*Original Article*

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# Measuring and Analyzing Scholarly Literature Published on Diabetes Mellitus Type 1 with Special Reference to Bradford Law of Scattering and Leimkuhler Model: A Scientometric Study

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**Abstract**

The present paper deals with the applicability of Bradford's law of Scattering to the literature on Diabetes Mellitus type 1 disease. The PubMed database has been selected to collect data for the present study. A total of 489 journals published 1542 articles during the year 2012 to 2021 on Diabetes Mellitus type 1 disease. It was found that Current Diabetes Reports was the top core journal that published the highest number of articles (100) along with citation 4550. Bradford's law was tested for applicability using a ranked list of journals and publishing output. The Diabetes Mellitus type 1 literature's journal distribution pattern corresponded to Bradford's distribution pattern. The applicability of Leimkuhler's model was also tested and it is also fitted to the selected disease dataset of Diabetes Mellitus Type-1.

**Keywords:** Bradford's law of scattering, Leimkuhler model, Diabetes Mellitus Type-1, Bradford's multiplier, Bradford's bibliograph.

## INTRODUCTION

Scientific knowledge is disseminated through a variety of publications, including periodicals, journals, theses, etc. To keep researchers up to date, journals forecast and identify new concepts, approaches, methodologies, growth, and advancements in the field. In various academic fields, researchers consistently gravitate towards certain journals due to the strong alignment between the journal's subject matter and the focus of their research endeavors. These highly referenced publications are referred to as the "core journals" for the specific field. The notion of core journals stems from Bradford's Law of Scattering, originally formulated by Samuel Clement Bradford in 1934. In 1948, Bradford consolidated his findings regarding the growing dispersion of relevant journal articles within a particular subject by establishing a relationship between the number of journals in the highly productive nucleus and the number of journals in subsequent less productive zones, each containing an equal number of papers.

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## Diabetes Mellitus Type 1

The present study focuses on the literature published on Diabetes Mellitus Type 1, the most

common disease. Type 1 diabetes mellitus (T1DM) is an autoimmune condition characterized by the immune system attacking and destroying insulin-producing beta cells in the pancreas. Insulin, a crucial anabolic hormone, plays a pivotal role in regulating glucose, lipid, protein, mineral metabolism, and growth. Its key functions include facilitating glucose entry into muscle and adipose cells, promoting liver glucose storage as glycogen and synthesizing fatty acids, enhancing amino acid uptake, limiting fat breakdown in adipose tissue, and encouraging potassium uptake into cells. Individuals diagnosed with type 1 diabetes mellitus necessitate lifelong insulin replacement therapy.[1]

## Review of Literature

**Alves**[2] analyzed the published literature on the Capital structure during the year 2014-2019 through the use of the Bradford Law. The Web of Science database was chosen for the collection of data in the study. The study's key finding was that 2017 marked the year with the most scholarly output on the topic (1,765 articles). The analysis revealed two authors who significantly distinguished themselves as the most prolific contributors within the thematic area. Across three distinct zones, the study identified a total of 134, 531, and 2,163 journals focusing on 2,387, 2,262, and 2,651 articles, respectively. According to the findings of the study, the other periodicals are regarded as "Noise" since they have merely released two or one article.

**Borgohain, Verma, Nazim and Sarkar**[3] investigated the application of Bradford's law and the Leimkuhler model in analyzing the Information Science literature, utilizing a dataset comprising 213 source items listed in the Scopus database over the study period spanning from 2001 to 2020. In the initial phase, a verbal formulation was employed to depict the journal distribution pattern, revealing a notable discrepancy from Bradford's distribution with a considerably high percentage of error in the actual observations. Following this, the Leimkuhler model was applied, with the determination of the Bradford multiplier (k) value. This application resulted in a minor percentage error of 0.0092357%. Subsequently, the data was graphically represented using Bradford's Bibliograph, offering a visual perspective. The most frequently cited journals in this study were Scientometrics (39 citations), Bulletin of the Medical Library Association (33 citations), and the Canadian Journal of Information and Library Science

**Chaturbhuj and Sadik Batcha**[7] explored the application of Bradford's law of scattering within the domain of fluid mechanics. The typical verbal formulation of 1: n: n2 was found to not align with the data in the context of fluid mechanics. The validation of Bradford's law was conducted using the Leimkuhler model, revealing a high level of accuracy up to 0.005% through a geometric series of 2:57:1462. In addition to applying Bradford's law, the research incorporated various Scientometrics indicators such as DCI (Density of Citation Index), ICI (Impact Contribution Index), author's ranking, and the ranking of the most preferred journals. These indicators were utilized for both qualitative and quantitative analyses of research output in the field of Fluid Mechanics. Furthermore, the study identified T.E. Tenduyar as the most prolific author in this domain. Moreover, it highlighted 'Chemical Engineering Science' as the highly preferred journal within the field of Fluid Mechanics. The research also sheds light on international collaboration trends among 13 highly contributing countries."

