

Pharmaceutical Sciences Research in Universities in Nigeria: The Collaboration and Citation Nexus, 2016-2025

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ABSTRACT

This study analysed pharmaceutical sciences research output from universities in Nigeria between 2016 and 2025 to examine the extent of collaboration and correlation between author count and citation count. The study was guided by four research questions and one hypothesis. The objectives of the study include determining the annual growth rate of Pharmaceutical Sciences research publications from Universities in Nigeria, the annual citation rate of their publications, examining the extent of collaboration among pharmaceutical science researchers in universities in Nigeria and the relationship between citation counts and the extent of authorship collaboration. A bibliometric research design was adopted, and a census of 633 articles in pharmaceutical sciences produced by researchers affiliated with Nigerian universities, as indexed in the Dimensions database, was analyzed. A coding instrument validated by experts and tested for inter-rater reliability using Cohen's Kappa (values greater than 0.81) was used for data extraction. Data were analyzed using descriptive statistics and Pearson's Product Moment Correlation. Findings revealed a steady annual growth rate of 4.35% in publications over the period, while mean citations per article rose from 0.14 in 2016 to 10.01 in 2025, representing a total citation growth of 13,750% and an average annual growth rate of 91.7%. The degree of collaboration among researchers was high at 97.95%, with international collaboration accounting for 40.44%. A statistically significant but weak positive correlation was found between citation counts and the extent of authorship collaboration. Conclusively, The Pharmaceutical Sciences research in universities in Nigeria is overwhelmingly collaborative, maintain strong global engagement but concentrated in few countries- USA, South Africa, UK and India. In addition, statistically significant but weak positive correlation exists between co-authorship extent and citation counts. It was recommended that universities and funding agencies establish funded centres for international research collaboration.

Keywords: Bibliometrics Analysis, Authorship Collaboration, Citation Counts, International Collaboration, Pharmaceutical Sciences Research and Nigeria.

BACKGROUND TO THE STUDY

A critical aspect of health science is drug discovery and development. Drug development includes all the activities involved in transforming a compound from the end-product of the discovery phase to a product approved for use, all of which are embedded in Pharmaceutical Sciences. Pharmaceutical Science is the base and crucial aspect of health sciences. It is important for the discovery and development of new drugs and treatments (Wathore, 2022). It plays an important role in improving human health. According to the American Association of College of Pharmacy (AACP), Research and Graduate Affairs Committee (2023), Pharmaceutical Sciences encompass a broad range of interdisciplinary fields related to drug discovering, optimization, delivery, optimal dosing, as well as health outcomes and policies. Pharmaceutical sciences aim to integrate the fundamental principles of physical and organic chemistry, biochemistry, biology and engineering to understand how to optimize drugs' delivery into the body and translate this integrated understanding into new and improved therapies against disease (Idoudi et al, 2021). It involves the study of the overall process of developing a new

chemical entity into an approved therapy that is safe and effective in treating or preventing diseases (Marino & Jamal, 2023). Pharmaceutical sciences pull a wide range of disciplines to discover, test and develop new drugs and therapies, as well as evaluate their effectiveness and safety.

There are several sub-disciplines in pharmaceutical sciences which include but not limited to, pharmaceutical and medicinal chemistry, pharmaceuticals, pharmaceutical microbiology and biotechnology, pharmacology and toxicology, pharmacognosy and traditional (herbal) medicine, pharmaceutical technology and industry pharmacy, clinical pharmacy and pharmacy management. These research fields are concerned with drug discovery, production of pharmaceutical products, development of the methods or processes of production, quality control (Jayaprakash & Chaman 2018), and the study of factors influencing the use and abuse of drugs, effectiveness and safety of drugs, and many more. Pharmaceutical sciences research, therefore, encompass all the activities involved in drug development, from its discovery to preclinical research and from clinical research to patient compliance. It is a scientific investigation that starts from the identification of chemical compounds, the development of a pharmaceutical product, its trial in animals and humans, and its use on patients. According to Mali (2017), pharmaceutical science research involves scientific and clinical inquiry from drug discovery through clinical trial research to the therapeutics of drug use in humans and animals. It also covers medication-related public health issues (antibiotic resistance, medication safety, and clinical toxicology), pharmacy education (initial, experimental, theoretical, and continuing), pharmacy workforce, and pharmacy governance (Obaid et al., 2022). Researchers in pharmaceutical sciences are involved in the synthesis of new drugs (often called molecules), new processes, clinical testing of the effects of such drugs on animals and humans, and obtaining the required license from the drug regulatory authorities.

Pharmaceutical sciences research, therefore, has a significant impact on the health and pharmaceutical sectors, on each pharmacy practitioner in healthcare settings, academics in universities (Idoudi et al, 2021), and the society at large. Pharmaceutical Science research promotes the advancement of pharmacy practice; enhances pharmacist-provided services, builds the evidence base for developing and commissioning new services, improves patient care, and contributes to health service knowledge (Obaid et al., 2022). According to Akel et al. (2022) pharmaceutical sciences research facilitates the implementation, monitoring and evaluation of drug policies and their impact on national health services. Research in pharmaceutical sciences, thus, contributes to the progress of a nation in health, industry, social and economic aspects. Pharmaceutical science research is a major driver of economic development in countries around the world. Growth in this sector can be considered one of several factors in the economic growth of a country or region (Arencibia-Jorge et al. 2016). Considering the importance of pharmaceutical sciences research in the overall development of the economy, it is therefore, necessary for nations to pay serious attention to developmental issues relating to this sector.

