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Bibliometric analysis of cancer publications in Nigeria during 2008 – 2012

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The bibliographic data on cancer literature of Nigeria was drawn from the Medline of National Library of Medicine (NLM), USA. This research work examines the conformity of Lotka's Law to authorship distribution during 2008-2012.Totally, 677 articles in cancer produced by 1,854 authors, was compiled for the analysis. Lotka's inverse power Law was used in testing the hypotheses. That is, $x^n y = c$ where the values of the exponent *n* and the constant *c* were computed; and Kolmogorov-Smimov (K-S) goodness-of-fit test was applied. The results suggested that all categories of author productivity distribution in this research work fit into Lotka's generalized inverse square law.

Key words: Bibliographic data, publication, cancer, impact factor.

INTRODUCTION

There exists a lack of knowledge regarding the quantity and quality of scientific yield in relation to cancer in Nigeria. Representation of cancer-related articles in the medical literature has not been well-established. The rapid increase in medical research publications has been facilitated by the development of the internet, integrated search engines, and on-line publishing (Glynn et al., 2010). The two principal repositories for medical research publications are the Web of Science (WoS) (Thompson Reuters), and PubMed (the National Library of Medicine (NLM)); the latter recognised as the most frequently used source for information in the medical field (Falagas et al., 2008).

Bibliometrics is a systematic method for evaluating research output which can help map changes in the interest of a scientific community over time and can provide insights into both qualitative and quantitative research trends. The bibliometrics indicator most commonly used to undertake qualitative analysis is the journal impact factor (IF) which is based on two elements; the numerator, which is the number of citations in the current year to items published in the previous 2 years, and the denominator, which is the number of substantive articles and reviews published in the same 2 years.

The principal focus of this study is to measure the quantity, authors' productivity, quality and relevance of cancer-related articles. This was achieved by retrieving relevant articles on the subject matter from the Medline database of the National Library of Medicine (NLM), USA, 2008 – 2012 with search terms CANCER AND NIGERIA

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AND ("2008/01/01": "2012/12/31").

LITERATURE REVIEW

Bibliometrics is derived from two different words: *biblion*, the Greek word for 'book', (which can be any literature) and *metrics*, the use of mathematical and statistical concepts, models and laws to analyse quantities (Hussain and Fatima, 2011). Thus, bibliometrics is a type of research method that uses quantitative analysis and statistics to describe patterns of publication within a given field or body of literature (Chuang et al., 2011). Janeving (2009) opined that with the bibliometric methods, the evaluation of research productivity for both individuals and institutions is made possible.

Lotka (1926) examined author productivity, i.e. the publication contributions of authors to a given discipline; he later propounded the Law of Scientific Productivity which states that the number of authors who have published a specific number of papers is approximately equal to the inverse square of that number multiplied by the number of authors who have published one paper only.

Nwagwu (2006), while testing the validity of Lotka's law of productivity on four author categories of Nigeria's biomedical research for the period 1967 to 2002, namely 'all authors', 'first authors', 'non-collaborative authors' and 'co-authors', discovered that it was only the data on the co-author category that did not conform with the law. Furthermore, he posited that many developing countries are yet to utilize bibliometric methods in scientific information gathering. Pulgarin (2012) proved that the two parameters of Lotka's law, the exponent n and the constant c, were influenced by the subject area's productivity and growth, by the type of area, the country, the time period, and the length of that period. A year later, a study by Sivakumar et al. (2013) averred that even though Lotka's law holds true in many scientific disciplines but same cannot be said about biology literature of central universities in India. In 2014, Kumar (2014) analysed the distribution of productivity of authors in the field of Human Computer Interaction (HCI) research from Science Citation Index-Expanded for 2006 – 2011. In his study, he tested Lotka's law of authors' productivity by comparing two different methodologies. He discovered that literature in the field of HCI research studies does conform to Lotka's law and concluded that the law is a standardized means of measuring authors' publication productivity in HCI research. However, Mahmood (2014) studied the exactness of Bibliometric laws through applications of Lotka's law to library and information science (LIS) and revealed that Lotka's law was not applicable to Pakistani LIS authors. The results of the study also indicated that majority of authors produced only one item in their entire professional career.

