

# Scientometric Analysis: A Health Science Perspective

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**Abstract:** Scientometrics is the study of science in a systematic manner differt from bibliometrics. Scientometrics helps us to understand literature, how citation done and research progression occurs. The scientometrics has changed over time from Lotka and Bradford who did research during 1910 to 1940. Then Eugene Garfield created the Science Citation Index and Derek de Solla Price made maps of science from 1950 to 1970. Later on Vasily Nalimov gave the name for this field. Now scientometrics uses computers and databases like Web of Science, Scopus etc. Now a days the tools like CiteSpace and VOSviewer also available to visualize the data. Scientometrics helps us to identify research progression, policy and funding of research. It is also useful to understand how research progresses in different part around the world. The scientometrics in the health sciences shows medical discoveries, collaborative research and research trends. This gives a clear picture about global research progression and trends. Scientometrics and its tools are essential for understanding scientometrics and its role in health science.

**Keywords:** Scientometric Analysis, Health Science.

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## I. INTRODUCTION

Scientometric analysis is the quantitative method of scientific study, used to analyze scientific literature, citation patterns, and research networks. It is used for evaluation of

the impact and development of scientific disciplines. Scientometrics is not equivalent to bibliometrics. Bibliometrics involves measurement of books and texts whereas, scientometrics looks at science as a whole and attempts to understand science using mathematics.<sup>[1,2]</sup>

## II. HISTORICAL DEVELOPMENT OF SCIENTOMETRICS

Table 1 Historical Development of Scientometrics

| Duration  | Historical Developments                                           |
|-----------|-------------------------------------------------------------------|
| 1910-1930 | Early Foundation Laws                                             |
| 1917      | Cole & Eales "Map literature volumes"                             |
| 1923      | Hulme introduces "Statistical Bibliography"                       |
| 1926      | Alfred J. Lotka's Law                                             |
| 1934      | Samuel C. Bradford's Law of Scattering                            |
| 1939      | Bernal Publishes "The Social Function of Science"                 |
| 1950-1960 | Rise of Modern Systems                                            |
| 1960      | Garfield established "Institute for Scientific Information (ISI)" |
| 1963      | Price publishes "Little Science, Big Science"                     |
| 1964      | "Science Citation Index (SCI)" launched                           |
| 1960-1970 | Formalization of rule & naming the Field                          |
| 1969      | Pritchard introduces "Bibliometrics"                              |
| 1969      | Nalimov & Mulchenko coined "Naukometriya" (Scientometrics)        |
| 1978      | "Scientometrics" Journal officially launches                      |

|         |                                                                            |
|---------|----------------------------------------------------------------------------|
| 1980    | Present: Digitalization & Expansion                                        |
| 1993    | Establishment of International Society for Scientometrics and Informetrics |
| 2005    | Hirsch introduces the Individual h-index                                   |
| Present | Shift to digital database, Webometrics, and real time altmetrics           |

➤ *Initial Empirical Foundations (1910 - 1940):*

Before the term 'scientometrics' was used, researchers who studied information, noticed that there were patterns in how knowledge was made and used. <sup>[1,2]</sup>

- Lotka's Law (1926): Alfred J. Lotka performed an important study on how scientists produce scientific work. He found that most of the literature was produced by a small group of scientists. Lotka's Law is based on foundational bibliometric principle. It explains the frequency of scientific productivity of authors. The Lotka's law states that the number of authors publishing 'n' number of papers are inversely proportional to  $n^2$ . It is around 60% of contributors in that particular field. <sup>[1,2,3,4]</sup>
- Bradford's Law of Scattering (1934): Samuel C. Bradford looked at how articles on a particular subject are spread across different academic journals. He showed that when you look for articles in more journals you get less and less useful information. It is a principle of bibliometrics which explains how articles on a particular topic are distributed across various scientific journals. <sup>[1,2,3,4]</sup>
- J.D. Bernal (1939): J.D. Bernal was British physicist wrote a book titled '*The Social Function of Science*'. He said that science can be studied and improved like any industry to make lives of people better. <sup>[1,2,3,4]</sup>

➤ *Technological Shift (1950 - 1960):*

After World War II, there was a change, in the way research was done. This change led to new information, which made the old libraries, where researchers used to organize the literature manually. With the help of computers, scenario has changed and it is possible to keep track of the information in more systematic manner. <sup>[2,3]</sup>

➤ *Era of Citation Index (1955 - 1964):*

In 1955 Eugene Garfield wrote an important paper on Science. He wanted to create a citation index of science.