Furthermore, in the face of global industrial competitiveness and the emergence of new diseases, the need to increase the production of new drugs from local raw materials as well as improve on existing ones becomes extremely important for Nigeria's survival as a nation (Okereke, et al. 2021). Thus, the research undertaken by pharmaceutical science researchers in Nigerian universities is expected to be useful enough to produce local industries that would be driven by the research work done. With great consideration to factors that pose challenges to pharmaceutical research in Nigerian universities, the input of research knowledge and collaborative efforts of pharmaceutical researchers in Nigerian universities would be of great help in strengthening the capacity of Nigerian industries to manufacture drugs from local raw materials. Collaboration in Pharmaceutical research is important, as it allows professionals, academics and practitioners to exchange knowledge, expertise and skills. Collaboration, holistically, is often helpful in tackling complex and important problems. It is a crucial component of all aspect of the academic and clinical learning through which common vision, goals and realities are developed and maintained (Rakhudu, et al., 2016). Research collaboration on the other hand can be seen as working together of individuals to achieve a common goal of producing new scientific knowledge (Ravasi, et al., 2024). Many researchers have revealed the importance of research collaborations of various types (international, inter-institutional, disciplinary and interdisciplinary) in developing research capacity (Razzaq et al., 2022; Abramo et al., 2017; & Fraszczyk et al., 2019). However, considerable emphasis is afforded to the benefits of international collaboration with numerous studies highlighting its potential to foster innovation, facilitate knowledge transfer and promote global problem-solving (Auanassova (2023); Fu, et al (2022); Samuel, et al. (2024) & Nasir et al. (2015). Cooperation of pharmaceutical researchers from Nigerian universities with

international researchers (researchers from developed countries) may help enhance research capacity as well as useful in sharing expertise. It may also lead to new discoveries that can be beneficial to the society.

Further, a substantial body of research such as (Shen et al. (2021); Velez-Estevez et al. (2022); Vieira (2023); Thelwall et al. (2023); and Vallejo et al. (2025) has consistently demonstrated that collaborative works are more desirable than non-collaborative works. Considering the number of citations that collaborative articles receive, the impact (measured by citations) of publications resulting from international research collaborations, is likely to be higher than that of publications from domestic research collaborations, especially if the research and innovative system of one or more countries involved in research collaboration is strong (Vieira, 2023).

Although many studies have investigated the scholarly impact of collaborative research in different fields, the scholarly impact of collaborative research by practitioners and researchers in the pharmaceutical sciences, especially in Nigerian universities, has long been overlooked. This study therefore analyzed the Pharmaceutical Sciences publications from universities in Nigeria to examine correlation between their author count and citation counts.

Purpose of the Study

The study generally sought to analyze publications of pharmaceutical sciences researchers in universities in Nigeria to examine correlation between their author count and citation count. Specifically, the study aimed to

1. Determine the annual growth rate of research publications of pharmaceutical sciences researcher in universities in Nigeria from 2016 to 2025
2. Determine the annual citation rate of publications of pharmaceutical sciences researchers in universities in Nigeria from 2016 to 2025
3. examine the extent of collaboration among pharmaceutical science researchers in universities in Nigeria.
4. To examine the relationship between citation counts and the extent of authorship collaboration for pharmaceutical sciences publications from universities in Nigerian

Research Questions

The following research questions have been formulated to guide the study

1. What is the annual growth rate of research publications of pharmaceutical sciences researcher in universities in Nigeria from 2016 to 2025
2. What is the annual citation rate of publications of pharmaceutical sciences researchers in universities in Nigeria from 2016 to 2025
3. To what extent do Pharmaceutical Science researchers in universities in Nigeria collaborate in research?
4. What is the relationship between the citation counts and the extent of authorship collaboration for pharmaceutical sciences publications from universities in Nigeria?

Hypothesis

The following hypothesis has been tested for this study at 0.05 level of significance:

HO₁. There is no statistically significant relationship between the citation rate of Pharmaceutical Sciences research in universities in Nigeria and their extent of collaboration.

Empirical Studies

Several empirical studies have investigated various aspects of research productivity. The majority of these studies have focused on assessing the growth rate of research output and citation counts with a particular emphasis on evaluating the scholarly impact of researchers within their respective domains. A subset of these studies has extended this analysis to examine the degree of research collaboration among researchers. However, a notable

gap exists in the literature, as there is a dearth of studies on the relationship between citation counts and the extent of authorship collaboration for pharmaceutical sciences publications from universities in Nigerian

Studies on growth rate of research publications

Jeys Shankar and Nishavathi (2018) conducted a study on Research Productivity of All India Institute of Medical Sciences (AIIMS) using bibliometric analysis. The study aimed at examining the growth of research literature produced by AIIMS for the period of 2007 to 2016. A total of 14,410 records were retrieved from the Scopus database. The result of the study revealed that the publication output mean, standard deviation, minimum and maximum were 1,441, 318.92, 1,087 and 2,141 respectively at 95.0% confidence level. The study also revealed that Indian Journal of Paediatrics, Indian Journal of Medical Research, and Indian Paediatrics were the most preferred journals among the faculties of AIIMS. This study and the present study adopted bibliometric research design and both used online database as data source. However, both studies differ in scope. The review study analyzes research productivity of all India Institute of Medical Sciences while the present study focused on Nigerian pharmaceutical sciences research.

Jayaprakash and Chaman (2018) studied Research Publication Trend in Pharmaceutical Sciences: A Bibliometric analysis during 2013-2017. The study analyzed the research output performance on Pharmaceutical Science subject. A total of 1,913 research articles published in Web of Science database were analyzed to find out the performance of Pharmaceutical Science professionals from all over the world in terms of growth during the period 2013-2017. This study reveals that the average number of publications per year was 382 and that a greater number of articles were published during 2016. In the contribution of documents, USA contributed 30.21% of the total publication. Among journals Acta Pharmaceutica Sinica B journal ranked first with 162 articles. This study and the present study aimed at examining pharmaceutical sciences research publication growth using bibliometrics method. However, the review study focused on the world pharmaceutical science journal articles indexed in Web of Science database while this study focused in Nigerian pharmaceutical sciences research publications indexed in Dimension database.

Durodolu, et al. (2019) analyzed the growth rate of Nigerian medical science research publications. Bibliometric analysis research method was adopted for the study. The documents included in this research were retrieved from Scopus database. The results revealed incremental research output in medical science between 2007 and 2016 with 2016 having the highest number. It also showed that the *Nigerian Journal of Clinical Practice* was the most widely patronized by Nigeria Medical researchers and that the growth rate of research productivity is 9.5 percent. This study and the present study adopted bibliometric research design and both used online database as data source. The two studies also aimed at examining the growth rate of researcher publications in Nigeria. The review study however, focused on Nigerian medical science research while this study focused on Nigerian pharmaceutical science research.