**Chung**[8] The research delved into an analysis of source documents and their references within the realm of classification systems research globally. Focusing on the period from 1981 to 1990, the study identified the core journals in this field. The results affirmed Bradford's law and the study pinpointed Catalogable & Classification Quarterly (CCQ) as the most productive journal, while Libral Resplices & Technical Services (LRTS) emerged as the most frequently cited journal in the field. Additionally, Knowledge Organization (KO), previously known as International Classification (IC), was recognized as the second most productive and frequently cited journal in this domain. The study emphasized that acquiring high-ranked international journals, as identified over the years, is a strategic approach to achieving extensive coverage of the field at an optimal cost.

**Gautam and Verma**[10] applied Bradford's Law of Scattering on LISA for the period of 14 years from 2001-2014. The study covered 11176 articles on Information Technology. The study found that Computer Communication journal occupied top place with 871 citations however Computer Network and Information Today were also the most cited journals with 802, and 267 citations respectively. The study revealed that a significant majority of studies on Information Technology were published in the English language, accounting for 84.04% of the publications. In terms of country-wise distribution, the highest proportion of these publications originated from the UK, constituting

38.4% with a total of 251 publications. Surprisingly, India secured the ninth position in terms of the number of publications related to information technology.

**Gayan and Singh**[11] conducted a study on Chemistry theses submitted to the Central Library Tripura University. Only theses submitted to the Indian ETD initiative Shodhganga was taken into account in the study. The study covered 20 theses consisting of 6214 citations from 2007 to 2016. Bradford's law was applied to determine the key journals in the field of chemistry. Phytochemistry was the most cited journal found during the study. The dataset in the study did not adhere to Bradford's law, but interestingly, it did align with Leimkuhler's model. The study also revealed a significant finding regarding the half-life of chemistry journals, which was determined to be 12.6 years The findings of the study will help researchers in the discipline of chemistry gain a better grasp of the peculiarities of their subject they will also assist librarians in their decision-making about document selection and collection building for their libraries.

**Gourikeremath, Hiremath, Kumbar, and Hadagali**[12] investigated Bradford's law of Scattering over Microbiology research in India from 2002 to 2016. A total of 25,744 papers published in total 328 journals were retrieved from the WoS database. The Bio-resource Technology Journal was found as the most productive journal with 1,610 (6.25%) of the papers, followed by Applied Biochemistry and Biotechnology with 1,019 (3.95%) and 746 (2.89%) articles. Theoretical aspects of Bradford's Law of Scattering were examined, and it was determined that the data did not conform to the present sample. Subsequently, the Leimkuhler model was employed, and it was successfully applied to the dataset, yielding a Bradford Multiplier (k) value of 14.17. Furthermore, the validation of Bradford's law was carried out through graphical formulation, and it confirmed all three characteristic features.

**Karuilancheran and Baskaran**[13] applied Bradford's approach to analyze research on diabetes and related diseases in India, utilizing data from the PubMed database. The analysis specifically focused on journal articles published in this domain from 1995 to 2013. The noteworthy findings of the study showcased that the Indian researchers made a substantial contribution, generating a total of 8,156 publications within the span of 19 years in the field of diabetes and allied diseases. Journal articles predominate among the different types of publications when compared to other types of publications. The core zone contained 31 journals in total, with 1/3 of the articles published. Journal of Association of Physicians of India and Indian Journal of Endocrinology Metabolism, the first two Indian journals, each published 697 articles or 9.73 percent of all articles published. The literature on diabetes and allied diseases does not support Bradford's law.

**Kumar and Senthil Kumar**[14] examined Bradford's Scattering law on 18,877 research papers written by Indian scientists in the field of Astronomy and Astrophysics from 1988 to 2017. The bibliographic data were retrieved from the WoS database and analyzed separately for different blocks of 10 years and for 30 years consolidated, and the core journals were identified in Astronomy and Astrophysics. The Bradford's law of scattering and Leimkuhler Model were applied for testing the validity of the collected data and failed to establish consistency in the scattering of literature due to the high-level concentration of articles in very few journals.

