the performance differed in many aspects, a few conclusions could be drawn. Gambia speeded up during 1972-1981 and during 1994-2016 with rising outputs. The citation life cycle of The Gambia revealed the peak citation was at the 3<sup>rd</sup> year, similar with other tropical countries. Not surprisingly, Gambian scientists most concerned are the categories of immunology, infectious diseases, environmental and occupational public health, tropical medicine, while 2 509 Gambian articles were published in 456 journals, dominated by *PLoS One*, *Transactions of the Royal Society of Tropical Medicine and Hygiene*, and *Journal of Infectious Diseases*. Interestingly, citations per publication and number of articles published were higher when neither the first author nor the corresponding authors were from Gambia. It can be due to Gambian researchers were mostly integrated into international research groups. With regards to international collaboration, more than 90 % of all articles published by Gambian researchers were international collaborations. Additionally, the UK conquered the ranking of the most collaborative country with Gambia. Most remarkably, for institutional independent publications, MRC unit was the most prolific institution that produced majority of Gambia publications and the other productive centre was ITC.

## RESUMEN

### **Publicaciones de Gambia en el Science Citation Index Expanded: bibliometría de instituciones y temas.**

Gambia es el país más pequeño de África occidental, pero ha contribuido con el mundo académico en las décadas pasadas. Este estudio caracteriza tipos de documentos, idioma, tendencias de publicación, temas y colaboración internacional de las publicaciones de Gambia entre 1900 y 2016, con base en el *Science Citation Index Expanded* en *Web of Science*. Los resultados indican que Gambia depende en gran medida de la colaboración internacional para publicar, principalmente del Reino Unido y EE.UU. Esta colaboración explica el aumento de la producción científica y el impacto científico de Gambia en los últimos años. El *Medical Research Council* (MRC) publicó el mayor número de artículos y ha cumplido una función importante en la colaboración internacional. La mayoría de publicaciones de Gambia se enfocan en medicina tropical, salud pública ambiental y ocupacional, inmunología y enfermedades



contagiosas. Con la información y las observaciones de este artículo obtenemos una rápida visión general de las publicaciones de Gambia, que puede ayudar a investigadores y administradores a tomar decisiones estratégicas.

**Palabras clave:** Gambia; *Web of Science*; *Scientometrics*; factor de impacto; colaboración.

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