A review of bibliographic information from the field of public health nutrition in West Africa by Grant et al. (2010) concluded that research output from this area was too low, given the magnitude of nutrition problems in the region. Other challenges facing developing countries' scholars, especially Africa, in the area of scientific research include low participation in international journals, publishing in journals with low impact factors, exclusion from international bibliographic databases, small circulations, inadequate funding, inadequate electronic resources, inadequate review and production staff, and difficulty in maintaining publication frequency (Tanya, 2005; Siegfried et al., 2006; Grant et al., 2010; Ajuwon et al., 2011; van Ejik et al., 2012).

While perusing biomedical literature, a bibliometric analysis of cancer literature is yet to be encountered. Nwagwu (2006) conducted analysis on Nigerian biomedical literature and concluded that research activities in local universities have shrunk over the years due to the several challenges previously mentioned. In the area of diabetes, Harande (2011) examined Nigerian literature between the years 1996 and 2009; he said that even though there is a rapid growth in the publication of diabetes-related literature in the country, there remains a need for all health and health-allied workers to collaborate on how to effectively combat the disease. In the area of HIV/AIDS, Uthman (2008) conducted a seminar work which discovered that articles with international collaboration appeared in journals with higher impact factors and also received more citations. Publication trend in biomedical research among African authors has indicated that Nigeria has produced more publications than other sub-Saharan countries excluding South Africa, due to efforts put into peer visibility and career advancement (Owolabi et al., 2007; Uthman and Uthman, 2007; Hofman et al., 2009).

METHODOLOGY

This research which extracted and analysed publications on cancer within the geographical location Nigeria considering a window period of 5 years (that is 2008 to 2012) was carried out using the Medline database of the National Library of Medicine (NLM), USA. A total of 677 articles by 1854 authors were retrieved using the advanced search and custom settings tool of the database with the keywords CANCER AND NIGERIA AND ("2008/01/01": "2012/12/31").

The dataset was analysed into the quantity of articles per year as shown in Figure **1**. Also, in order to estimate the productivity of authors on the subject, authors were categorised into four groups (Nwagwu, 2006):

a). All authors: Here, authors for each article were extracted and counted. This is in conformity with the author counting method used in bibliometric analysis in which the number of occurrence of an author in the dataset equals the total credit to be awarded to the author.

b). First author: Here, counting was done considering only the first author of each publication where there are more than one authors. This was achieved using the first author column provided by the database.

c). Co-authors: This was done by considering only articles written by more than one authors. Then the authors for these articles were

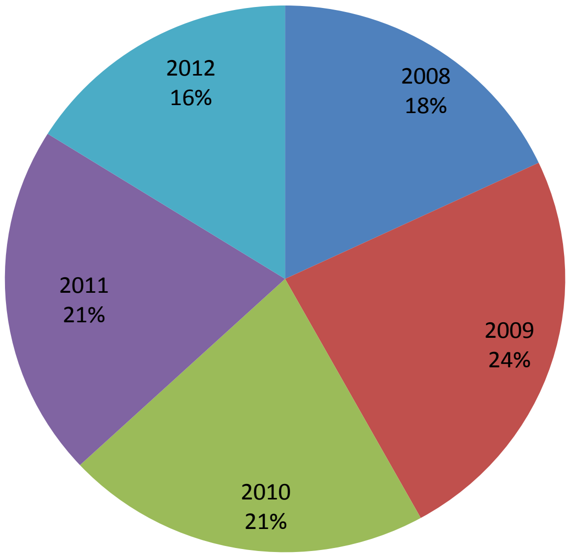

Figure 1. Distribution of articles over the year.

counted.

d). Non-collaborative authors: This was achieved by considering only single-authored articles. Credits were awarded by counting these authors.

The estimation of the productivity of the literature on this area of interest was done using the Lotka's law ($X^{\propto}Y = C$) with aid of LOTKA software. This is a computer program for fitting a power law distribution such as Lotka's law. It basically follows Nicholl's methodology, using a maximum likelihood approach to estimate parameters, and a Kolmogorov-Smirnov test for goodness-of-fit.

The bibliometric variables used for the analysis are: number of authors, place of publication, year of publication, impact factor, institutional affiliation, number of pages, first authors, co-authors, non-collaborative authors and single-authored paper.