**Nash Stewart, Kruesi, and Del Mar**[17] evaluated the applicability of Bradford's law for Cochrane Review of Cochrane Library-recognized works on "Acute Otitis Media" (AOM) and "Pneumonia," using the extraction and grouping of randomized controlled trials approach (RCTs). The study, while basically reflecting Bradford's law, was not very successful in forecasting the amount of literature on a given topic from RCTs. The study found that Zone 3 size varied from what the traditional Bradford model predicted may be due to the highly interdisciplinary nature of acute respiratory infections, which span the fields of primary care, pediatrics, and infectious diseases in addition to general internal medicine, or it may be due to classification issues with the "subject. he study's observation of a significant share of high-quality Randomized Controlled Trials (RCTs) originating from the extensive Zone 3 in journals underscores the established perspective that thoroughly exploring the tail end of the distribution is essential for encompassing pertinent literature

**Qio, Zhao, Yang, and Dong**[18] explored the background, genesis, developmental issues, and applications of Bradford's law. In this respect, they have also interpreted the inferences made by B.C. Vickery, F.F. Leimkuhler, B.C. Brooks, and. H.A. Cmojibcob in the law, which has resulted in the manifestation of a common understanding of its fundamental ideas and changing trends. The study also sheds insight on Bradford's legal application requirements, central regions, and restrictions.

**Ramakrishna, Dhanamjayab, and Talawar**[19] used the Web of Science database to test Bradford's Law of Scattering for Indian Dental Science publications from 1999 to 2018. The study found that total 5865 articles were scattered in 144 journals during the study period and highlighted most productive journal is Oral Oncology with 463 articles followed by the Journal of Moral Surgery with 386 articles. In this study, Bradford's law of scattering was tested and found not to fit for the present data set. Subsequently, an additional examination of the Leimkuhler model was conducted, revealing an exceptionally low percentage of error. The resulting Bradford Multiplier (k) was calculated at 9.37.

**Revathi and Ranganathan**[20] analyzed the growth of neurochemistry publications and the journal-wise distribution of these publications from 1989 to 2020. Specifically, the study applied the Bradford distribution law and the Leimkuhler model to understand the publication patterns. The study involved 3,232 research publications scattered across 983 journals. The analysis identified the Journal of Neurochemistry as the most productive journal in the field of neurochemistry during the specified timeframe. However, the verification of the Bradford law and Leimkuhler model did not fit the observed publication data.

**Sanaur**[21] tested the applicability of Bradford's law for the scattering of publications in economics from India and China. The study analyzed data from 887 journals publishing 1,924 economics publications from India and 1,627 journals publishing 4,427 Chinese economics publications. The study found that the journal distribution pattern of the economics literature in both India and China fits Bradford's distribution pattern. Additionally, Egghe's model was found to be valid for both datasets. The data also revealed that the majority of the economics research publications in both countries are dispersed across various journals of a multidisciplinary nature, primarily in social sciences and agricultural sciences. Consequently, the study concluded that economics publications from both India and China are not highly concentrated in core or nucleus journals within the field of economics.

**Singh and Bebi**[22] analyzed 260 Ph.D. theses submitted during 1995-2008, encompassing a total of 9,997 references scattered across 934 journals. The study identified that the journal "Economic & Political Weekly" was the most cited journal, comprising 22.8% of the citations, followed by "The Punjab Past and Present" with 1.80% of the citations. Furthermore, the study found that Bradford's law of scattering was applicable to the distribution of citations in the present study.

**Sudhier**[23] reviewed the scholarly contribution of various facets of Bradford's Law, specifically focusing on the five-year data from journals (2004-2008) cited by physicists at the Indian Institute of Science (IISc), Bengaluru. The goal was to examine the applicability of Bradford's Law of Scattering in this context. The study encompassed 690 periodicals, containing 11,319 references gathered from 79 doctoral theses. From the analysis, it was determined that the most preferred journals among physicists at IISc were Physical Review-B with 9.53% citations, Physical Review-A with 7.69%, and Astrophysical Journal with 5.47% citations. However, the study concluded that the journal distribution pattern observed in the IISc doctoral thesis did not fit Bradford's distribution pattern.

**Wahid and Idrees**[25] applied the accepted formulations of Bradford's Law on 251 articles published in the Pakistan Journal of Psychological Research from 1986 to 2012. The study analyzed 6,890 citations used by the authors and formed a ranked list of cited journals using Egghe's formulation of Bradford's Law of Scattering. The key finding that journals were the most frequently cited sources is important, as it indicates the significance of scholarly journals as primary sources of information and research in the field being studied. The majority of the mentioned journals were US-based publications. Self-citations by authors and journals were extremely rare. The most often cited journal among those on a ranked list was determined to be the Journal of Applied Psychology.[24] major journals were found in the study when Bradford's Law was used. The only journal from Pakistan to be included in the list of essential journals is the Pakistan Journal of Psychology Research. This law was found to be appropriate for the selected Journal's citations.