Rathika and Thanuskodi (2020) analyzed “Research output on Encephalitis Literature during the year 2008-2017”. Bibliometric method was used for the study. The data were retrieved from the Web of Science database. The study aimed at investigating relative growth rate, exponential growth rate, doubling time, etc. The study revealed that Encephalitis published 6,405 articles within the study period. The highest number of articles was published in the year 2017. USA had the highest number of publications with 2,331 (36.39%). The study indicated that the relative growth rate of total research output decreased gradually from 0.29 in 2008 to 0.07 in 2017. The mean relative growth rate was 0.11. This study and the present study employed the same research method that is bibliometrics but they differ in scope.

Zhang et al. (2022) analyzed the research status, hotspots, frontiers and development trends of pharmaceutical care from the perspective of bibliometrics. A total of 3289 institutions from 105 countries/regions published 2906 papers in 669 academic journals, which were cited 50027 times. In the past 10 years, papers in the field of pharmaceutical care have shown a significant growth trend and scholars have become increasingly interested in research on related content in the field of pharmaceutical care.

Studies on citation rate of research publications

Gupta & Gupta, (2014) analyzed 76 highly cited publications in clinical pharmacology research output in India during 2000-2014 using bibliometric method. Indian Clinical Pharmacology research had 1.45% of world's research output of highly cited papers in clinical pharmacology research. India was ranked 10th highest country of the world's highly cited research output according to the Scopus database at 0.75% share of India's research output. These 76 highly cited publications received 14,059 citations with an average citation of 184.99 per article. The value of Major Contributor Index varied among the prolific institutions as well as the productive authors. This study and the present study adopted bibliometric research design and both used online database as data source. However, both studies differ in scope. The study analyzed research productivity of an area (clinical pharmacology) of pharmaceutical sciences while the present study focused on general pharmaceutical sciences research in Nigeria.

Ahmed et al. (2016) conducted Clinical Pharmacology Research in India: A Scientometric Assessment of Publication Output during 2005-2014. The paper examined 8,519 publications on clinical pharmacology research in India as covered in Scopus database during 2005-2014, using various quantitative and qualitative parameters with a focus on its growth, citation quality, share of national international collaborative papers, subject-wise distribution, impact of its leading scholars and contribution to most productive journals, etc. The result indicated that India's global publication share in clinical pharmacology was 4.80, which increased from 2.65% to 6.69% from 2005-2009 to 2010-2014. India's publications in clinical pharmacology witness an annual average growth rate of 25.89% and citation per paper of 6.75 during 2005-2014, which decreased from 9.14 to 4.08 from 2005-2009 to 2010-2014. Nearly 61% of the Indian publications on clinical pharmacology registered citations from 0 to 605 citations and these citations witnessed highly skewed distribution. India's share of international collaborative publications in the total output was 12.22% during 2005-2014, which decreased from 13.99% to 11.76% from 2005-2009 to 2010-2014. The 10 most productive journals in India's clinical pharmacology research contributed 33.82% share to the total India's publication output in clinical pharmacology during 2005-2014. India's publication output in clinical pharmacology had 51 highly cited papers with each receiving 100 or more citations. These highly cited papers received a total of 8597 citations with average citation per paper of 168.57. This study and the present study adopted bibliometric research design and used online database as data source. However, they differ in scope.

Ahmed and Ullah (2018) carried out a bibliometric evaluation of articles published in Pakistan Journal of Pharmaceutical Sciences (PJPS) from 2006 to 2015. Bibliometrics was used to determine publication pattern and identifies research trends in a field. All articles published in PJPS during ten years were analyzed using MS Excel. A total of 951 authors contributed 1172 articles to PJPS from 2006 to 2015. The average number of citations per article was 28.67% and the average length of the articles was 6.34 pages. This study and the review study adopted bibliometric research design but the review study used a journal (PJPS) website as data source. The two studies also differ in scope. The review study analyzed research publication of a Pakistan Journal of Pharmaceutical Sciences while the present study focused on Nigerian pharmaceutical sciences research.

Vijayakumar, Sivasubramaniyan, and Rao (2019) carried out study to investigate the "Bibliometrics analysis of the Indian Journal of Nuclear medicine during the period 2014-2018". The data for the study were obtained from the Scopus bibliographic database. The main objectives of the study were to examine the authorship pattern, and most productive year. A total of 513 papers published in the study period were analyzed. The most productive year was 2017 with 114(22.22%) publications. The highest citation was received in the year 2014 with 195(36.25%). Out of 513 publications 465 (90.64%) are collaborated works. The two studies examined the citation rate of research publications using databases as data source. They however, differ in scope. The review study covered Indian Nuclear medicine while this study focused on Nigerian pharmaceutical science research publications.

Das et al (2019) studied highly cited research in pharmaceutical sciences of India during 1998-2017 with a view to understand the impact of highly cited articles in Indian Pharmaceutical research and the role of research organizations, contributing authors and their international collaborations. The result revealed that India with 274 highly cited articles holds the 10th position with 2.51% of the world's share during 1998-2017. These 274 Highly Cited papers received 90,911 citations with an average of 331.79 citations per papers. There are 14 Indian institutions having more than 5 publications and Major Contributor Index value more than 0.5, which are

considered more productive and have the potential to conduct research independently. The two studies also aimed at examining the citation rate of research publications using online databases as data source but their scopes differ. The review study focused on Indian Pharmaceutical research while this study focused on Nigerian pharmaceutical science research.