Hypotheses

1. All authors' category distribution on cancer within Medline (2008 – 2012) fits Lotka's Law.
2. First author category distribution on cancer within Medline (2008 – 2012) fits Lotka's Law.
3. Non-collaborative author category distribution on cancer within Medline (2008 – 2012) fits Lotka's Law.
4. Co-author category distribution on cancer within Medline (2008 – 2012) fits Lotka's Law

Impact factor of journal

The journals in the dataset for this study were ranked in the order of number of publications within the period of consideration. Then, the first ten ranked journals were selected which consist of fourteen (14) journals. In order to calculate the Impact Factor (IF) of these fourteen (14) journals, the Publish or Perish (PoP) software by Harzing (2007) was used.

The total number of citations that each journal received per year was obtained by summing up the total number of citations obtained by all the articles published in a given journal per year for the entire period of study, i.e. 2008-2012. The same approach used to calculate the impact factor (IF) for ISI-indexed journals was adopted in order to obtain the IF of the 14 journals evaluated in this study.

The ISI (Thomson Reuters, 2009) uses the following formula in calculating a given journal's.

$$IF = \frac{cited\ in\ recent\ articles}{numberofrecent\ articles}$$

This study considered the number of citations earned by each journal in 2012 from articles published in the respective journals in 2008 to 2011 for purpose of calculating the journal Impact Factor (IF). Having obtained citations received in 2012 and the number of publications in a given journal in 2008, 2009, 2010, 2011 or 2012, the above formula was used to calculate each journal's IF.

RESULTS

A total of 677 articles (Table 1) by 1854 authors were retrieved for analysis. It was observed that year 2009 witnessed the highest number of articles (162 papers) written on cancer while year 2012 witnessed the lowest number of publications with 109 articles (Figure 1). In order to establish the pattern of the distribution of the dataset, a graph of the four categories of authors was plotted. Figure 2 shows the number of authors against their contributions (x). The reverse j-shape of the curves shows that the distribution of authors in each category is in conformity with the bibliometric distribution (a social distribution).

The productivity of researchers on the subject matter was estimated using Lotka's law by organizing the data as a distribution of articles over authors for each of the categories of authors, as shown in Table 1. From Table 1b, it can be observed that the co-author category has the highest number of authors with 74.20%, which is an indication of high level of collaboration on the subject matter. The non-collaborative author category has the lowest number of authors with 2.78% of the total number of authors, which also confirms the last statement. While the first author category contributed 23.03%. It should be noted that the non-collaborative author category indicates authors who singly authored an article and that this dataset shows that sole-authorship or single-authorship is not really a common practice on research on cancer.

We did not just stop there as we went further to estimate the productivity of the category of author of the dataset using Lotka's law and also testing whether this dataset can be explained using this law. The outcome is as shown in Table 2 and explained below. We tested for the hypotheses of the productivity pattern of each of the different author categories using Kolmogorov-Smirnov benchmark.

All authors

This category of authors which consist of 1,843 authors is the total number of authors in the dataset. An examination of the distribution of articles in this category (Table 1b) shows that about 76% of the scientists contributed just one article each in the bibliography while

Table 1a. Distribution of articles over authors before truncation.

	All authors	First authors	Non-collaborative authors	Co-authors
Contribution (X)	**Total %**	**Total %**	**Total %**	**Total %**
Total	1854	474	57	1529
1	75.5	75.7	93.0	78.55
2	12.9	15.0	5.3	11.45
3	5.2	4.0	1.8	5.30
4	2.4	3.0		1.90
5	1.5	1.7		1.18
6	0.5	0.4		0.46
7	0.3			0.39
8	0.7			0.39
9	0.3			0.07
10	0			0.00
11	0.2	0.2		0.13
12	0.2			0.07
13	0			0.00
14	0			0.00
15	0.1			0.00
16	0			0.00
17	0.1			0.07
18	0.1			0.00
19	0			0.00
20	0.1			0.07

Table 1b. Distribution of articles over authors after truncation.

