A Comparative Study: Application of Bradford's Law of Scattering to the Epidemiology Literature of India and Japan

Nirmala Biradar[*], **Prakash Kumbar**

Assistant Librarian, Prof. S S Basavanal Library, Karnatak University, India

Corresponding Author: *Nirmala Biradar, Assistant Librarian, Prof. S S Basavanal Library, Karnatak University, India, Email: biradarnirmala541@gmail.com*

ABSTRACT

This paper deals with the applicability of Bradford law of scattering of the publications of India and Japan. The data for the study collected from Web of Science database, 359 journals publishing 6436Epidemiology subject publications from India and 895journals published 8770 Japan Epidemiology publications. The ranked list of journals prepared for both the datasets and the applicability of Bradford's law was tested. The journals distribution pattern of the Epidemiology literature fit Bradford's distribution pattern. The applicability of Egghe's model (modification of Leimkuhler's model) was also tested and found valid for both the datasets.

Keywords: *Bradford's Law, Leimkuhler's Model, Egghe's Model, Epidemiology, India, Japan*

INTRODUCTION

Scientific journals are the significant primary sources of information which communicate the nascent, original research findings and new ideas developed by the scientists through the research articles to the fellow researchers in the chosen field of interest and helps in subsequently kindling the new ideas for further research. Journals identify and forecast of existing new concepts, approaches, techniques and growth and developments in the subject in order to keep the researchers well informed. Studies have shown that research output in a subject field concentrated in a few selected journals, regarded as core journals because of the similarity of the association of ideas between the subject of journals and areas of research work.

The idea of core journals was first identified by S C Bradford in 1934. There are other techniques to find out the core journals in the subject field, such as citation indexing technique, impact factor value of journals etc. These techniques made convenient for the libraries to identify core journals in a given subject field out of a large number of journals. The other factors like increasing the cost of journals, dwindling library budgets and many other challenges continuously bother libraries. Bradford's technique is the most popular in bibliometric studies with suitable mathematical evidence.

Bradford's law explains how the research articles on any given subject field scattered or spread across different journals. It was first reported in 1934 in the journal engineering by Bradford and, subsequently, in a book titled Documentation by the same author in 1948 where the verbal formulation and graphical representation of his law are explained. The present paper examines the application of Bradford's law to the epidemiology literature published by India and Japan scholars during 1989-2018.

PREVIOUS STUDIES

Brookes (1969) the law of scattering of publications formulated by Bradford in 1948 was not expressed as a mathematical formula, which prevented its practical application. In the subsequent two decades, attempts at such formulation were made, but it was only recently that equations were derived to express this law, which is a particular instance of the distribution known as zipf's law. The Bradford law is of great importance for solving many problems of functional adequacy and rationalization of library systems. It can be used to compile and analyze bibliographies of science papers. **Gupta** (1991) citographies were compiled for citation data of items published in 1977 and 1987 volumes of Ethiopian Medical Journal. Citographies were analyzed and Bradford's Law was applied to them to test its applicability.

Rank list of journals based on the number of citations received by them was made for 1977 and 1987. Lin and Hong (2011) this study used both the Bradford's Law and the Lotka's Law in the traditional bibliometrics to explore the web users' behavior on Wiki Websites. In addition, by doing a case study for the "Taiwan Baseball Wiki", a digital archive website which was independently developed by Taiwan, this research discussed both the distribution of the web pages and the productivity of the editors on this Wiki Website. Kumar (2013) eighty doctoral dissertations submitted to the Bidhan Chandra Krishi Viswavidyalaya (BCKV) and Uttar Banga Krishi Viswavidyalaya (UBK.V), West Bengal from 1991-2010 by the research scholars of horticulture are taken as the source materials. A total number of 10845 references were appended to the eighty dissertations, of which, 8437 were journal articles. Gourikeremath, et.al. (2017) the present paper investigates Bradford's Law of scattering for the 'Microbiology' literature in India for the period 2002-2016 as accessible in the Web of Science Core Collection database. A total of 25,744 articles related to Microbiology literature published in journals during the study period are retrieved. **Ram and *Paliwal*** (2014) the paper presents an overview on scholarly contribution presented on Bradford law applied in different studies both theoretical as well as practical aspects of the law and it is being tested here over Psoriasis literature. The data for this study has been taken from PubMed for the period of 50 years (1960-2009) and it yielded 24031 citations. **Sudhier** (2010) one of the areas in bibliometric research concerns the application of most commonly used bibliometric laws such as Bradford's Law of Scattering. The paper gives a review of the scholarly contribution on the various facets of Bradford's Law. In addition to the theoretical aspects of the law, review covers papers dealing with the application of the law in the various subject fields. **Kumar** (2013) a study on twenty-year data of journals cited by the horticulture scientists was carried out to examine the applicability of Bradford's law of scattering. Applicability of Bradford's law was tested. The journal distribution pattern of the horticulture doctoral dissertations does not fit the Bradford's distribution pattern. The distribution of the journals in three zones was made and the number of references in each zone was then estimated. **Singh and Bebi** (2014) the study covers 260 Ph.D. theses submitted during 1995-2008 that have a total of 9,997 references