Studies on the Extent of Research Collaboration

Gupta and Ahmed (2018) carried out “Pancreatitis cancer research in India during 2007-2016”. the data for the study were retrieved from the Scopus database. The study adopted bibliometric technique. A total of 1168 articles obtained from the database were examined. The result of the study indicated that international collaborative publications in pancreatic research were 26.71% during the specified period. United State of America has the largest publications share with 65.06%, followed by Japan (16.35%). This study and the present study adopted bibliometric research design and both used online database as data source. However, both studies differ in scope. Chaman et al., (2019) analyzed the Indian publications output in Pharmacology and Pharmacy during 2004-2018 on several parameters including India’s overall contribution, its growth pattern, citation impact, the share of international collaboration, identification of significant participating countries in India’s international collaboration. A total of 37,734 papers published in Web of Science Citation Database where analyzed. The findings indicated India publication increased from 1045 papers in 2005 to 3,042 papers in 2014 and decreased from 2,898 in 2015 to 1,817 in 2018. The study also revealed that Indian research output on Pharmacology and Pharmacy is quite low in the global context as reflected from its publication output per thousand publication (0.001) and its world publication share (3.28%) during 2004-2018. The findings also indicated that the impact and quality of Indian research is low compared to select development and developing countries. India’s international collaboration was largest with USA 2,531 Papers (44,117 citations) with 17,043 average citations per paper. This study and the present study adopted bibliometric research design and both used online database as data source. However, both studies differ in scope. The study analyzed Indian research output on Pharmacology and Pharmacy while this study focused on Nigerian pharmaceutical sciences research.

Rathika and Thanuskodi (2021) studied Relative Growth Rate and Doubling Time of Publications Productivity of Nuclear Medicine Research. The study aims to recognize the growth of scientific output in the field of Nuclear Medicine for a period of 30 years (from 1991 to 2020). A total of 12,632 records were retrieved from the Web of Science database. The result of the study indicated that Nuclear Medicine records the maximum number of publications in the year 2020 with 771 (6.10%) publications and the least number of publications in the year 1992 with 170 (1.35%) publications. The annual growth rate of publications during the year 1991-2020 was between -2.30 and 13.88. The Degree of Collaboration was on the increasing trend throughout the period and it ranged from 0.60 to 0.92 during the period (1991 to 2020). The minimum value (0.60) in the year 1991 and the maximum value 0.92 was in the years 2013, 2015, and 2020. This study and the present study adopted bibliometric research design and both used online database as data source. However, both studies differ in scope. The review study analyzed Publications Productivity of world Nuclear Medicine Research while this study focused on Nigerian pharmaceutical sciences research.

Wathore and Pawar (2024) analysed research papers published in the Research Journal of Pharmacy and Technology (RJPT) for five years from 2008 to 2013. The study adopted bibliometrics research method. The data used for study was obtained from the journal archive's official website RJPT. The retrieved data was analyzed to understand the pattern of authorship, degree of collaboration, and region-wise distribution of authors. The study revealed that dual-authored publications constituted the highest percentage (60.20%) of the total publications, followed by single-authored publications (21.42%). The degree of collaboration was highest during the years 2008 and 2010, with 0.99, respectively, and the lowest in the year 2011 with 0.96. The total degree of collaborations for the period 2008 to 2012 was 0.98. This study and the review study adopted bibliometric research design but the review study used a journal (RJPT) website as data source. The two studies also differ in scope.

Studies on the Relationship Between the Citation Rate of Research Publications and their Extent of Collaboration

Shen et al. (2021) examined the strength and consistency of the relationship between scientific collaboration and citation count, using meta-analytic methods and measuring scientific collaboration by co-authorship. After the literature search and initial selection, 361 relevant papers were found. Based on the inclusion and exclusion criteria, 92 papers involving 340 effect sizes were included. A random-effect meta-analysis showed a significant positive and weak correlation between scientific collaboration and citation count ($r = 0.146$). Tests of publication bias and heterogeneity revealed that the result was reliable. In addition, disciplines, countries, document types and citation sources were found to influence the correlation as moderators significantly. This study and the review study adopted bibliometric research design and both used online database as source data but the two studies differ in scope. The study analyzed research publication o while the present study focused on Nigerian pharmaceutical sciences research.

Wang et al. (2024) examined the factors contributing to higher citations by distinguishing between the quality of work and the home country effect. International co-authorship was used as a key variable. The study analyzed citation patterns across a diverse range of fields over a 10-year period and differentiated between citations accrued in the authors' countries and citations received in other countries. The results revealed that publications with international co-authorship received significantly more citations from abroad. They also observed that domestic citations from authors' countries increase faster than foreign citations and that the effect is more pronounced over a longer period of time.

RESEARCH METHOD

The study employed a bibliometric research design. This design was deemed suitable because it enables the quantitative analysis of large datasets of academic publications, allowing for the examination of research productivity and trend in research which this study sought to explore. The population of the study consists of 633 articles of pharmaceutical sciences produced within 2016 to 2025 by researchers affiliated with universities in Nigerian as indexed in Dimension database. No sampling was done as the number is manageable.

Database selection: the researcher purposively selected dimension database because the database provides comprehensive coverage of global research publications. It allows for large-scale data analytics, enabling one to analyze vast amounts of publication data and identify trends, patterns, and correlations. Furthermore, dimension provides a range of bibliometric indicators, such as citation counts, collaboration networks which are essential for evaluating research productivity and impact. It is free access database that enables one export data in various formats and is regularly updated.

Search Strategy: Data were collected using filtration and extraction technique. The field of search was Pharmacology and Pharmaceutical Sciences (3214). Publication type was open access articles.

The search was conducted using the following keywords: ('Pharmaceutical Sciences' OR 'Pharmacy Research') AND ('Nigerian Universities' OR 'Universities' AND 'Nigeria').

Records identified through database search was $n = 2,647$

Inclusion and exclusion criteria were applied to provide accurate examination of productivity of universities in Nigeria pharmaceutical science research,

Inclusion Criteria

Publications were included if they were

Published in English

Published between 2016 to 2024

Affiliated with a Nigerian University

Classified under pharmaceutical sciences

Exclusion criteria

Publications were excluded if they were
Published in language other than English
Published outside the specified period
Not affiliated with a Nigerian university
Not classified under pharmaceutical sciences

After excluding publications that are not relevant for the study, n=633 publications. Thus, a total of 633 publications was used for the study.

Data analysis was conducted using both descriptive, inferential and network analysis. Descriptive analysis was used to determine the annual distribution of publications and citation counts, as well as to identify the most productive journals.

Inferential analysis (Pearson's correlation analysis) was applied to address research questions 4 which is to examine the relationship between citation counts and the extent of authorship collaboration for pharmaceutical sciences publications from universities in Nigeria.