	All authors	First authors	Non-collaborative authors	Co-authors
Contribution (X)	**Total %**	**Total %**	**Total %**	**Total %**
Total	1843	473	57	1524
1	76.0	75.9	93.0	78.8
2	13.0	15.0	5.3	11.5
3	5.3	4.0	1.8	5.3
4	2.4	3.0		1.9
5	1.5	1.7		1.2
6	0.5	0.4		0.5
7	0.3			0.4
8	0.7			0.4
9	0.3			0.1

about 13% contributed only two items each, and about 5.3% contributed to three articles each. On the other hand, only about 0.3% of the authors in the bibliography contributed at least 9 items each. When this outcome was tested with the productivity pattern of the Lotka's law it was found out that this category fits the law with the value α = 2.5973 and k = 76.55% against Lotka's own benchmark in which k = 60.79.

The Kolmogorov-Smirnov statistic output indicates that the maximum absolute difference, D_{max} is less than the critical value at all levels of significance (Table 2 – All authors). This as shown by Dmax = 0.0103 (sig. level (1%) = 0.0379; sig. level (5%) = 0.0316; sig. level (10%) = 0.0283) showing that Lotka's law is valid in this case. Therefore, we do not reject the null hypothesis and conclude that this category of authors follows Lotka's inverse power law.

First authors

This category of authors has 473 authors where about

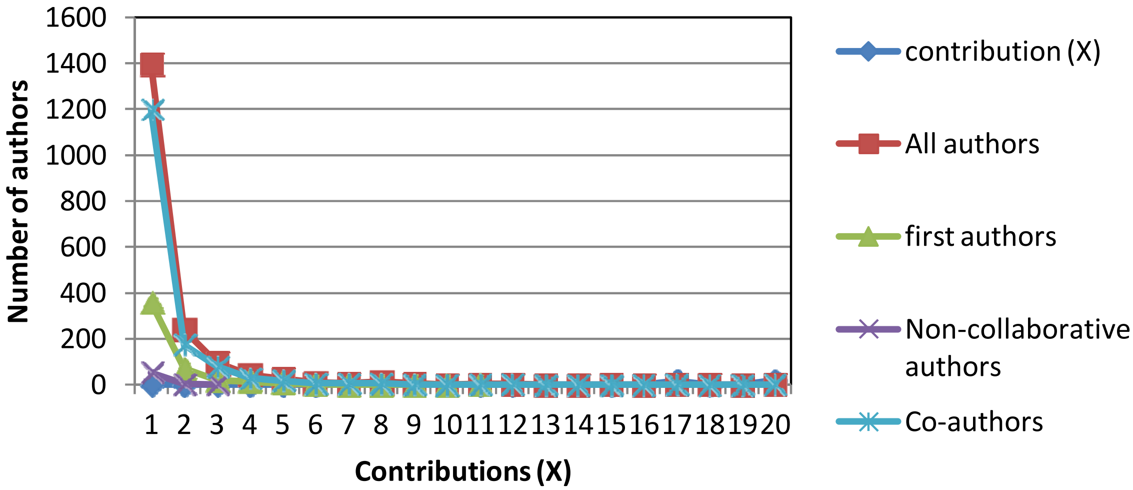

Figure 2. Size-frequency distribution of authors making x contributions.

Table 2. Parameters of various categories.

					Kolmogorov Smirnov Statistics		
Author categories	D Max	Parameter	N	Df	1%	5%	10%
All authors	0.0103	α = 2.5973 k = 76.55%	1854	19	0.0379	0.0316	0.0283
First Authors	0.0274	α = 2.6992 k = 78.48%	473	10	0.0749	0.0625	0.056
Non-collaborative authors	0.0316	α = 3.6709 k = 89.82%	57	2	0.2159	0.1801	0.1616
Co-authors	0.0111	α = 2.621 k = 79.29%	1524	19	0.0417	0.0348	0.0312

76% authors wrote just one article, 15% made 2 contributions and 0.4% made has the highest number of articles which is 6. From Table 3, we have α = 2.6992 and K = 78.48% (a value higher than Lotkas' 60.79) where Dmax = 0.0274 is lower that KS = 0.0749, 0.0625 and 0.056 at 1, 5 and 10% levels of significance respectively. We can therefore infer here also that we do not reject the null hypothesis and that this category of authors fits Lotka's inverse power law.