scattered in 934 journals. The study found that the journal Economic & Political Weekly is the most cited journal with 22.8% citations, followed by The Punjab Past and Present with 1.80% citations. Bradford's law of scattering fits to the present study. **Ram and Paliwal** (2014) the paper presents an overview on scholarly contribution presented on Bradford law applied in different studies both theoretical as well as practical aspects of the law and it is being tested here over Psoriasis literature. The data for this study has been taken from PubMed for the period of 50 years (1960-2009) and it yielded 24031 citations. Biradar and Tadsad (2015) conducted a study which is based on 5219 citations, appended to the 47 PhD theses of economics submitted to Karnatak University, Dharwad for the award of doctoral degree in Economics during the period 2009-2013. **Banateppanavar** (2015) the present paper aims at analyzing the research output performance of library and information science (LIS) professionals. Citation analysis of all the journal articles published in the Collection Building journal during 2009-2012 is carried out. **Gourikeremath** (2017) the present paper investigates Bradford's Law of scattering for the 'Microbiology' literature in India for the period 2002-2016 as accessible in the Web of Science Core Collection database. A total of 25,744 articles related to Microbiology literature published in journals during the study period are retrieved. **Mizoguchi,** and **Kano** (2019) there are many rare diseases and biomedical research efforts for treatment of each disease have been ongoing. However, few reports are available to analyze overall trends for how research and development have been performed for rare diseases generally. In this research, the correlations between research and development indicators of rare diseases were examined with international comparisons among Japan, the US, and Europe. **Cano-Oron** (2019) Users access to Google to find out about health issues is frequent among citizens. This research analyzes the best results of three generic searches on homeopathy, collected in four waves in five countries: Spain, France, Mexico, the United Kingdom, and the United States. **Lo et. al.** (2019) Comic books are becoming increasingly popular in the field of education. In the past, comic books were excluded from school libraries and classrooms. However, with the resurgence in the popularity of comic books and students' increased demands for them, they are now considered as recreational reading with

educational value. In response to this, school libraries have begun collecting comic books and including them as part of their regular collections. **Ismayilov and Mammadova** (2019) the comparatively study of the library and information services provided by three academic libraries – Baku State University Scientific Library, ADA University Library and Information Services and Khazar University Library and Information Center – located in Baku, Azerbaijan. **Vazquez** (2019) in recent years, academic journals have evolved to become a vehicle for scientific communication that is acknowledged by the official organizations that certify their quality. This enables assessments to be performed, determining how a discipline has evolved through the analysis of bibliometric indicators and the keywords used to index the articles. **Das and Ramesh** (2019) the present study throws light on the scholarly communication of three leading countries in the field of pharmaceutical research as reflected in SCOPUS database during 1998-2017. In terms of publication output, United States with two leading Asian countries, China and India leads with 40.54 per cent share of the global research publication share in pharmaceutical sciences.

OBJECTIVES OF THE STUDY

The main objectives of the study were:

- To prepare the rank list of journals and study the phenomenon for the scattering of journals in India and Japan epidemiology publications.
- To verify Bradford's law of scattering to epidemiology literature.

METHODOLOGY

The present study focused on the verification of Bradford's law of scattering to the research outcome of Indian and Japan epidemiology research output published during 1989-2018. The data for this study was collected from the Web of Knowledge portal, a comprehensive citation indexing database containing databases sciences, social sciences and arts and humanities. The query was designed by refereeing the various topics in the subject and the country. The data was downloaded, which include 6436 publications appeared in 359 journals contributed by Indian scholars, and 895 journals contributed 8770 research articles by Japan scholars. The study identified the journals and their corresponding frequency of articles for the verification of Bradford's law of scattering suggested by Bradford and Egghe's model i.e. modification of the Leimkuhler's model (Wardikar, 2013), (sangam, Savanur & Hullolli, 2018).

