

# INDIAN CONTRIBUTION TO ANTIBIOTICS RESEARCH: A SCIENTOMETRIC STUDY

**ABSTRACT**  
of  
Thesis  
Submitted for the Award of the Degree of  
**Doctor of Philosophy**  
in  
**Library and Information Science**

Supervisor  
**DR. M. P. SINGH**  
Professor



Submitted by  
**VIJAY KUMAR BHARATI**  
Research Scholar

DEPARTMENT OF LIBRARY & INFORMATION SCIENCE  
(SCHOOL OF INFORMATION SCIENCE AND TECHNOLOGY)  
BABASAHEB BHIMRAO AMBEDKAR UNIVERSITY  
(A CENTRAL UNIVERSITY)  
VIDYAVIHAR, RAEBARELI ROAD, LUCKNOW-226025  
UTTAR PRADESH, INDIA

Enrollment No. 642/18

Year 2021

# **ABSTRACT**

---

---

## **1. BACKGROUND**

The present study *Indian Contribution to Antibiotics Research: A Scientometric Study* is the result of a comprehensive analysis of research output by Indian scientists and researchers mainly in the field of antibiotics research.

Scientometrics is the field of study which concerns itself with measuring and analysing scholarly literature of science discipline. It is the most powerful technique for conducting a quantitative study of research production and technological progress of science. Generally, scientometrics term is used for quantitative analysis of science subjects while bibliometrics is used for other than science subject. It is one of the best way in getting knowledge of scientific productivity of individual author/scientist, institution and journal. It is helpful to know the pattern of literature growth, nature of research publications, collaborative research, age of literature used and information needs of the authors. It can be also used to support the decision-making by government funding agencies and universities, identify the core competency of countries in an area of research, and help in expert selection within a field.

Antibiotics are playing a much larger role in our economy and society. Before the discovery of antibiotics not only in India but in the world there were a large number of deaths from infections and bacterial diseases. Antibiotics are considered to be the biggest milestone of the twentieth century in the field of science and medicine. These medicines have been used primarily to reduce the mortality and morbidity rates of infectious and anti-bacterial diseases. In this way, antibiotics are directly related to our life, so that an attempt was made in the present study to measure the trends in various aspects of published literature in the field of antibiotics research at the Indian context. In order to better understand the research contribution of India in the field of antibiotics, this study has been conducted and analysed.

## **2. STATEMENT OF THE PROBLEM**

The problem selected for the current study is entitled "Indian Contribution to Antibiotics Research: A Scientometric Study" with the Scopus database during 2011-

2020. Since antibiotics are directly related to our lives, so it is very important to know what Indian research output is being done in this field. During the literature review, it has been found that few studies have been done on the research trends in the scholarly literature on various disciplines of medical science with different databases but there has been no comprehensive study the assessment of Indian contribution to antibiotics research with the Scopus database during 2011-2020. Therefore, there is a need to assess and map the strength of Indian scientists in scientific production in the field of 'antibiotics', which aims to provide a scientometrics overview of Indian scientists on antibiotics research in the world level.

### **3. REVIEW OF THE LITERATURE**

The literature relating to basic bibliometrics rules and more than a hundred studies allied to antibiotics and bibliometrics or scientometrics has been reviewed. After reviewing the existing literature, it has been observed that standard bibliometrics and scientometrics techniques such as Bradford, Lotka, and Zipf's terms and activity index, growth rate, collaboration index, etc. have been used by previous authors. In addition, the citation counting was emphasized in most of the research papers, and many studies incorporating recent techniques of bibliometrics or scientometrics. The researcher has also used some software and techniques that have not been used in earlier studies such as citation maps, co-authored visualizer maps, historical maps, bibliographic coupling maps, co-word maps, and more. On the basis of the review, it was also known that a lot of studies are being done in the medical field by scientometrics and the subject of this study is progressing not only in India but also in other parts of the world. Finally, it has been found that no study has been attempted on the Indian contribution to antibiotics research productivity. The researcher has therefore chosen scientometrics as the subject area and analysed the productivity of antibiotics research included in the Scopus database during the period 2011–2020.