**Wardikar and Gudadhe**[26] delved into assessing the relevance of Bradford's Law of Scattering by examining the data derived from journals cited by Ph.D. research scholars at universities in Maharashtra for their doctoral research. The dataset encompassed 798 periodicals, comprising a total of 5,467 references collated from 138 theses over the period of 1982 to 2010. In terms of journal preference, Annals of Library Science and Documentation emerged as the most cited journal, securing the top spot with a total of 207 citations. Following closely were College and Research Libraries with 184 citations and Herold of Library Science with 160 citations, signifying the notable preference for

these journals among the research scholars. The study also shed light on the distribution of citations across different journal categories. Notably, each journal category represented approximately one-third of the total journals, illustrating a proportional distribution in a 15:55:728 ratio. These categories collectively covered a significant volume of citations, amounting to 1,844, 1,829, and 1,794 citations, respectively.

## Objectives of the Study

The primary aim of this study is to apply Bradford's Law of Scattering and the Leimkuhler Model to analyze the literature within the domain of Type 1 Diabetes Mellitus. The secondary objectives of the study can be stated as follows:

i. To prepare the ranked list of core journals.
ii. To find out number of articles published in related journals.
iii. To find out total number of citations.

## Methodology

The data for the present study has been collected from the PubMed database, maintained by the United States National Library of Medicine (https://pubmed.ncbi.nlm.nih.gov/). It is found that total 489 journals produced 1542 articles from the year 2012-2021 and these 489 journals have been analyzed to test the applicability of Bradford Law. The study covers only Review articles published over 10 years.

5.1 Search strategy: The search approach utilized to compile data regarding Type 1 Diabetes Mellitus is described below:

Search: diabetes mellitus type 1 Filters: Free full text, Review, in the last 10 years, English, MEDLINE

"diabetes mellitus, type-1" (MeSH Terms) or"type 1 diabetes mellitus"(All Fields) or "diabetes mellitus type 1"(All Fields) and [y_10(Filter)] and [freefultext(Filter)] and [review(Filter)] and [medline(Filter)] and [English(Filter)].

## Data Analysis and Interpretation

Core journal studies typically assist in the selection of journals within a specific subject field. In Table 1, journals are organized in descending order based on the frequency of articles, and the table includes the number of citations attributed to articles published in each respective journal. The ranking of journals is determined by their contributions in terms of articles, following a quantitative criterion. The journal with the highest number of contributed articles is ranked as number 1, followed by the second highest at rank 2, and so forth. It's important to emphasize that the ranking of journals is solely based on quantitative criteria and does not incorporate qualitative assessments.

**Table 1:** Top 50 Journals published in the field of Diabetes Type 1

| Journal | Number of articles | Cumulative Number of Articles | Number of Citations | Cumulative Number of citations |
|---|---|---|---|---|
| Current Diabetes Reports | 100 (6.49 %) | 100 | 4550 (4.98%) | 4550 |
| International Journal of Molecular Sciences | 61 (3.96%) | 161 | 1545 (1.69%) | 6095 |
| Journal of Diabetes Science and Technology | 54 (3.50%) | 215 | 2467 (2.70%) | 8562 |
| Diabetologia | 53 (3.44%) | 268 | 4511 (4.94%) | 13073 |
| Frontier in Immunology | 46 (2.98%) | 314 | 442 (0.48%) | 13515 |
| Frontiers in Endocrinology | 42 (2.72%) | 356 | 303 (0.33%) | 13818 |
| Nutrients | 34 (2.20%) | 390 | 2328 (2.55%) | 16146 |
| Journal of Diabetes Research | 27 (1.75%) | 417 | 1047 (1.15%) | 17193 |
| Current Opinion in Endocrinology Diabetes & Obesity | 25 (1.62%) | 442 | 457 (0.50%) | 17650 |
| Diabetes | 24 (1.56%) | 466 | 2229 (2.44%) | 21795 |
| Diabetic Medicine | 24 (1.56%) | 490 | 1916 (2.10%) | 21795 |
| Cochrane Database of Systematic Reviews | 22 (1.43%) | 512 | 3287 (3.60%) | 25082 |
| Pediatric Diabetes | 21 (1.36%) | 533 | 1405 (1.54%) | 26487 |
| Diabetes Obesity & Metabolism | 21 (1.36%) | 554 | 1286 (1.41%) | 27773 |