RESULTS AND DISCUSSIONS

The data analysis, results and discussion of the results are presented in this chapter.

Presentation of Results

Research Question 1: What is the annual growth rate of research publications of pharmaceutical sciences researcher in universities in Nigerian from 2016 to 2025

Table 1: Publications of Pharmaceutical Sciences in Nigerian Universities from 2016 to 2025

Publication Year	Number of publications	Percentage publication	Annual Growth
2016	44	6.95	-
2017	51	8.06	7
2018	45	7.11	-6
2019	47	7.42	2
2020	56	8.85	9
2021	82	12.95	26
2022	83	13.11	1
2023	64	10.11	-19
2024	78	12.32	14
2025	83	13.11	5
Total publication	633	100	39

It could be observed from table 1 that the total publication of pharmaceutical sciences in Nigerian universities was 633 while the annual average publication was approximately 63.3 publications. The publication growth rate from 2016 to 2025 was 88.64% while the average annual growth rate was 4.33%. The year with highest publication were in 2022 and 2025 with 83(13.11%) publications each. This was followed by 82 (12.95%) articles published in 2021. The next was 78 (12.32) articles, published in 2024 and 64 (10.11) articles published in 2023. Other years article publications were less than 60.

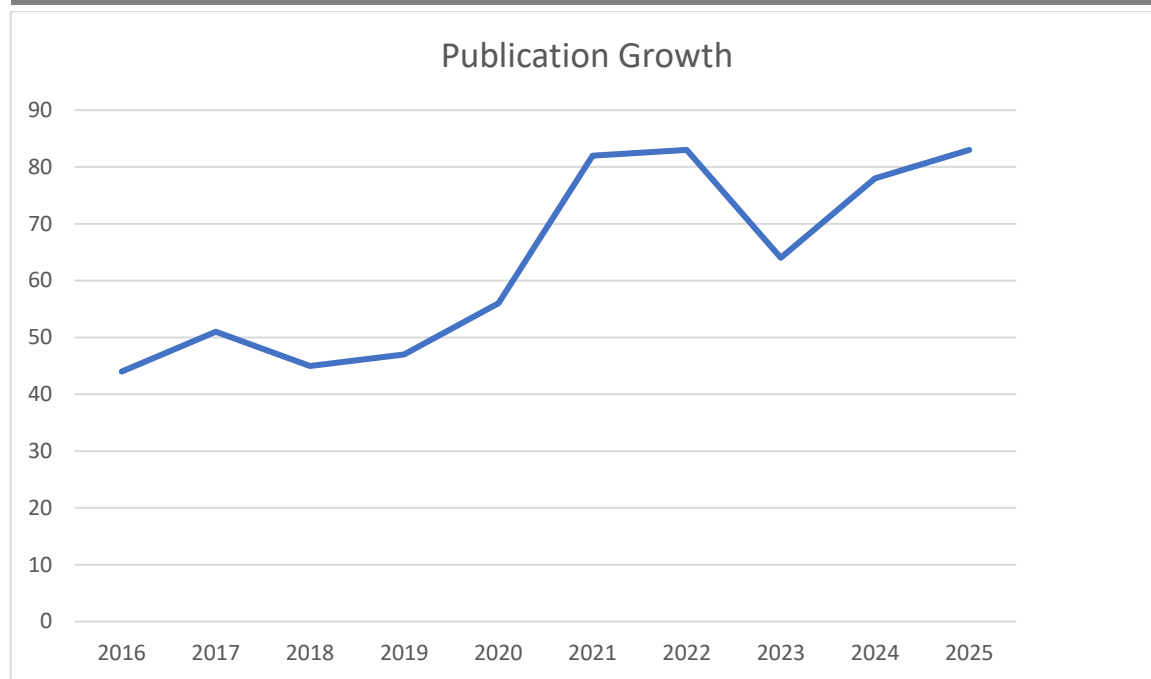


Chart1: Line graph

Chart 1 shows the line graph of publications of pharmaceutical sciences research from Nigerian universities within 2016 and 2025. It could be observed from the graph that publication increased gradually between 2016 and 2020 from 44 to 56 publications. From 2020 to 2022 there was a significant rise in publication from 56 to 83. The line shows a sudden V-shaped drop in 2023 (64). However, there was a rapid recovery in 2024(78 publications), ultimately returning to a peak of 83 publications in 2025.

Research Question 2: What is the annual citation rate of publications of pharmaceutical sciences researchers in universities in Nigeria from 2016 to 2025

Table 2: Annual citations of research publication of Pharmaceutical Sciences in Nigerian Universities from 2016 to 2025

Year	Total Publication	Total Citation	% Citation	Mean citation
2016	44	6	0.15	0.14
2017	51	48	1.20	0.94
2018	45	147	3.67	3.50
2019	47	296	7.40	6.30
2020	56	354	8.85	6.32
2021	82	552	13.80	6.73
2022	83	565	14.12	6.81
2023	64	588	14.70	9.19
2024	78	613	15.32	7.86
2025	83	831	20.77	10.01
Total	633	4001	100	6.32

It could be observed from table 2 that pharmaceutical sciences research of Nigeria universities yielded a total of 4001 citations with overall mean citation of 6.32. Out of 633 articles, 454 (71.72%) articles have been cited at least once. The highest citations occurred in 2025 with 831 (20.77%) citations and mean citation of 20.77. The year 2024 yielded 613 (15.32%) citations with mean citation of 7.86. The next was 2023 which attracted 588 (14.70%) citations while publications of 2022 yielded 565 (14.20%) citations. In the years 2020 and 2021,

354(8.85%) and 552 (13.80%) citations were respectively obtained. Citations of 2019 and beyond were below 500. There is also increase in mean citation from 0.14 in 2016 to 10.01 in 2025. The total number of citations grew by 13,750% between 2016 to 2025 while the average rate of growth in citation of pharmaceutical sciences research across Nigerian universities is 91.7% per annum.