### **4. OBJECTIVES OF THE STUDY**

The scientometric study of publications on antibiotics research by Indian scientists and researchers are completed with the following objectives:

- i. To study the contribution of Indian scientists and to compare India's performance with the world's performance in the field of antibiotics research.
- ii. To analyse country wise, language-wise, communication channel distribution of research work on antibiotics.
- iii. To examine the various growth pattern such as AGR, RGR and doubling time of the literature.
- iv. To identify the core journals and prolific authors in the research.
- v. To study the authorship pattern in the context of single and multiple authors.
- vi. To examine collaboration patterns.
- vii. To find out the applicability of Bradford's law and Lotka's law in antibiotics research in India.
- viii. To study citation patterns on antibiotics research.

## **5. HYPOTHESES OF THE STUDY**

The following hypotheses are formulated and tested:

- i. India is the leading country in antibiotics publication in the World.
- ii. English is most preferred language and USA is most productive country in antibiotics research.
- iii. The proportional growth rate on antibiotics is almost the same in India and the world.
- iv. Journals are most preferred communication channels for research publication.
- v. Joint authorship publications are preferred for research publication.
- vi. Collaboration between 2 to 4 authors is more prevalent among authors.
- vii. Degree of Collaboration is high in research publications.
- viii. Bradford's law of scattering of journals and Lotka's law of scientific productivity is applicable in this research.

## **6. SCOPE AND LIMITATIONS OF THE STUDY**

Antibiotics research literature output, though available in parallel another database sources also but in this study, no one database has been included for publication measurement except the Scopus database.

The scientometric study is focused on the productivity of antibiotics research for ten years i.e. 2011-2020 only, so papers published up to 2010 and in 2021 have been excluded from the study.

## **7. CHAPTERIZATION OF THE RESEARCH WORK:**

The thesis has been divided into the following five chapters.

### **Chapter 1: Introduction**

This is a brief introductory part of the thesis, which introduces scientometrics and antibiotics. In this chapter first, scientometrics and its related terms such as bibliometrics, librametrics, and informetrics, etc. have been explained. It also gives a short description of bibliometrics law and its related formulas. The historical background of antibiotics, common antibiotics and their uses, their functions, and disadvantages, have also been elaborated in this chapter.

### **Chapter 2: Review of the Literature**

In this chapter, the purposes and steps of reviewing literature have been explained. The chapter is divided into two parts: in the first part, the basics papers related to the fundamental bibliometrics and scientometrics have been reviewed and in the second part, the reputed papers related to bibliometrics study in the context of antibiotics and its allied has been reviewed. More than 100 related core research papers published in leading peer-reviewed journals indexed by Scopus, Web of Science and PubMed, etc. databases have been reviewed and arranged chronologically in increasing order. For references and in-text citation, Publication manual of American Psychological Association (APA) 7th edition has been used with little modifications as and when necessary.

### **Chapter 3: Research Design and Methodology**

This chapter gives a blueprint of the research work, like formulation of the research problem, objectives, scope and limitations, hypothesis formation, methods of data collection, data sorting, data analysis and data interpretations. Applicability of fundamental bibliometrics laws and their related formulas, such as relative growth rate (RGR) and doubling time (DT), activity index, degree of collaboration (DC),

---

collaboration index (CI), Lotka's law, Bradford's law of scattering of journals and an overview of Vosviewer, Biblioshiny, etc. have also been elaborated in this chapter.

#### **Chapter 4: Data Analysis and Interpretation**

In this chapter, the data retrieved from Scopus databases on antibiotics research from 2011 to 2020 have been analysed on the basis of certain formulas with the help of MS Excel, Vosviewer, and Biblioshiny software. The analysis has been taken based on objectives and their interpretations were done using statistical formulas. The tables and graphs are created based on data analysis. Some bibliometrics laws, such as Lotka's law, Bradford's law of scattering of journals, have also been applied to measure the research output. Further, hypotheses have been tested with the help of statistical formulas such as the z- test, f-test, t-test, and chi-square test.

#### **Chapter 5: Findings, Conclusion and Suggestions**

This chapter made up findings, conclusion, suggestions, and area of further studies. Findings are a collection of summarized form of data interpretations, which are based on previous chapter-4. After findings, the conclusion, suggestions, and areas for further research have been stated in this chapter.

### **8. DATA COLLECTION**

The Scopus database launched in the year 2004 by Elsevier has been chosen as the data collection platform for this study. The Scopus databases offer the largest collection of articles of Indian scientists in the field of antibiotics. A major strength of this database is that it provides adequate coverage of the most important and influential journals and core literature internationally in science & technologies as well as antibiotics. The study was extracted from articles on antibiotics published over a 10 year period starting from 2011 to 2020. For the purpose of covering all available articles on the antibiotics, the search keyword (TITLE-ABS-KEY(antibiotics) AND PUBYEAR > 2010 AND PUBYEAR < 2021) and (TITLE-ABS-KEY (antibiotics) AND PUBYEAR > 2010 AND PUBYEAR < 2021 AND ( LIMIT-TO ( AFFILCOUNTRY, "India" ) ) ) has been used then it is refined as per needs.