*Table Cont...*

| | | | | |
|---|---|---|---|---|
| Clinical and Experimental Immunology | 17 (1.10%) | 571 | 1056 (1.16%) | 28829 |
| Diabetes Technology & Therapeutics | 17 (1.10%) | 588 | 1040 (1.14%) | 29869 |
| Pediatric Endocrinology, Diabetes & Metabolism | 17 (1.10%) | 605 | 127 (0.14%) | 29996 |
| PLoS One | 16 (1.04%) | 621 | 1351 (1.48%) | 31347 |
| Current Diabetes Reviews | 12 (0.78%) | 633 | 1411 (1.54%) | 32758 |
| Molecular Metabolism | 12 (0.78%) | 645 | 576 (0.63%) | 33334 |
| Drug Design, Development and Therapy | 12 (0.78%) | 657 | 260 (0.28%) | 33594 |
| Nature Reviews Endocrinology | 11 (0.71%) | 668 | 2568 (2.81%) | 36162 |
| BioMed Research International | 11 (0.71%) | 679 | 748 (0.08%) | 36910 |
| Cells | 11 (0.71%) | 690 | 242 (0.26%) | 37152 |
| International Journal of Environmental Research & Public Health | 11 (0.71%) | 701 | 50 (0.05%) | 37202 |
| Cold Spring Harber Perspective in Medicine | 10 (0.65%) | 711 | 1278 (1.39%) | 38480 |
| Annals of the NewYork Academy of Sciences | 9 (0.58%) | 720 | 1034 (1.13%) | 39514 |
| Diabetes Metabolism/Research & Reviews | 9 (0.58%) | 729 | 666 (0.73%) | 40180 |
| CurrentOsteoporosis Reports | 9 (0.58%) | 738 | 649 (0.71%) | 40829 |
| Endocrinology &Metabolism Clinics of North America | 9 (0.58%) | 747 | 614 (0.67%) | 41443 |
| Journal of Diabetes Investigation | 9 (0.58%) | 756 | 510 (0.56%) | 41953 |
| Journal of Autoimmunity | 9 (0.58%) | 765 | 470 (0.51%) | 42423 |
| Clinical Immunology | 8 (0.52%) | 773 | 348 (0.38%) | 42771 |
| The Journal of Clinical Investigation | 8 (0.52%) | 781 | 316 (0.34%) | 43087 |
| The Review of Diabetic Studies | 8 (0.52%) | 789 | 308 (0.33%) | 43395 |
| Discovery Medicine | 8 (0.52%) | 797 | 291 (0.32%) | 43686 |
| Current Opinion in Immunology | 8 (0.52%) | 805 | 198 (0.22%) | 43884 |
| Cardiovascular Diabetology | 7 (0.45%) | 812 | 489 (0.54%) | 44373 |
| World Journal of Gastroenterology | 7 (0.45%) | 819 | 435 (0.48%) | 44808 |
| Diabetes Research & Clinical Practice | 7 (0.45%) | 826 | 397 (0.43%) | 45205 |
| BMJ Open | 7 (0.45%) | 833 | 378 (0.41%) | 45583 |
| Stem Cells Translational Medicine | 7 (0.45%) | 840 | 367 (0.40%) | 45950 |
| Endocrine Reviews | 6 (0.39%) | 846 | 992 (1.09%) | 46942 |
| Arteriosclerosis, Thrombosis, and Vascular Biology | 6 (0.39%) | 852 | 545 (0.59%) | 47487 |
| Islets | 6 (0.39%) | 858 | 357 (0.39%) | 47844 |
| Sensors (Basel) | 6 (0.39%) | 864 | 235 (0.26%) | 48079 |
| Biomolecules | 6 (0.39%) | 870 | 119 (0.13%) | 48198 |
| Biomedicine & Pharmacotherapy | 6 (0.39%) | 876 | 105 (0.11%) | 48303 |
| BMJ Open Diabetes Research & Care | 6 (0.39%) | 882 | 72 (0.08%) | 48375 |
| Internal Medicine | 6 (0.39%) | 888 | 60 (0.07%) | 48435 |
| Other Journals | 654 (42.41%) | 1542 | 42958 (47.0%) | 91393 |

Table 1 depicts overall rank of the top 50 journals. After analysis of the scattering of total of 1542 articles in 489 journals it is found that Current Diabetes Reports is a top-ranked journal that contributes the highest number of articles (6.49%) as well as the highest number of citations (4.98%) followed by the second- ranked journal International Journal of Molecular Sciences with 3.96% of articles. Journal of Diabetes Science and Technology got 3rd rank with 3.50% of the total articles. It is clear from the table that among 489 journals,12 journals are core journals that contribute 33.20% of the total article.