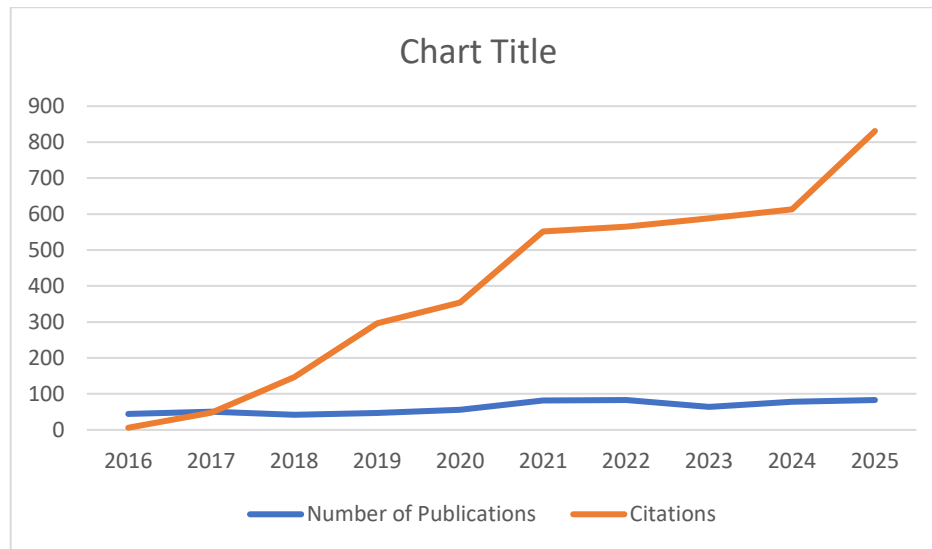


Chart 2: Graph Line

Chart 2 illustrates the annual trends in the number of publications and citations for pharmaceutical sciences research from Nigerian universities between 2016 and 2025. Citation started at 6 in 2016 from 44 publication and rises rapidly to 552 in 2021. There was a modest increase around 2021-2023. A sharp increase occurred in 2024 to 2025 to over 800 citations. The widening gap between the two lines shows that average citation increases yearly.

The most interesting feature of the chart is the divergency of the two lines depicting the volume of the publications and their citations (impact). At the beginning of the period, the two lines are nearly overlapping. In 2026, there were 44 publications with only six citations. During this phase the research output was actually higher than the citation count. Around 2018, the red line crosses above the blue line. From this point forward, the impact gap begins to open as citations start to outpace the number of publications.

Research Question 3: To what extent do Pharmaceutical Science researchers in universities in Nigerian collaborate in research?

Table 3a: The pattern of authorship collaboration in Pharmaceutical Sciences research in Nigerian universities from 2016 to 2025.

Year	Document Authorship										Total
	Single	2	3	4	5	6	7	8	9	10 -	
2016	1	8	8	8	6	6	4	3	-	-	44
2017	1	5	12	13	5	2	7	3	1	2	51
2018	1	7	11	10	6	5	2	-	2	1	45
2019	0	7	10	5	8	5	2	6	-	4	47
2020	0	8	15	10	6	5	5	4	1	2	56
2021	3	6	11	16	13	8	8	5	3	9	82
2022	0	6	18	15	19	11	4	1	1	8	83
2023	2	5	13	10	12	4	7	3	3	5	64
2024	1	8	14	10	11	7	8	3	6	10	78
2025	4	8	11	11	8	15	4	4	6	12	83
Total	13	68	123	108	94	68	51	32	23	53	633

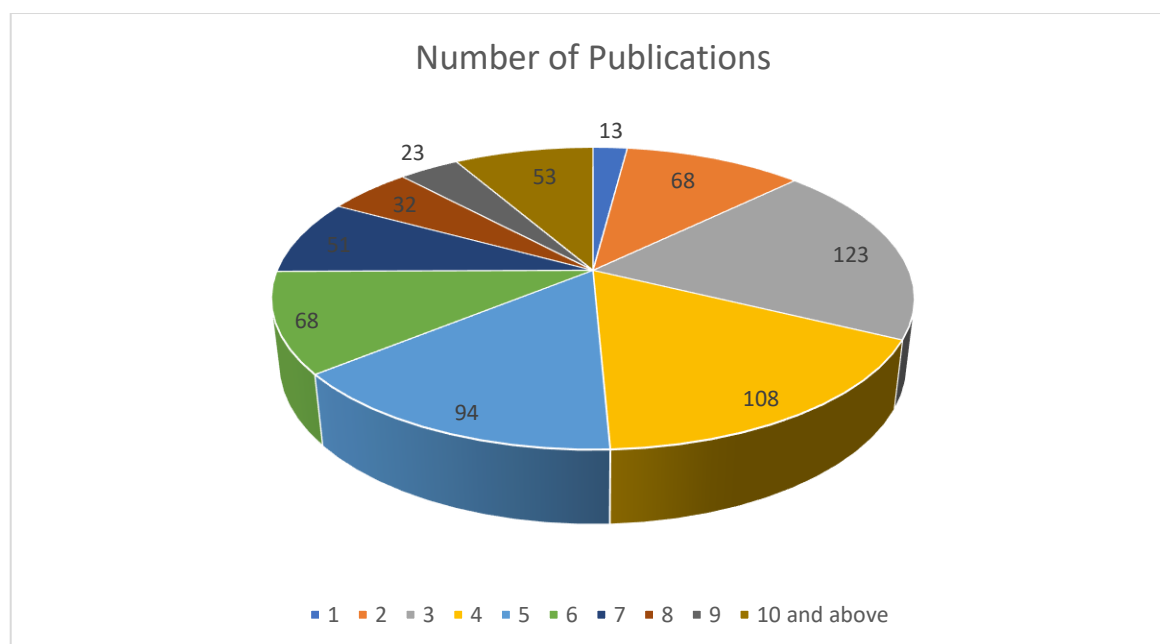


Chart 3a: Pie Chart

Based on illustrations provided in table 3a and chart 3a, dominant collaboration pattern was 3, 4 and 5 authorship accounting for over half (51.3%) of the total publications. Three author publication are the largest single category with 123 (19.4%). This is followed by 4 authors with 108 (10.7%). The next was Five authorship with 94 (14.85%) publications. Other categories were below seventy publications. Interestingly papers with 10 or more authors (8.4%) are more frequent than those with single, 7, 8 or 9 authors.