Eugene Garfield got this idea from Shepards Citations. This is a tool that lawyers use to look at court cases. Eugene Garfield thought that the references cited at the end of a research papers could make a kind of index. This index would show how ideas are connected. <sup>(1-3)</sup> Five years later in 1960 Eugene Garfield established the *Institute for Scientific Information*. Then in 1964 he launched the *Science Citation Index*. Initially the researchers used to get information by using Science Citation Index. <sup>[1,3]</sup>

➤ *The Father of Scientometrics (1961 - 1963):*

Derek J. De Solla Price was British physicist who was pioneered the mathematical study of science, formulated Price's Law, defined the concept of the '*invisible college*'. He was called as father of Scientometrics. Derek J. De Solla Price wrote two important books in 1961 and 1963 namely '*Science Since Babylon*' and '*Little Science, Big Science*'. In these books he stated that the number of research papers was growing very rapidly. The number of research papers was doubling every ten to fifteen years. He also looked at how research papers cited each other and showed that science could be thought of as a network. <sup>[1-5]</sup>

➤ *Terms and Nomenclature (1966–1970):*

Vasily V. Nalimov (1966) was a Russian mathematician who came up with the term *Naukometriya* and wrote a book '*Naukometriya*', meaning "*measurement of science*". He wrote that the development of scientific study is an information process, and he thought of it like a stream of statistical information. <sup>[1-3]</sup>

Tibor Braun (1978), who was a chemist from Hungary took Vasily V. Nalimov's term and used it in English. Tibor Braun started a journal called *Scientometrics* in 1978. <sup>[1,3,4,5]</sup>

➤ *Expansion, Critiques, and the Modern Era (1980–Present):*

In the modern era use of computer became more common and easier to access data. <sup>[1-4]</sup>

Table 2 Expansion, Critiques, and the Modern Era (1980–Present)

| Sr No | Database       | Publisher  | History                                                         |
|-------|----------------|------------|-----------------------------------------------------------------|
| 1     | Web of Science | Clarivate  | Originating from the Institute for Scientific Information (ISI) |
| 2     | Scopus         | Elsevier   | Extensive, multidisciplinary scope of content                   |
| 3     | Open Access    | Dimensions | A scholarly publication freely available on the public domain   |

➤ *Commercial Evolution:*

The original ISI index is changed into the Web of Science. It is now owned by Clarivate. The Web of Science had to compete with Elsevier, Scopus and Google Scholar database, which were launched in 2004. <sup>[1-5]</sup>

➤ *The Proliferation of Metrics:*

In 2005 a physicist named Jorge E. Hirsch came up with the H-index. The H-index is a measure of a researcher

work and its citation. Around this time people also started using the Journal Impact Factor, which was coined by Garfield. <sup>[1-5]</sup>

➤ *Network Mapping and Visualization:*

In the year 2010 new softwares like CiteSpace and VOSviewer became available. These tools took lists of citations and turned them into maps that showed how people

were working together all around the world and what new subjects were being studied.<sup>[1-3]</sup>

➤ *Altmetrics:*

Because of the internet, the field of metrics started. This means tracking research work like how many times research work was mentioned on social media or how many times a article cites a researcher or how many times downloads data from a repository or how many times someone bookmarks a webpage. This helps us to see what kind of impact research is having in time on the Web of Science and other database.<sup>[1-5]</sup>

### III. ROLE OF SCIENTOMETRIC ANALYSIS

➤ *Administrative Accountability and Policy Formulation:*

The role of scientometric tracking is very important for administrators who manage research and for science ministries. They need it to make science policy, manage resources and set up the organization.<sup>[7]</sup>