### *Application of Bradford Law of Scattering*

The British mathematician and librarian, Samuel C. Bradford (1878-1948) is recognized for formulating the law regarding the distribution of publications within a subject, often referred to as

the law of bibliographic scattering. This principle elucidates how literature related to a specific subject is dispersed and distributed across various journals. Bradford's Law posits that "if scientific journals are arranged in order of decreasing productivity of articles on a given subject, they may be divided into a nucleus of periodicals more particularly devoted to the subject and several groups or zones containing the same number of articles as the nucleus."

Bradford further elucidated that these succeeding zones follow a ratio of 1: n: n2, where n is a multiplier. The term "nucleus" was coined by Bradford to represent the first zone of periodicals predominantly focused on the given subject. Subsequently, the remaining papers on the subject are distributed across other journals based on the defined ratio. This framework provides a quantitative understanding of how scientific literature is distributed, allowing for the identification of key journals at the core of a subject and a subsequent dispersion of articles in peripheral journals.[1]

**Table 2:** Distribution of Journal

| Rank | Number of Journal | Cumulative Number of Journal | Log Cumulative number of Journal | Number of articles | Total Number of Articles | Cumulative Number of Articles |
|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 0 | 100 | 100 | 100 |
| 2 | 1 | 2 | 0.69 | 61 | 61 | 161 |
| 3 | 1 | 3 | 1.09 | 54 | 54 | 215 |
| 4 | 1 | 4 | 1.38 | 53 | 53 | 268 |
| 5 | 1 | 5 | 1.61 | 46 | 46 | 314 |
| 6 | 1 | 6 | 1.79 | 42 | 42 | 356 |
| 7 | 1 | 7 | 1.94 | 34 | 34 | 390 |
| 8 | 1 | 8 | 2.08 | 37 | 37 | 417 |
| 9 | 1 | 9 | 2.19 | 25 | 25 | 442 |
| 10 | 2 | 11 | 2.4 | 24 | 24 | 490 |
| 11 | 1 | 12 | 2.48 | 22 | 22 | 512 |
| 12 | 2 | 14 | 2.64 | 21 | 42 | 554 |
| 13 | 3 | 17 | 2.83 | 17 | 51 | 605 |
| 14 | 1 | 18 | 2.89 | 16 | 16 | 621 |
| 15 | 3 | 21 | 3.04 | 12 | 36 | 657 |
| 16 | 4 | 25 | 3.21 | 11 | 44 | 701 |
| 17 | 1 | 26 | 3.26 | 10 | 10 | 711 |
| 18 | 6 | 32 | 3.47 | 9 | 54 | 765 |
| 19 | 5 | 37 | 3.61 | 8 | 40 | 805 |
| 20 | 5 | 42 | 3.74 | 7 | 35 | 840 |
| 21 | 8 | 50 | 3.91 | 6 | 48 | 888 |
| 22 | 5 | 55 | 4 | 5 | 25 | 913 |
| 23 | 17 | 72 | 4.28 | 4 | 68 | 981 |
| 24 | 36 | 108 | 4.68 | 3 | 108 | 1089 |
| 25 | 72 | 180 | 5.19 | 2 | 144 | 1233 |
| 26 | 309 | 489 | - | 1 | 309 | 1542 |
| Total | 489 | - | - | - | 1542 | - |

### *Verbal Formulation of Bradford's Law*

Table 2 provides comprehensive information about highly productive journals. The data in the table is organized based on rank, the number of journals, cumulative number of journals, logarithm of cumulative number of journals, number of articles, and cumulative total of articles. The arrangement of journals in the table follows a descending order based on article productivity, thereby facilitating the

assessment and verification of Bradford's law in verbal terms.

In order to test the Bradford Law of Scattering, the 489 journals were arranged according to the decreasing order of articles produced by them. Then, all the journals are divided into three zones, each zone is designed to contain approximately the same number of articles.