RESULTS AND DISCUSSION

Publication Productivity

Analyzing and quantifying the process of scientific knowledge production in different subjects is an interest to scientometric. The scientific productivity of countries refers to the increase of research activities in terms of research output in different forms and languages over a period of time. Scientometric studies on the growth of publications regarded as the most objective and reliable method of assessment.

The year-wise growth of a number of publications by India and Japan is tabulated in table 1 and the depicted in the figure-1. There are 6436 publications published by the Indian scholars in the field of epidemiology during 1989-2018 with an average of 214.53 papers per year. The year 2018witnessed the most productive year having (12.33%) papers published, followed by (11.46%) in the year 2017 and (11.62%) papers in 2016. The data shows study growth of publications during the period of study. Similarly, there were 8770 publications by Japan scholars during 1989-2018 with an average of 292 publications per year. The year 2018 witnessed the most productive year with 10% of the total papers, followed by (8.57%) in 2017 and 7.60% papers in 2016. It can be noticed from the figure-1 that the Japan publications grew at a steady rate and during 2004 onwards the growth of publications shows steep high as compared to Indian publications.

Table1. *Year-Wise Contribution of India and Japan Publications in the Field of Epidemiology*

India				Japan		
Year	Publications	Cumulative Publications	%	Publications	Cumulative Publications	%
1989	10	10	0.15	05	05	0.05
1990	08	18	0.12	17	22	0.19
1991	30	48	0.46	58	80	0.66
1992	21	69	0.32	59	139	0.67
1993	27	96	0.41	55	194	0.62

1994	40	136	0.62	87	281	0.99
1995	32	168	0.49	95	376	1.08
1996	53	221	0.82	107	483	1.22
1997	45	266	0.69	119	602	1.35
1998	56	322	0.87	115	717	1.31
1999	57	379	0.88	162	879	1.84
2000	63	442	0.97	155	1034	1.76
2001	73	515	1.13	170	1204	1.93
2002	95	610	1.47	181	1385	2.06
2003	105	715	1.63	189	1574	2.15
2004	113	828	1.75	212	1786	2.41
2005	121	949	1.88	270	2056	3.07
2006	134	1083	2.08	263	2319	2.99
2007	151	1234	2.34	302	2621	3.44
2008	254	1488	3.94	315	2936	3.59
2009	244	1732	3.79	364	3300	4.15
2010	314	2046	4.87	426	3726	4.85
2011	307	2353	4.77	473	4199	5.39
2012	394	2747	6.12	518	4717	5.90
2013	389	3136	6.04	553	5270	6.30
2014	436	3572	6.77	589	5859	6.71
2015	584	4156	9.07	622	6481	7.09
2016	748	4904	11.62	667	7148	7.60
2017	738	5642	11.46	752	7900	8.57
2018	794	6436	12.33	870	8770	9.92
Total	**6436**			**8770**		
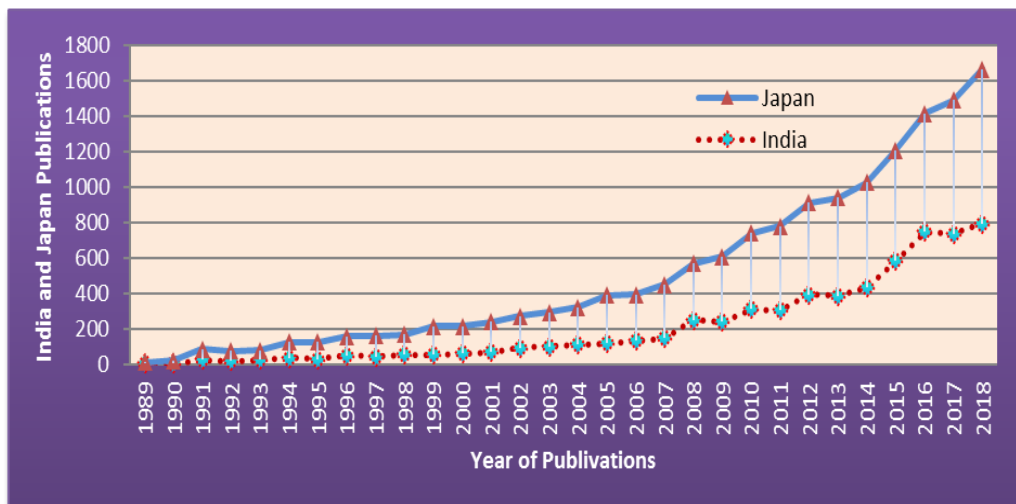
Fig1. *Publication productivity of Epidemiology literature research*