➤ *Standardizing Funding and Career Evaluations:*

Scientometric tracking helps us to see how well research is progressing, to find out what are strong and weak areas and to make decisions about improvement and promotions.<sup>[8]</sup>

➤ *Mapping Trends:*

Scientometric analysis is useful in mapping research and citation trends of the researches and also helpful to find out impact factor as well as indexing status of journals.<sup>[9]</sup>

➤ *Managing Regional Disparities:*

The scientometric analysis can reveals regional – state-wise, country-wise disparities in research area so that adequate suggestions and appropriate actions can be initiated at respective level. This helps research institutions for fair coverage of research domain so that blind spots of research are covered.<sup>[10,11]</sup>

➤ *Scientometric Analysis: Health Science Perspectives:*

In health sciences, scientometric analysis show how medical break throughs occurs over time. It also helps to map out who is collaborating together on research areas. We can see how funding influence the research activity and which emerging topics are being studied.<sup>[12-16]</sup>

It gives an overview of the methods used in analysis. The review also looks at how scientometric analysis applied in health science research. We can see trends in analysis and what they mean for health science research.<sup>[12-13]</sup>

➤ *Methodological Framework of Health Scientometrics:*

The research data from medical and public health fields is used for analysis. This analysis turns the data into maps that are easy to understand.<sup>[12-13]</sup>

Table 3 Methodological Framework of Health Scientometrics

| Component              | Standard Instruments & Datasets                            | Purpose in Health Sciences                                                    |
|------------------------|------------------------------------------------------------|-------------------------------------------------------------------------------|
| Important Data Sources | Google Scholar, Scopus, Dimensions, PubMed, Web of Science | Comprehensive retrieval of clinical trials, epidemiology studies, and reviews |
| Mapping Software       | CiteSpace, VOSviewer, Bibliometrix (R package)             | Visualizing keyword, co-citations, and timeline evolution                     |
| Key Metrics            | H-index, Citation Impact, Impact Factor                    | Evaluating institutional outputs, author productivity, and journal influence  |

### IV. CORE APPLICATIONS IN THE HEALTH DOMAIN

➤ *Tracking Epidemiological Trends and Disease Manifestations:*

Scientometrics is really important in global health problems before and after disease outbreak such as the SARS epidemic or the COVID-19 pandemic.<sup>[12-15]</sup> In another scenario, studies on Hemorrhagic Fever with Renal Syndrome scientists initially studied the basics of the virus. Later on other scientist studied on various factors such as environment, disease spreads and how it affects the human body.<sup>[12]</sup>

➤ *Evaluating Emerging Technologies in Healthcare:*

Artificial Intelligence in medicine and personalized healthcare is growing rapidly by more than 30% every year which can be seen through scientometric analysis.<sup>[12-15]</sup> Use of Artificial Intelligence in diagnostics and medical imaging using genomic data helps for clinical decisions.<sup>[12]</sup>

➤ *Regional and Global Research Disparities:*

Scientometrics shows that research production is not same within the country and around the world. There are regional and global research disparities. The health priorities of every country are totally different. Research on health science journals in Africa found differences because some African countries do not have a health science journal that is listed internationally in major databases.<sup>[13-15]</sup>

➤ *Policy, Management, and Interdisciplinary Fields:*

Scientometric methods are also used in health, clinical pharmacy and health literacy. These methods are useful to search topics such as aging or dementia care and community health care.<sup>[12-15]</sup>

➤ *Critical Trends in Scientific Collaboration:*

A common finding in studies about health science is that they rely a lot on scientific networks.<sup>[12-13]</sup> The countries such as US, UK, China and Canada usually have publications as well as citations, in wide areas of health.<sup>[12-13]</sup> They work together and have a lot of collaboration within their country. When countries work together on research it

tends to get more citations and helps to spread new methods rapidly especially in precision of medicine.<sup>[12-15]</sup>

## V. CONCLUSION

The scientometric analysis in the health sciences shows a rapidly increasing literature related to international research collaboration, medical & technological innovation, and collaborative interdisciplinary research. It gives a clear picture about global research progression and collaboration trends. Scientometrics and its tools are essential for understanding scientometrics and its role in health science.

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