**Table 3:** Bradford's Zones and Number of Articles

| Zone | Journal Observed | Percentage of Journals | Articles | Cumulative articles | Bradford Multiplier |
|---|---|---|---|---|---|
| 1 | 12 | 2.46 | 512 | 512 | - |
| 2 | 75 | 15.40 | 514 | 1026 | 6.25 |
| 3 | 400 | 82.14 | 514 | 1540 | 5.33 |
| | 487 | 100 | 1540 | | 5.79 (Mean Value) |

Table 3 outlines the distribution of journals and the corresponding number of articles in the three zones, incorporating the value of Bradford's multiplier. It is found that 12 journals of the nucleus zone produced 512 articles which are 1/3rd of the total articles, the first zone of 75 journals covered 514 articles which contained another 1/3rd article of the total articles and the Second zone with 400 journal produced 514 articles covering remaining 1/3rd articles.

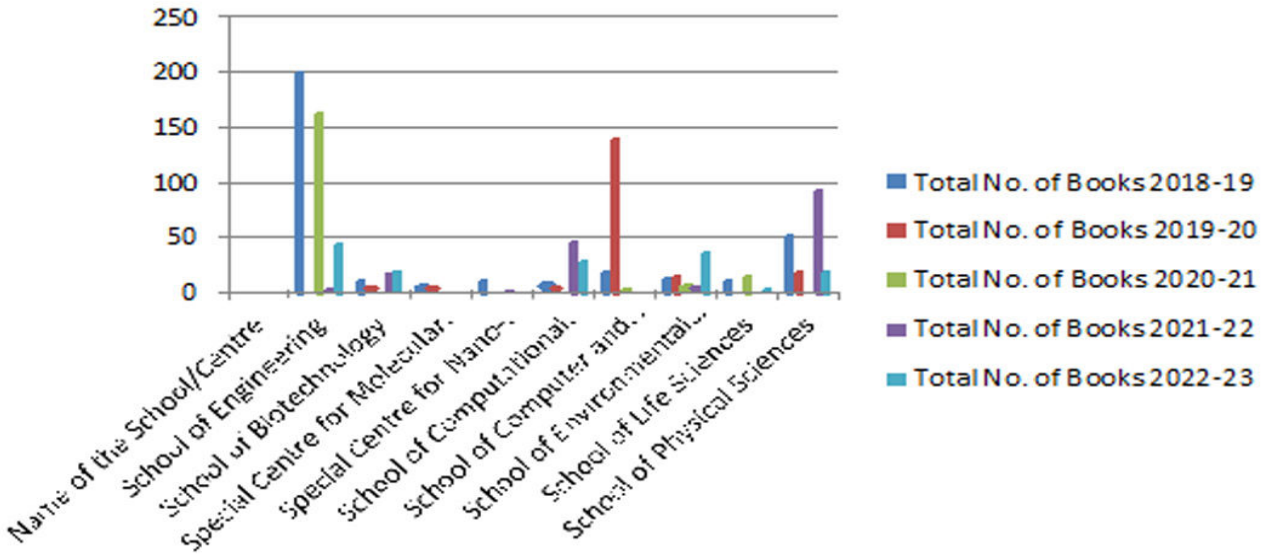


**Fig. 1:** Bradford Bibliograph

According to Bradford, the relationship between the zones is 1: n: $n^2$, if the values put in this ratio, then Bradford ratio is = 12:12*6:12*6* = 12:72:432

while the relationship of each zone in the present study is = 12:75:400

Bradford's multiplier was arrived at by dividing the number of journal titles of a zone by its preceding zone.

= (75/12) + (400/75)/2 = 6.25+5.33/2 = 11.58/2 = 5.79

Thus $1:n:n^2$ = 12: 12*5.79: 12* $(5.79)^2$ = 12:69.48:402.29

On the basis of the mean value of the Bradford multiplier derived from table 3, The percentage of error was calculated as

(12+ (12*5.79) + 12*$(5.79)^2$ – (12+75+400)

= (12+69.48+402.29) - (487)

Percentage of error= $\frac{483.77-487}{487} * 100$ = -0.66

Here, the percentage of error is negative so Bradford's law of scattering applies to the given dataset of Diabetes Mellitus Type-1. Bradford provided a graphical representation of his law, often referred to as the "Bradford distribution"

or "Bradford curve. Mathematical Models were later suggested later by Vickery (1948)[24], Leimkuhler (1967), Brookes (1969)[6] and Egghe (1990). Leimkuhler[16] developed a model based on Bradford's verbal formulation.

$$R(r)= a \log (1+br) \quad (1)$$

r = 1,2,3……

While explaining Leimukhler's law, Egghe shows that

$$a = Y0 / \log k \quad (2)$$

$$b = k – 1 / r0. \quad (3)$$

where $r^0$ = the number of articles in the first Bradford zone,

Y0 = the number of articles in all Bradford zones (all these zones of item being of equal sizes), and

k = the Bradford multiplier

R(r) = is the cumulative number of articles produced by the journals of rank 1,2,3…r a and b are constants appearing in the law of Leimkuhler.