Ranked List of Journals in Epidemiology Literature

The ranked list of journals publishing Epidemiology literature by Indian Scholar is tabulated in the Table 2 The total 359 journal ranks were awarded, all these journals published as many as 6436 articles in epidemiology subject during 1989-2018. Among these journals, Indian Journal of Indian Journal of Medical Research tops the journal ranking list by publishing the highest number of articles 646 (10.03%), followed by Journal of Evolution of Medical and Dental Sciences Jemds 563

(8.74%) articles and Plos One occupied the third rank with 403 (6.26%). Indian Journal of Animal Sciences with 311 (4.83%) articles respectively took the fourth rank and Journal of Clinical and Diagnostic Research 196 (3.04%) the fifth rank, and so on.

The top five ranked journals in the ranked list contributed to nearly 59% of the total articles and the five journals contributed are not even 1% of the total number of journals. The research output of epidemiology by Indian scholars was not concentrated on a small set of nucleus or core journals. In other words, a large number of Indian

epidemiology research articles 2279 (35%) are scattered over across 539 (95%) a large number of journals. These journals are of multidisciplinary subjects in sciences and Animal sciences.

Table2. *Ranking of Journals Publishing Epidemiology Literature by India*

Sl.No	Ranking of Journals	TP	%	TC	%	ACPP	H-Index
1	Indian Journal Of Medical Research	646	10.03	4671	6.63	18.99	35
2	Journal Of Evolution Of Medical And Dental Sciences Jemds	563	8.74	06	0.00	0.04	1
3	Plos One	403	6.26	1844	2.62	16.32	24
4	Indian Journal Of Animal Sciences	311	4.83	274	0.38	2.47	8
5	Journal Of Clinical And Diagnostic Research	196	3.04	114	0.16	1.19	5
6	Indian Journal Of Medical Microbiology	183	2.84	697	0.99	8.40	16
7	Indian Pediatrics	172	2.67	553	0.78	7.68	13
8	Infection Genetics And Evolution	151	2.34	1063	1.51	15.63	22
9	Indian Journal Of Pediatrics	148	2.29	345	0.49	5.95	10
10	Indian Journal Of Cancer	54	0.83	413	0.58	7.65	11
11	Epidemiology And Infection	43	0.66	571	0.81	13.28	13
12	International Journal Of Scientific Study	43	0.66	5	0.00	0.12	1
13	Journal Of Gastroenterology And Hepatology	43	0.66	1691	2.40	39.33	23
14	Journal Of Clinical Microbiology	42	0.65	1596	2.26	38.00	26
15	Vaccine	42	0.65	699	0.99	16.64	15
16	National Medical Journal Of India	41	0.63	538	0.76	13.12	11
17	International Journal Of Infectious Diseases	39	0.60	358	0.50	9.18	11
18	American Journal Of Tropical Medicine And Hygiene	38	0.59	531	0.75	13.97	15
19	Current Science	38	0.59	305	0.43	8.03	10
20	Journal Of Medical Virology	38	0.59	739	1.05	19.45	16
21	Plos Neglected Tropical Diseases	38	0.59	743	1.05	19.55	17
22	Asian Pacific Journal Of Cancer Prevention	37	0.57	562	0.79	15.19	15
23	Transactions Of The Royal Society Of Tropical Medicine And Hygiene	35	0.54	730	1.03	20.86	15
24	Journal Of Medical Microbiology	34	0.52	526	0.74	15.47	15
25	American Journal Of Infection Control	33	0.51	670	0.95	20.30	10
26	Mycoses	33	0.51	598	0.84	18.12	14
27	International Journal Of Tuberculosis And Lung Disease	32	0.49	884	1.25	27.63	15
28	Indian Journal Of Pathology And Microbiology	30	0.46	231	0.32	7.70	10
29	Tropical Animal Health And Production	30	0.46	309	0.43	10.30	12
30	Diabetes Technology Therapeutics	29	0.45	444	0.63	15.31	12
31	Neurology India	29	0.45	310	0.44	10.69	10
32	European Respiratory Journal	27	0.41	250	0.35	9.26	3
33	Bulletin Of The World Health Organization	26	0.40	1690	2.40	65.00	19
34	Indian Journal Of Dermatology Venereology Leprology	26	0.40	301	0.42	11.58	9
35	Journal Of Tropical Pediatrics	26	0.40	238	0.33	9.15	9
36	85 Journals (Publication Within The Range Of 25-11)	458	7.11	19859	28.22	84.99	932
37	539 Journals (Publication Within The Range Of 10-1)	2279	35.41	25013	35.5	99.05	1073
	Total	**6436**		**70371**			