Thus, according to the objectives, the description of the relevant articles, authors, journals, year of publication, number of citations, institutes, countries,

keywords, and title of bibliography, etc., download and export in different formats as required, using the above search criteria.

## 9. DATA ANALYSIS AND INTERPRETATION

In this part of the research, the collected data by using the prescribed tools based on the proposed objectives were analysed and explored some findings and conclusions. There are some bibliometric parameters of imported bibliographical data, which are calculated in this study, shown in the following table.

### Bibliometric parameters

S. No.	Bibliometric data	Bibliometric parameters	Descriptions
1.	Year of publication	Evolution of publications AGR RGR DT Activity Index Collaborative Index	
2.	Keywords	Most Used Keywords	Author Keywords
3.	Article title	Most Cited Articles	Position in the citation ranking, title of the article, authors, journal, year of publication, number of citations, evolution of citations over the years
4.	Funding Agencies	Most funded agencies	Detail of sponsors
5.	Authorship	More productive authors Single and Multi- authored Most cited authors	Position in the citation ranking, name of the author, institution, H-index, number of publications, number of citations, evolution of citations in the field of study over the years

6.	Institutions	Most cited institutions More productive institutions	Position in the citation ranking, institution name, country, number of publications, number of citations
7.	Journals	More productive journals More cited journals	Position in the citation ranking, name of the journal, publishing area, SJR or JCR,, number of publications, number of citations
8.	Countries	More productive countries Most collaborative countries	Position in the citation ranking, country name, number of publications, number of citations
9.	Bibliometrics laws		Bradford's law Lotka's law

### 9.1 VOSviewer

VOSviewer is a type of software tool used to construct and visualize a bibliometric network of data received from a database. It was developed in the year 2007 by Nees Jan van Eck and Ludo Waltman at Leiden University's Center for Science and Technology Studies (CWTS). VOSviewer version 1.6.15 has been installed to construct and visualize bibliometric networks of citation, bibliographic coupling, and co-citation or co-author relationships.

### 9.2 Biblioshiny

Biblioshiny is metrics software that offers you a web-based bibliometric GUI. In this study, Biblioshiny software has also been used to construct and visualize a co-occurrence network of keywords extracted from a body of scientific literature.

### 9.3 Referencing Style

Referencing style is a compilation of guidelines for properly acknowledging the views, concepts, and works of others. In this research work, the 7th edition of the APA referencing style has been used to refer to the documents. 7th edition was

published on October 11, 2019 by Raimo Streefkerk and revised on December 24, 2020.

#### 9.4 Statistical Tools for Scientometric Analysis

Data exported from the Scopus database was analysed using following various bibliometric formulas, laws, and principles:

##### i. Calculation of Annual Growth Rate

The formula used for AGR calculation is given by Kumar and Kaliyaperumal in 2015. The following formula is used for AGR Calculation:

$$\text{AGR} = \frac{W_2 - W_1}{W_1} \times 100$$

In this formula AGR represent Annual Growth Rate, W<sub>2</sub> present the end value of the publication and W<sub>1</sub> present the first/ initial value of the publication

##### ii. Calculation of Relative Growth Rate (RGR)

The RGR is calculated by the following formula:

$$\text{Relative Growth Rate (RGR)} = \frac{\text{Log } e W_2 - \text{Log } e W_1}{T_2 - T_1}$$

Where

RGR = Growth rate over the particular period of time

Log *e* W<sub>1</sub> = Log of initial number of publications / pages

Log *e* W<sub>2</sub> = Log of the final number of publications / pages after a particular period of the interval

T<sub>2</sub>-T<sub>1</sub> = the unit difference between the initial time and final time.

##### iii. Doubling Time (DT)

The doubling time of the publication on a research is calculated by the following formula:

$$\text{Doubling Time (DT)} = \frac{0.693}{R}$$

Whereas 0.639 is the constant value in the formula and R represent the relative growth rate (RGR) in the concerned year.