It is demonstrated in the formation of Bradford groups that the number of groups p is a parameter that can be freely chosen. Egghe (1990)[9] demonstrated the mathematical technique for computing the Bradford Multiplier k as

$$k= (e^y * ym)^{1/p} \quad (4)$$

Where $e^y$ is Euler's number ($e^2$=1.781)

If the sources are ranked in decreasing order of productivity, then ym is the number of articles in the most productive journals. Then y0 and r0 as follows

$Y_0 = y^2_m \log k$ …….. (5)

$R_0 = (k-1)\, y_m$.....(6)

Once p is chosen, the value of k can be calculated by using

$$k = (1.781\, y_m)^{1/p} \quad \text{and } Y_0 = A/P \quad (7)$$

where A denotes the total number of articles.

Let T denote the total number of journals in the Bradford group, there are r0 k(i-1) sources (i= 1,2,3. p)

$T= r_0+r_0 k + r_0 k^2+……..+ r_0 k^{(p-2)}$.....(8)

So, $r_0 = T/1+k+k^2+…. + k^{(p-1)} = T(k-1)/(k^p-1)$ (9)

Since A and T are known from the data set, r0 and Y0 are calculated, once p is calculated by the formula (7).

### *Application of Leimkuhler (1967)'s Model*

Though the dataset fits into Bradford's model, Leimkuhler's Model[22] is employed for the verification of Bradford's law of scattering. For the application of Bradford's law, three zones were selected, p=3, then the value of k can be calculated using the formula 4,

$k = (1.781 * Y_m)^{1/p}$

$= (1.781 * 4550)^{1/3} = 20.08$

$Y_0 = A/P = 1540/ 3 = 513.33$

$r_0= T(k-1)/ (k^p-1) = 487 (20.08 - 1)/ (20.08^3- 1)= 1.14$

$r_1=r_0*k = 1.14*20.08=22.89$

$r_2 = r_0*k^2$

$= 1.14*(20.08)^2$

$= 459.65$

$a = Y_0 / \log k = 513.33/ \log 20.08 = 3.94.03$

$b = k- 1/ r_0 = 20.08-1/ 1.14 = 16.73$

The number of Journals in the nucleus is found to be 1.14 1.14:1.14*20.08:1.14*20.08*20.08

1.14:22.89:459.65=1.14+22.89+459.65=483.68

Percentage of error = $\frac{483.68-487}{487} * 100 = -0.68$

## Diagrammatic Representation

A graph with a horizontal x-axis representing the logarithmic of the cumulative number of journals and a vertical y-axis representing the cumulative number of articles is displayed to demonstrate the applicability of Bradford's law of scattering. Fig. 1 shows that the resulting bibliography begins exponentially and subsequently follows a linear curve, suggesting an application of Bradford's law of scattering.

## CONCLUSION

For the evaluation of scientific research output and to determine scientific indicators scientometric studies have proven to be very useful. Libraries in present times cannot afford to acquire everything, they require to serve the user community. For this purpose, the selection and acquisition of the best literature in the form of books and journals in a given field of research is essential. Scattering is one such bibliometric law that helps professionals to judiciously use its resources in the best possible way.

This research endeavor centers on the application of Bradford's Law of Scattering to analyze the dispersion of journal publications concerning Type 1 Diabetes Mellitus. The study focuses on the timeframe from 2012 to 2021, utilizing data sourced from the PubMed database 1542 publications about the type 1 diabetes mellitus condition were published in total of 489 journals. Current Diabetes Report published 100 (6.49%) articles with citations 4550 (4.98%) followed by the International Journal of Molecular Sciences produced 61 (3.96%) with 1545 (1.96%) and the Journal of Diabetes Science and Technology published 54 (3.50%) with 2467 (2.70%). Bradford's law was tested based on the ranked list of journals and publishing output. The literature on Diabetes Mellitus type 1 was distributed in journals according to Bradford's distribution pattern. The distribution pattern of Type 1 Diabetes Mellitus literature in journals aligns with Bradford's Law distribution model, which follows the 1:n:n2 pattern. When we consider the mean multiplier value of 5.79, Bradford's Law is a good fit for this journal distribution, as the percentage of error is minimal at 0.38 percent. Furthermore, when we apply Leimkuhler's model to validate this pattern using the dataset for Diabetes, it also demonstrates validity. The percentage of error is negligible at -0.68 percent, affirming the applicability and suitability of this model for analyzing the selected dataset on Diabetes.

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