Table III lists the ranking of journals publishing epidemiology literature by Japan scholars. The total of 895 journals publishing 8770 various types of documents in epidemiology subject during 1989-2018. Among these journals Plos One tops the journal ranking list publishing 665 (7.58%) articles, followed by Journal of Medical Virology 544 (6.20%) articles and Journal of

Veterinary Medical Science occupied the third position with 432 (4.92%) articles. The Journal of Clinical Microbiology with 325 (3.70%) articles and Japanese Journal of Infectious Diseases with 218 (2.48%) articles with fourth and fifth rank respectively.

The analysis shows that the research work on epidemiology in Japan is scattered in various

journals and not concentrated on the few core or nucleus journals. We observe a similar trend among the scholar in publishing research output in epidemiology in India and Japan. The top ten ranked journals in the ranked list contributed to 44% of the total literature and the top-ranked ten journals contributed not even 1% of the total number of journals. The majority of the publications 2831 (33%) (Published in the range of 1-10 articles each) are scattered across large number 2904 (41%) of journals.

Table3. *Ranking of Journals Publishing Epidemiology Literature by Japan*

Sl. No	Journals	Total Publications	Percentage	Total Citations	Percentage	ACPP	H-Index
1	Plos One	665	7.58	1974	1.79	12.11	24
2	Journal of Medical Virology	544	6.20	3651	3.32	25.18	35
3	Journal of Veterinary Medical Science	432	4.92	1301	1.18	9.71	20
4	Journal of Clinical Microbiology	325	3.70	6511	5.93	51.67	44
5	Japanese Journal of Infectious Diseases	218	2.48	2487	2.26	20.90	25
6	Circulation Journal	194	1.33	2046	1.05	21.77	29
7	Circulation	192	1.23	4304	0.67	46.78	27
8	Microbiology And Immunology	188	1.16	1467	0.92	16.67	22
9	Journal of Gastroenterology And Hepatology	177	2.21	2697	1.86	35.03	28
10	Pediatrics International	171	2.18	1063	3.92	14.97	18
11	Journal of Gastroenterology	168	2.14	2231	1.33	32.33	26
12	Japanese Journal of Clinical Oncology	162	2.01	1465	2.45	23.63	24
13	Journal of Epidemiology	117	1.94	1153	0.96	9.77	18
14	Internal Medicine	108	1.91	746	2.03	6.72	14
15	Journal of Infection And Chemotherapy	102	1.84	1013	1.33	9.29	18
16	American Journal of Infection Control	60	0.68	395	0.35	6.17	11
17	Epidemiology And Infection	60	0.68	814	0.74	13.57	17
18	Hepatology Research	60	0.68	1234	1.12	20.23	17
19	Infection Genetics And Evolution	52	0.59	745	0.67	13.30	5
20	Stroke	51	0.58	3515	3.20	68.92	36
21	Archives Of Virology	50	0.57	1766	1.60	34.63	20
22	Hypertension Research	49	0.55	1016	0.92	19.92	20
23	Antimicrobial Agents And Chemotherapy	46	0.52	1232	1.012	25.67	20
24	European Respiratory Journal	46	0.52	1137	1.03	24.72	10
25	International Journal Of Cancer	43	0.49	1362	1.24	30.95	20
26	Journal of Medical Microbiology	43	0.49	680	0.61	15.11	15
27	World Journal of Gastroenterology	41	0.46	730	0.66	17.8	16
28	Atherosclerosis	40	0.45	699	0.63	17.48	14
29	Journal of Dermatology	40	0.45	353	0.32	8.40	11
30	Psychiatry And Clinical Neurosciences	40	0.45	807	0.73	20.18	16
31	Bmc Infectious Diseases	39	0.44	538	0.49	13.12	10
32	Vaccine	38	0.43	689	0.62	17.23	13
33	Clinical And Experimental Nephrology	36	0.41	309	0.28	8.58	10
34	International Journal of Urology	36	0.41	564	0.51	14.46	15
35	Scientific Reports	35	0.39	278	0.25	7.13	8
36	Tohoku Journal of Experimental Medicine	35	0.39	417	0.37	11.91	11
37	24 Journals (Publication Within	1981	22.58	16212	14.77	23.13	619