#### iv. Degree of Collaboration (DC) and Collaboration index

The following formula was suggested by Subramanyam is used to calculate the degree of collaboration in this study.

$$C = \frac{N_m}{(N_m + N_s)}$$

Where C = Degree of collaboration

$N_m$  = Number of multiple authored papers

$N_s$  = Number of single authored papers

#### v. Collaboration index

The Collaboration Index (CI) has been presented by (Lawani, 1980). The Collaboration index is represented mathematically

$$C.I = N_{am} / N_a,$$

Where,  $N_{am}$  is the number of authors of total joint publications and  $N_a$  denotes the number of total articles

#### vi. Lorenz Curve

The cumulative percent curve is known as the Lorenz curve. It's a graphical representation of two series dispersion. The steps below are used to create the curve.

- i. The two series components are added up individually.
- ii. Percentages of the total are calculated from the accumulated components
- iii. The percentages are then represented as subject and factor on the graph.

The Lorenz curve is used to calculate deviation from the mean. It's a handy tool for displaying the type and degree of dispersion. It also allows you to compare

the level of dispersion between two series.

### vii. Activity Index

The activity index is calculated as following formula:

$$\text{Activity index (AI)} = \frac{N_{ig} / N_{ia}}{N_{wg} / N_{wa}} \times 100$$

Where, Nig is No. of Indian publications in antibiotics

Nia is No. of Indian publications in all subjects

Nwg is No. of all countries publications in antibiotics

Nwa is No. of all countries publications in all subjects

### vii. Lotka's Law

According to the Lotka's law "the number of authors contributing  $n$  (1) is  $1/n^2$  of those who make; and the proportion of all contributors, who make a single contribution, is about 60 %." It can be said by the applicability of this law that out of all the authors in a given field, 60 % of the authors will be published only one article and 15 % of the authors will publish only two articles (1/260 times, 60) and 7% of authors will publish three articles (1/3. times, 60) and further calculation will be made in the same way. Similarly, Lotka's law of scientific productivity states that only six percent of authors in an area will publish more than 10 articles.

### ix. Bradford's Law

Bradford elaborated that journals can be divided into three zones, each zone having the same articles but with a difference in the number of journals.

- Journals of the first zone, in which the number of journals is very less, in such journals one-third of all published articles are published. This type of journal is very less; this is called the core journals of the subject concerned.
- Journals of the second zone, in which the number of published articles will be equal to the first zone but the number of journals, will be more.

- Journals of the third zone, in which the number of published articles will be equal to the second zone but the number of journals, will be much more than that.

The mathematical relation of the number of journals in the core is a constant  $n$  for the first field and the relation  $n^2$  is for the second field. Bradford expressed this relationship as 1:  $n$ :  $n^2$ .

**x. Mean**

$$\text{Mean} = \frac{x_1 + x_2 + \dots + x_n}{n}$$

**xi. Median**

Median =  $[(n+1)/2]^{\text{th}}$  observation, if  $n$  is odd.

Median = mean of  $(n/2)^{\text{th}}$  observation and  $[(n/2)+1]^{\text{th}}$  observation, if  $n$  is even.

**xii. Mode**

Arrange the data in ascending order to get the mode. Then count, how many times each number appears. The mode is the number that appears the most.

**xiii. Standard Deviation**

$$S = \sqrt{\frac{\sum(x - \bar{x})^2}{n - 1}}$$

$$= \sqrt{\frac{n}{n - 1}(\bar{x}^2 - \bar{x}^2)}$$

or

$$\text{where } \bar{x}^2 = \frac{\sum x^2}{n} \text{ (It is called mean of squares)}$$

$\bar{x}^2$  is squared mean

$S$  is standard division.

and  $n$  is number of individuals in the sample.

Standard deviation as a variability is most adaptable to statistical analysis.

**xiv. Variance**

Variance is nothing, but it is square of the standard deviation.

$$\text{Variance} = S^2$$

---

**10. FINDINGS OF THE STUDY**

- There were a steady growth of publication for India (except 2017-2018), while in the world, it has been increased consistently.
- The low dispersion has visible on the Lorenz curve in India and world publications on antibiotics research. The cumulative proportion for both India and the world is almost equal.
- The India was a leading country in antibiotics research, retained at third position in world.
- USA was the most collaborative country followed by United Kingdom.
- Research activities of Indian contribution to antibiotics research were strong in the world.
- Journal articles were found most communication channel in antibiotics research
- Bradford's law of scattering of articles in journals is not applicable in antibiotics research.
- *Journal of Clinical and Diagnostic Research* published from India was the most preferred journal ranked at the first position.
- Among the top twenty leading journals, five journals are published from other countries like the USA, United Kingdom, Switzerland, and the Netherlands.
- *English language* was found most preferred language in antibiotics research. Some papers were found in Turkish, French, Spanish language.
- AIIMS New Delhi was observed as the most productive institution in India
- Veeraraghavan, B. affiliated to Department of Clinical Microbiology, Christian Medical College, Vellore, India was published the highest 125 articles on antibiotics.