Table 3b: The degree of collaborations in Pharmaceutical Science research in Nigerian universities from 2016 to 2025.

Year	Documents				International Collaboration	% of International Collaboration
	Single	Multi Author	Total	Degree of Collaboration		
2016	1	43	44	97.73	16	6.25
2017	1	50	51	98.04	14	5.47
2018	1	44	45	97.80	12	4.69
2019	0	47	47	100	22	8.59
2020	0	56	56	100	16	6.25
2021	3	79	82	96.34	24	9.38
2022	0	83	83	100	53	20.70
2023	2	62	64	96.88	40	15.63
2024	1	77	78	98.72	28	10.94
2025	4	79	83	95.18	31	12.11
Total	13	620	633	97.95	256	100

It could be observed from table 3b that out of 633 publications, 620 (97.95%) were multi-authored contributions. This indicates that nearly all the years, research output involved teamwork and shared effort. Three years; 2019, 2020 and 2022 experienced total collaboration suggesting a highly collaborative research environment. The degree of collaboration is measured by using the formula suggested by Subramanian. $DC = \frac{NM}{TP} \times 100$ where, DC = Degree of Collaboration, NM = Number of Multi-Authored Contribution and TP = Total Publication.

Hence, $DC = 620/633 \times 100$, $DC = 97.95\%$. The degree of collaboration is 97.95%. It could be observed from the same table that international collaboration accounted for 40% of the total publications yielding 256 publications. In 2022, greatest number of international collaborations was observed with 20% (53) publications. The years 2023 was next with 40 (15.63) publications. This is followed by the most current year (2025) with 31(12.11) of total international collaborative publications. Applying Subramanian formular, the degree of international collaboration is 40.44%.

Table 3c: International Collaborations in Pharmaceutical Science research in Nigerian universities from 2016 to 2025

COUNTRY	US	South A	UK	India	Tanzania	China	Malaysia	Australia	Uganda	Canada	Germany	Saudi	Belgium	Egypt	Pakistan	Ghana	Spain	8 con with 3	16 with 2	27 with 1	Total
Numb er of Pub	33	28	21	14	9	7	7	7	6	6	6	6	5	5	5	4	4	24	32	27	256
% Pub	12.9	10.9	8.2	5.5	3.5	2.7	2.7	2.7	2.3	2.3	2.3	2.3	2.0	2.0	2.0	1.7	1.7	8.0	14.3	12.9	10.0

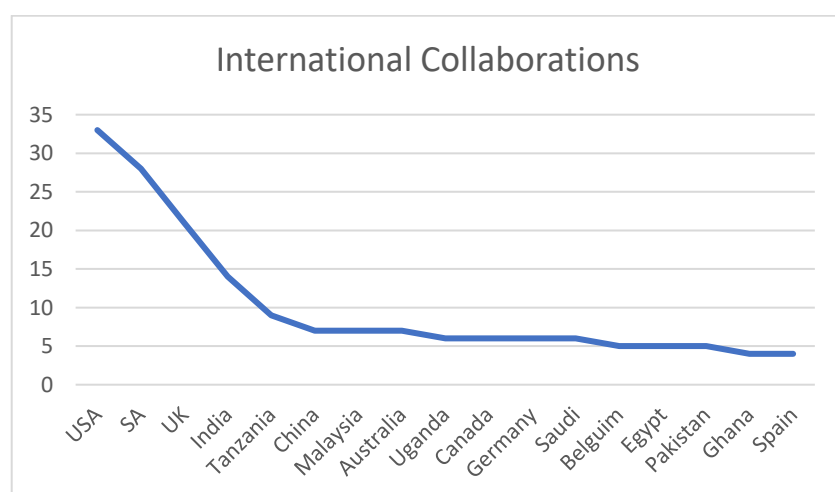


Chart 3b: Line Graph

Table 3c and chart 3b provides a breakdown of international collaboration in pharmaceutical sciences involving Nigerian universities from 2016 to 2025. Pharmaceutical sciences researchers in Nigerian universities collaborated with researchers from 68 foreign country institutions. The degree of international collaboration was 40.44%. There is a clear concentration of partnerships with a few countries- United State, South Africa and United Kingdom. These countries accounted for approximately 32% (82) publications. The leading partner is United States, accounting for 12.89% (33) publications. South Africa ranked second with 8.20% (28) publications. This is followed by UK with 8.20% (21) publications.

Research Question 4: What is the relationship between the citation counts and the extent of authorship collaboration for pharmaceutical sciences publications from universities in Nigeria?

Table 4: Spearman correlation coefficient of citation counts of publications of Pharmaceutical Science researcher in Nigerian universities and extent of their authorship collaboration. Spearman's rank correlation was used because of non-normal distribution of publication counts.

Correlations				
			Authorship	Citation
Spearman's rho	Authorship	Correlation Coefficient	1.000	.298**
		Sig. (2-tailed)	.	.007
		N	80	80
	Citation	Correlation Coefficient	.298**	1.000
		Sig. (2-tailed)	.007	.
		N	80	80
**. Correlation is significant at the 0.01 level (2-tailed).				

The Decision Rule

If Sig. ≤ 0.05 'n Reject H_0 . (Result is statistically significant at the 5% level.

If sig. ≥ 0.05 'n Fail to reject H_0 (Result not statistically significant. The effect could easily be due to chance)
Significant Value (p-value): $0.007 < 0.05$, thus the null hypothesis that states that there is no significant relationship between the citation rate of Pharmaceutical Sciences research and their extent of collaboration is rejected.

Following the interpretation of Spearman $R_s \leq 0.30$ is considered a weak-to-moderate relationship. With a Spearman's correlation of 0.298, there is a weak positive relationship between the citation counts of publications of core pharmaceutical sciences researcher in Nigerian universities and extent of their authorship collaboration.