	The Range of 24-34)						
38	93 Journals (Publication Within The Range of 23-12)	2858	32.58	19011	17.32	25.01	901
39	742 Journals (Publication Within The Range of 11-1)	3931	44.82	21132	19.25	38.75	1236
	Total	**8770**		**109744**			

Bradford's Law of Scattering

Identifying the journals in a subject field is an important aspect of scientometric studies especially Bradford's law of scattering, has its application in the acquisition policy of journals in libraries and information centers.

Bradford law of scattering describes how the literature on a particular subject is scattered or distributed in various journals, and he formulated that, "if a scientific journal is 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. When the number of periodicals in the nucleus in the and succeeding zones will be as *1: n: n2''* where *n* is a multiplier (Bradford, 1934).

Bradford gave a graphical model for his law. The mathematical models were suggested later by Vickery (1948), Leimkuhler (1967), Brookes (1969a, 1969b), Wilkinson (1972), Egghe (1985, 1986, 1990a, 1990b), Basu (1992), RavichandraRao (1998). These scholars gave the mathematical models for the scattering of articles in journals are mentioned here (Sudhier, 2010).

Brooke's Model (1969)

$$F(x) = a + b \log x \qquad (1)$$

Where *F(x)* is the cumulative number of references contained in the first *x* most productive journals, and *a* and *b* are constants. This is the most widely used formulation of Bradford's Law.

Vickery (1948) extended the verbal formulation to show that it can be applied to any number of zones of equal yield.

Leimkulher's (1967) Model

$$R(r) = a \log(1 + br) \qquad (2)$$

Where R (r) is the cumulative number of articles contributed by journals ranked 1 through *r*, and *a* and *b* are parameters. Where *r = 1, 2, 3 ....*

F. Egghe's model (1985, 1986) Modifications for Calculating Bradford's Multiplier based on Leimkuhler's Model

$$k = (e^r X Y_m)^{1}/_p \qquad (3)$$

Where γ is Euler's number ($e^r = 1.781$), p = Number of zones i.e. 3. Y_m Number of items in the most productivity sources.

r_0 = Number of journals in the nucleus zone of Bradford is calculated as:

$$r_0 = \frac{T(k-1)}{(k^p - 1)} \qquad (4)$$

Where T= Total Number of Journals

Application of Bradford's Law

India

Table III presents details of the articles published by the Indian scholars in the field of Epidemiology. Furthermore, the frequency of journal articles arranged in decreasing order of the articles to test Bradford's law.

For testing of the verbal formulation of Bradford's law, the 359 journal titles were divided into three zones. The distribution of journals and a corresponding number of articles in the three zones along with the value of Bradford multiplier are shown in Table 4.

In the present dataset, the first 4 journals publishing 1923 articles, followed by 116 journals containing 2234 articles and next 239 journals containing 2279 articles. It can be noticed that the three zones are almost exactly the 1/3rd of the total articles as suggested by Bradford.

Table4. *Scattering of Journals and Articles over Bradford Zone*

Zone	Journals	Articles	Bradford Multiplier
1st	4	1923	-
2nd	116	2234	5.4
3rd	539	2279	2.6
Total	**659**	**6436**	**Avg. 4**

The identified zones arranged in the geometric series in the form of *1: n: n2* as given by Bradford. We found that the relationship of each zone in the present study is 4:16:64.

Here, 4 journals found in the nucleus zone and the mean value of Bradford's multiplier is n=4. Therefore, 4: (4 x 4): (4 x 4²):: 1 : n : n² 4: 16: 64

Since the percentage of error is negative here, the data fits well Bradford's law.