Non-collaborative authors

57 authors appear in this category of single author. The result obtained here suggests that this category of authors like the previous two categories also conform to Lotka's law of author productivity and generalised power inverse law. This as shown in table where α = 3.6709 and K = 89.82%. Since the maximum deviation, Dmax = 0.0316 falls within the critical values KS = 0.2159, 0.1801, 0.1616, 5 and 10% significance level respect-tively, then we do not reject the null hypothesis and we can conclude that this category conforms with Lotka's Law.

Co-authors

In this category, the total number of authors, 1524 in which about 79% of the authors in this category made a single contribution each while about 12% made 2 contributions each, about 5% made 3 contributions each and more than 4% contributed between 4 and 9 articles. Just as before, we compared this dataset with Lotka's law and found out that this category also agreed with the law as shown in Table 3 with the parameters Dmax = 0.011, α = 2.621, K = 79.29%, KS = 0.0417, 0.0348, 0.0312 at 1, 5 and 10% level of significance, respectively.

Journals and authors' impact

The impact factors of the fourteen (14) Journals that fall within the 1st ten ranks are as shown in Table 4. Here we

Table 3. Rank of journals publications and Impact factor.

Journal name	Publications	Rank	Journal name	Impact factor	Rank IF
Nigerian Journal of Clinical Practice	60	1	Psycho-Oncology	12	1
Nigerian journal of medicine	40	2	Nigerian journal of medicine	3.92	2
The Nigerian postgraduate medical journal	40	2	American Journal of Obstetrics & Gynaecology	3.64	3
African journal of medicine and medical sciences	36	3	The Nigerian postgraduate medical journal	3.17	4
West African Journal of Medicine	34	4	African journal of medicine and medical sciences	3	5
Annals of African Medicine	25	5	Nigerian Quarterly Journal of Hospital Medicine	3	5
Nigerian Quarterly Journal of Hospital Medicine	25	5	Nigerian Journal of Clinical Practice	2.19	6
African Health Sciences	21	6	African Health Sciences	2.09	7
African Journal of Paediatric Surgery (AJPS)	14	7	Infectious Agents and Cancer	1.67	8
American Journal of Obstetrics and Gynaecology	10	8	West African Journal of Medicine	1.6	9
The Pan African Medical Journal (PAMJ)	9	9	Annals of African Medicine	0.71	10
Infectious Agents and Cancer	8	10	The Pan African Medical Journal	0.27	11
Psycho-Oncology	8	10	African Journal of Paediatric Surgery	0.2	12

considered number of citations earned by each journal in 2012 from paper published in the respective journals in 2008, 2009, 2010, or 2011.

Psycho-Oncology is ranked first in terms of the impact factor having an impact factor of 12, followed by Nigerian journal of medicine (IF = 3.92) and American Journal of Obstetrics and Gynaecology occupying the third position with IF = 3.64. While, Annals of African Medicine, Pan African Medical Journal (PAMJ) and African Journal of Paediatric Surgery (AJPS) have the lowest impact factor value of 0.71, 0.27 and 0.2 respectively.

Akang E. E. has the highest the number contributions of 20 articles in the dataset, followed closely by Abdulkareem F. B. and Banjo A. A. with 18 and 17 articles respectively. While Mohammed A., Niu Q. and Huo D. show high h-index of 106, 101 and 90 respectively.

DISCUSSION

The distribution of cancer publications on Nigeria within the period 2008–2012 reflects certain regularities which are often the characteristics of a bibliometric distribution. All the categories of authors used for this study showed such regularities which are abound in the social and biomedical sciences (Nwagwu, 2006). This is reflected in the reverse j-shape of the distribution. Observably, as the number of articles published increases, authors producing that many publications become less frequent.

The findings of this study show that at the various significance levels, all the four categories of authors did conform with the Lotka's inverse power law at different parameters α = 2.5973, 2.699, 3.6709, 2.621 and k = 76.55%, 78.48%, 89.82%, 79.29% for 'all authors', 'first authors', 'non-collaborative' and co-authors' respectively. This shows that the productivity coefficient of 'all authors' and co-author categories (approximately 2.6) is an indication of a very high productivity of authors in these categories. Also, the research publications on cancer witness high number of collaborative effort as shown by high number of co-authored article when compared to single-authored article.