- 
- The percentage of multiple authors is more than single authors and the trend of collaborative research is increasing with time. Among Joint authorship, four authors have published the highest number of papers.
  - Lotka's law of scientific productivity is applicable on this study.
  - Antibiotics were the most recurring author keyword followed by antibiotic resistance and antimicrobial resistance.
  - The highest 37529 citations (16.15 citations per document) counted in 2013 and lowest in 2020 (2.1 citations per document).
  - *Swaminathan, S.* affiliated to Department of Clinical Research, Tuberculosis Research Centre, ICMR, Chennai, India has been received the highest citations followed by *Sarin, S.K* affiliated to Institute of Liver and Biliary Sciences, New Delhi, India and *Paul, V.K* affiliated to AIIMS, New Delhi.
  - *Surviving sepsis campaign: international guidelines for the management of severe sepsis and septic shock: 2012* was the most cited document followed by *Surviving Sepsis Campaign: International Guidelines for Management of Sepsis and Septic Shock: 2016* and *Antibiotic resistance-the need for global solutions*.
  - *Plos One* was the most cited journal followed by the *Frontiers in Microbiology* and the *Journal of Clinical and Diagnostic Research*.
  - India was the most cited countries by authors followed by the USA and Korea.

## 11. CONCLUSION

The study concludes that there has been a steady trend towards the growing development of research literature in the field of antibiotics. Indian contribution to antibiotics research was strong in the world. India was the leading country secured third rank in the world and growth proportion of research productivity was almost same in India and the world. The International collaboration with other countries in antibiotics research was very less and Indian contributions to foreign journals are found basically non-existent. Joint authorship has been preferred and the trend of

collaborative research is increasing with time. Indian contribution to journals on antibiotics does not follow Bradford's law of scattering of articles; however, Indian author productivity follows the Lotka's law of scientific productivity.

We must look at scientometrics in a holistic manner, it is not only counting papers, it is far more than that, the role of scientometrics is to make policy making, decision making, strengthening of research and forecasting, etc.

## **12. SUGGESTIONS**

Based on the findings of the study, the following suggestions are recommended:

- 12.1 In order to improve the quality of antibiotics research, additional financial support should be given to specialized research institutes, universities, and other research institutes/organizations in the form of research grants and complex tools to the researchers.
- 12.2 Funding agencies, health research organizations and other institutions in India should be encouraged to provide for research projects on antibiotics and their infrastructure facilities.
- 12.3 Antibiotics research and discovery are tough and time-consuming, thus scientists must be provided the appropriate care and protection under the effects of professional exposure and external pressures so that they may dedicate their whole focus to study, leading to increased development and final publication.
- 12.4 Indian contributions to foreign journals are basically non-existent. Some of the most prestigious journals do not have contributions. There is a need to develop a national plan to encourage institutions with low publishing productivity to publish in international journals. They can collaborate with larger universities in their geographic area to publish their papers together.
- 12.5 From the inference of this study, the capability of the author could be acknowledged. Therefore, the individual scientist may be inspired to issue more contributions as an alternative to team contributions.

12.6 During the study, it became known that international collaboration with other countries in antibiotics research is very less, so universities and institutes should continuously organize conferences and workshops at the national and international levels and motivate them to research with other countries.

### **13. AREA FOR FURTHER RESEARCH**

13.1 The present study is based on the Scopus database, but antibiotics are mainly related to Medical Science. Therefore, there is a need for a comprehensive and comparative bibliometric study on antibiotics research with different databases, such as Pubmed, EMBASE (Excerpta Medica Database), UpToDate, and Web of Science.

13.2 The present bibliometric study is based on the Indian point of view, but the field of antibiotics is very wide, therefore, a global level bibliometric study on this subject may be done.

13.3 Today, antibiotic resistance is a very big problem and we all are getting affected by it, so a Bibliometric study on this subject can be done at the Indian and global level.

13.4 Altmetrics may provide more immediate engagement data in online tools and environments, it includes the number of article downloads, citation of research, and citation counts in scholarly information sources via social media sources, etc. therefore an altmetrics study can be done on this topic.