Application of Egghe's Model

Though the dataset fits into Bradford's model, to compare the Egghe's model i.e. modification of Leimkuhler 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 by using mathematical

formula (3), the obtained value of the Bradford's multiplier k is 5.51. The number of articles in each zone is yo = 641.33.

The = number of journals in the nucleus of Bradford is calculated using the equation (4) and hence

The No. of Journals in the nucleus zone is 4, similarly, the number of journals in the second the third zones are 35.27 and 619 respectively. Therefore, the distribution is written as:

4.05: (4.05X5.51): (4.05 x 5.51²) :: 1 : k : k2 i.e. 4.05:22.31:15.07

Table5. *Scattering of Journals and Articles Over Bradford Zone*

Zone	Journals	Articles	Bradford Multiplier
1st	4.05	2021	-
2nd	35.27	2144	6.5
3rd	619.58	2271	4.9
Total	**659**	**6436**	

From the above table, it's clear that the journals contributing articles to each zone increase by multiplier 5.5. Top 24 journals appeared in the nucleus zone contributed 2021 articles, followed by 4.05 approx. 35.27 journals in the second zone containing 2144 articles and 619.58 journals with 2271 articles in the third zone. Since the percentage of error is very negligible, Bradford's law fits very well in this data set.

Japan

The ranked list of journals and the corresponding frequency of articles published by Chinese scholars in the field of Epidemiology is shown in Table IV. For the verification of verbal formulation of Bradford's law, the 659 journal titles published 6436 articles were divided into three zones. The table VI provides the zone-wise journals and their corresponding articles along with the Bradford multiplier.

Table6. *Scattering of Journals and Articles Over Bradford Zone*

Zone	Journals	Articles	Bradford Multiplier
1st	6	2378	-
2nd	54	2713	6.4
3rd	835	3679	7.8
Total	**895**	**8770**	**Avg. 5.5**

In the present dataset, the top 6 journals publishing 2378 articles in the nucleus zone, followed by 54 journals containing 2713 articles second zone and 835journals containing 3679 articles in the third zone. The mean value of Bradford's multiplier is n=5.5. It can be noticed that the three zones are almost exactly the 1/3rd of the total articles as suggested by Bradford.

The identified zones arranged in the geometric series in the form of *1: n: n2* as given by Bradford. We found that the relationship of each zone in the present study is *6: 295.65: 1222.79*. Since the percentage of error is (-1.94) negligible here, the data fits well Bradford's law.

Application of Egghe's model

Here also, though the dataset fits into Bradford's model, to compare the scattering of journals in

the different zones, the Egghe's model i.e. modification of Leimkuhler is employed. Total articles were equal-divided into three zones (p=3) is yo = 641.33. . Then by using mathematical formula (3) and (4), the obtained value of the Bradford's multiplier and number of journals in the nucleus zone were $k = 4.9231$ and respectively.

The No. of Journals in the nucleus zone is 10.95, followed by, the number of journals in the second the third zones are 305.57 and 578.48 respectively. Therefore, the distribution is written as:

10.95: (10.95x 4.92): (10.95x 4.92²):: 1 : k : k²

i.e. 10.95:53.874: 107.748

Table7. *Scattering of Journals and Articles Over Bradford Zone*

Zone	Journals	Articles	Bradford Multiplier
1st	10.95	2936	-
2nd	305.57	2640	9.8213
3rd	578.48	3194	12.9102
Total	**895**	**8770**	

From the above table, it's clear that the journals contributing articles to each zone increase by multiplier 4. 9231. Top 11 journals appeared in the nucleus zone contributed 2936 articles, followed by 306 journals in the second zone containing 2640 articles and 578 journals with 3194 articles in the third zone. Since the percentage of error is very negligible, Bradford's law fits very well in this data set.

CONCLUSION

The journal distribution pattern of the Epidemiology literature published during 1991-2018 from India and Japan countries fit the Bradford distribution pattern. Similarly, when the Egghe's model applied for the same data set for the verification of Bradford's law and found that both the data sets fit Bradford's distribution pattern with the unequal number of articles in the three zones. The data also revealed that majority of the epidemiology research publications of both the countries scattered across various journals of multi-disciplinary nature mostly in sciences and animal sciences. In other words, both India and Japan Epidemiology publications not concentrated much in core or nucleus journals in Epidemiology.