It will be interesting to note that this study when compared with Nwagwu (2006), there is great similarity among the various categories of authors where he conducted a study on the productivity pattern of biomedical authors of Nigeria during 1967–2002, except for the 'co-authors' category where he discovered that this category did not conform with the inverse power law. Since impact factors (IF) are generally perceived to be measures of quality or influence, Psycho-Oncology is of very high quality (IF = 12), followed by Nigerian journal of medicine (IF = 3.92) and American Journal of Obstetrics & Gynaecology (IF = 3.64). Those that are of low quality are the Annals of African Medicine (IF = 0.71), The Pan African Medical Journal (IF = 0.27) and African Journal of Paediatric Surgery (IF = 0.2).

Conclusion

Lotka's Law of scientific productivity is one of the laws of bibliometrics used to characterise authors' productivity.

Table 4. Rank of author contribution and impact of the 1st ten ranked.

Authors' contribution			Authors' impact		
Name of author	**Contribution**	**Rank**	**Name of author**	**h-index**	**Rank**
AkangE. E.	20	1	MohammedA.	106	1
AbdulkareemF.B.	18	2	NiuQ.	101	2
BanjoA. A.	17	3	HuoD.	90	3
AnunobiC. C.	15	4	OlopadeO. I.	59	4
AsuquoM. E.	12	5	SalakoA. A.	36	5
HuoD.	12	5	RahmanG. A.	32	6
SamailaM. O.	12	5	AdebamowoC.	28	7
AdeyemiB. F.	11	6	AdebamowoC. A.	24	8
Adisa A. O.	11	6	BanjoA. A.	19	9
MandongB. M.	11	6	AdeyemoW. L.	19	9
OlopadeO. I.	11	6	RotimiO.	18	10
DaramolaA. O.	9	7	AkangE. E.	17	11
EbugheG.	9	7	SilasO. A.	16	12
EchejohG. O.	9	7	LawalO. O.	13	13
IraborD. O.	9	7	AdesunkanmiA. R.	13	13
OkoloC. A.	9	7	OgundiranT. O.	12	14
Olu-EddoA. N.	9	7	ArowoloO. A.	12	14
AdebamowoC.	8	8	IkechebeluJ. I.	12	14
AdebamowoC. A.	8	8	AsuquoM. E.	9	15
AnyanwuS. N.	8	8	MandongB. M.	9	15
BadmosK. B.	8	8	DaramolaA. O.	9	15
BasseyE. E.	8	8	OkoloC. A.	9	15
EyesanS. U.	8	8	BasseyE. E.	9	15
EzeomeE. R.	8	8	EzeomeE. R.	9	15
NzegwuM. A.	8	8	AdenipekunA.	9	15
ObalumD. C.	8	8	AnunobiC. C.	8	16
OgundiranT. O.	8	8	OluwasolaA. O.	8	16
OgunG. O.	8	8	AbdulkareemF. B.	7	17
OluwasolaA. O.	8	8	AdisaA. O.	7	17
RahmanG. A.	8	8	EbugheG.	7	17
AdeyemoW. L.	7	9	ManassehA. N.	7	17
AkindeO. R.	7	9	NzegwuM. A.	6	18
LawalO. O.	7	9	OmotiC. E.	6	18
MohammedA.	7	9	AlatiseO. I.	6	18
OmotiC. E.	7	9	SamailaM. O.	5	19
OnyiaorahI. V.	7	9	EchejohG. O.	5	19
AdenipekunA.	6	10	Irabor D. O.	5	19
AdesunkanmiA. R.	6	10	Olu-EddoA. N.	5	19
AlatiseO. I.	6	10	ObalumD. C.	5	19
ArowoloO. A.	6	10	OgunGO.	5	19
IkechebeluJI	6	10	AdeyemiB. F.	4	20
ManassehA. N.	6	10	AnyanwuS. N.	4	20
NiuQ.	6	10	BadmosKB	4	20
RotimiO.	6	10	OnyiaorahI. V.	4	20
SalakoA. A.	6	10	Eyesan .S.U	3	21
Silas O. A.	6	10	Akinde O. R.	3	21

This study adopted the generalized inverse form of this law in estimating and understanding the productivity pattern of authors'contributions on the disease, cancer, within the window period 2008 – 2012 using the Medline database of the National Library of Medicine (NLM), USA. This study revealed that all the categories of authors conformed with the Lotka's law and thus applicable to studying authors' productivity of cancer publications in Nigeria.

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