DISCUSSION OF FINDINGS

The growth rate of research publications of pharmaceutical sciences across universities in Nigeria was 88.64 percent. A growth of 88.64% from 2016 to 2025 indicates a significant upward trajectory. This means that the pharmaceutical research output of universities in Nigeria has almost doubled within the past decade. This finding is in line with earlier findings of Zhang et al. (2022); Hugar and Sab (2018); Mousavi et al. (2013) among others who observed that research output in the field of pharmaceutical sciences have shown a significant growth in the past decades. The growth rate of 88.64% in pharmaceutical sciences research publications across Nigerian universities from 2016 to 2025 indicates a significant domestic expansion in academic output. This steady increase places Nigeria among the top contributors to pharmaceutical research in Africa, though its global positioning and practical industrial impact remain distinct from other leading nations (Atanda et al., 2025).

The findings also revealed that the average annual growth rate was 4.33%. This means that every year, the number of pharmaceutical research articles published by Nigeria universities increases by 4.33% compared to the previous year. This finding is similar with the finding of Idoudi et al. (2021) who revealed that the average annual growth rate of Pharmaceutical Sciences-related articles in Qatar from 2013-2020 was 6.90%. If this trend continues, the total volume of research literature produced by Nigerian academic pharmacist will roughly double in approximately ten to thirteen years. This is consistent with the observation of Baladi et al. (2018) who stated that the annual yields of pharmaceutical sciences research worldwide grew more than three times in the past two decades.

The study reported that out of the 633 articles analyzed 454 (71.72%) have received at least one citation with overall mean citation of 6.32. This means on average, each published research article in pharmaceutical sciences from Nigeria universities has been cited 6.32 times. This result is not far from results of mean citation of other countries in pharmaceutical sciences related areas for instance, Ahmed et al. (2016) revealed that Clinical Pharmacology Research of India witness an average citation per paper of 6.75 during 2005-2014. Interestingly, Nigerian pharmaceutical science institutions witnessed citation growth rate of 13,750% over the 10-year interval. This signifies that the volume or impact of citations at the end of the decade (2025) is roughly 138 times larger than it was at the beginning (2016). This remarkably high citation rate suggests that Nigerian pharmaceutical research is increasingly improving impact and extensively being utilized and referenced by scholars.

Perhaps more critical than the total volume is the speed of the growth. An average annual growth of 91.7% in citation rates indicates that the influence of their research is nearly doubling every year, showcasing a rapidly rising profile for Nigerian academic pharmacist.

This high growth rate of citations may typically stem from researchers publishing in high impact, internationally indexed journals (like Scopus, Web of Science, Dimension and other databases). The rise in citations may also be attributed to increased collaborative efforts, which is known to significantly boost citation count.

The degree of collaboration remained exceptionally high. It never drops below 95% throughout the 10 years interval. This indicates that Nigerian research in the field of pharmaceutical sciences is almost exclusively a team-driven effort, maintaining a remarkably high baseline throughout the decade. Interestingly, there was total collaboration in 2019, 2020 and 2022 with degree of collaboration reaching maximum score of 100%. In other words, not a single solo authored paper was published. Looking at the entire ten-year dataset, 97.94% of the articles were collaborative efforts (620 out of 633 articles), leaving single authors with a negligible share of just 2.05%. This finding is consistent with the observations of other researchers in health-related areas. For instance, Rathika and Thanuskodi (2021) observed that collaboration of researchers in Nuclear Medicine was on the increasing trend throughout the period and it ranged from 0.60 to 0.92 during the period (1991 to 2020). Also, Wathore and Pawar (2024) revealed that the total degree of collaborations in Research Journal of Pharmacy and Technology (RJPT) for the period 2008 to 2012 was 98%.

Nigerian pharmaceutical sciences researchers collaborated with institutions across 68 foreign countries, demonstrating wide global engagement. Nearly half (40.44%) of the research outputs involve international partners. This high metric underscores a strong reliance on cross-border knowledge exchange. The findings also revealed a distinct concentration of research partnerships within a small group of high-output nations. The top four collaborating countries- United State (12.9%), South Africa (10.9%), United Kingdom (8.2%) and India (5.5%), collectively accounted for 37.5% of all collaborative outputs. However, the graph depicts a long tail ecosystem where 51 out of the 68 collaborating countries yield fewer publications. This disparity indicated that while Nigerian institution pharmaceutical sciences researchers possess a wide global reach, many international linkages remain isolated. These findings are similar to findings of Chaman et al. (2019) and Gupta and Ahmed (2018) who observed that the India's international collaboration in Pancreatitis cancer and Pharmacology/Pharmacy research respectively was largest with USA.

A Spearman's rank-order correlation was run to determine the relationship between extent of authorship and citation counts of pharmaceutical sciences publication in Nigerian universities. There was a statistically significant, weak positive correlation between extent of authorship and citation counts ($r = 0.298$). Thus, the null hypothesis was rejected. This result strongly aligns with the findings of Shen et al. (2021) who observed a significant positive and weak correlation between scientific collaboration and citation count ($r = 0.146$). By rejecting the null hypothesis, researcher confirmed that the relationship observed ($r=0.298$) is not due to random chance, but represents a genuine trend among pharmaceutical science researchers; as more authors collaborate on paper, the citation count tends to rise. However, because the correlation is weak (under 0.3), authorship extent only explains a small portion of why a paper gets cited. Other factors such as the quality of research, journal prestige, or the specific sub-field may likely play much larger roles.

CONCLUSION

The Pharmaceutical sciences research in universities in Nigeria is overwhelmingly collaborative, maintain strong global engagement. However, international collaboration revealed over concentration in few countries- USA, South Africa, UK and India. In addition, statistically significant but weak positive correlation exists between co-authorship extent and citation counts.

RECOMMENDATIONS

Based on the problems observed, the following recommendations were made Universities and funding agencies should establish funded centres for international research collaboration to promote collaborations with institutions across countries. This can expose Nigerian researchers to diverse methodologies relevant to pharmaceutical innovations.

Implications of the Findings

The weak but significant positive correlation between authorship collaboration and citation counts suggest that collaborative work enhances scholarly impact. For the Nigerian pharmaceutical industry, this is a great opportunity to enhance academic collaborations for joint research and development projects. Strengthening structured partnerships between universities, research institutes, and pharmaceutical firms can facilitate technology transfer and transformation of research output into practical innovations in drug production, quality control, and traditional medicine development.

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