REFERENCES

[1] Banateppanavar, Koteppa P., and Vindya, A.B. (2015). Bradford's zone to LIS publications published in collection building journal from 2009-2012: a citation study. Collection Building. 2015, 34(2), 65-74.

[2] Biradar, N., and Tadsad, P. G. (2015). Citation Analysis of PhD theses of economics submitted to Karnatak University, Dharwad (2009-2013). Journal of Library Development. 1(2), 1-19. ISBN.2395-518X.

[3] Brookes, B. C. (1969). Bradford's law and the bibliography of science, Nature 224(5223), 953-956 (1969). 6 Ref. 1969.

[4] Cano-Oron, Lorena. (2019). Dr. Google, what can you tell me about homeopathy? Comparative study of the top10 websites in the United States, United Kingdom, France, Mexico and Spain. El Profesional de la Información. mar/apr2019, 28(2), 1-12.

[5] Das, Priyambada., and Ramesh, D. B. (2019). Trends in Pharmaceutical Scholarly Communications from India, China and United States: A Comparative Study. DESIDOC Journal of Library & Information Technology. 39(5), 230-237.

[6] Gourikeremath, Gouri N. et.al. (2017). Application of Bradford's law of Scattering to the Literature of Microbiology in India. Library Philosophy & Practice. 1-18.

[7] Gourikeremath, Gouri N. et.al. (2017). Application of Bradford's law of Scattering to the Literature of Microbiology in India. Library Philosophy & Practice, 1-18.

[8] Gupta, D. (1991). Application of Bradford's Law to citation data of Ethiopian Medical Journal Annals of Library Science & Documentation. 38(3), 85-98.

[9] Ismayilov, Khalil., Ismayilov, Nadir., and Mammadova, Vafa. (2019). Library information services in academic libraries of Azerbaijan: a comparative study. Library Management. 40(6), 461-477.

[10] Kumar, Tunga, Santosh. (2013) Application of Bradford's Law of Scattering to The Horticulture Literature: A Citation Study of Doctoral Dissertations 1991-2010. SRELS Journal of Information Management. 50(3), 305-316.

[11] Kumar, Tunga. Santosh. (2013). Application of Bradford's Law of Scattering to The Horticulture Literature: A Citation Study of Doctoral Dissertations 1991-2010. SRELS Journal of Information Management. 50(3), 305-316.

[12] Lin, Sinn-Cheng., and Hong, Ming-Chen (2011). Application of Bradford's Law and Lotka's Law to Web Metrics Study on the Wiki Website. Journal of Educational Media & Library Sciences. Spring 2011, 48(3), 342-346.

[13] Lo, Patrick. Et. al. (2019). Librarians' perceptions of educational values of comic books: A comparative study between Hong Kong, Taiwan, Japan, Australia and New Zealand. Journal of Librarianship & Information Science. 51(4), 1103-1119.

[14] Mizoguchi, Hirokuni. and Kano, Shingo. (2019). Comparative analysis of correlations of research and development indicators for rare diseases among Japan, the US, and Europe. Scientometrics. 120(2), 361-374.

[15] Ram, S., and Paliwal, Nitin. (2014). Assessment of Bradford Law's of Scattering to Psoriasis

Literature through Bibliometric Snapshot. DESIDOC Journal of Library & Information Technology. 34(1), 46-56.

[16] Ram, S., and Paliwal, Nitin. (2014). Assessment of Bradford Law's of Scattering to Psoriasis Literature through Bibliometric Snapshot. DESIDOC Journal of Library & Information Technology. 34(1), 46-56.

[17] Singh, K. P., and Bebi. (2014). Application of Bradford's Law on journal citations: A study of Ph.D. theses in social sciences of University of Delhi. Annals of Library & Information Studies. 61(2), 112-120.

[18] Sudhier, K.G. (2010). Application of Bradford's Law of Scattering to the Physics Literature: A Study of Doctoral Theses Citations at the Indian Institute of Science. DESIDOC Journal of Library & Information Technology. 30(2), 3-14.

[19] Vazquez, Merce. (2019). scientific output in library and information science: A comparative study of the journals Anales de Documentacion and BiD textos universitaris en biblioteconomiai documentacio. Journal of Librarianship & Information Science. 51(2), 440-457.