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Dengue Research: Three Dimensional Bibliometric Study of the Global Research Output During 1989-2015

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ABSTRACT

Dengue fever is undoubtedly one of the most rapidly spread mosquito borne re-emerging infection that poses significant threat to about half of the world's population. People working in this field have taken dengue seriously it is reflected from the continuous increasing number of publications during 1989-2015. This study is an attempt to make a 3D bibliometric portfolio of research on dengue. This 3D bibliometric analysis portray the dengue research through various measures quality, quantity, consistency and two secondary indicators h index and z index. The data retrieved from the Web of Science. Number of publications increases 70 folds in given time span during 1989-2015. Vietnam has the highest impact (quality) while India has the lowest impact among the leading countries. Taiwan has a higher variability 0.41 (consistency η), whereas Germany has a lower consistency. Walter Reed Army Institute of Research WRAIR of USA has the highest impact (quality) while Universidade DE Sao Paulo of Brazil has the lowest impact among the organisations in the list. University of Texas Medical Branch Galveston (USA) has a highest consistency 0.33, whereas University of Massachusetts System (USA) has a lowest consistency (0.03).

Keywords: Bibliometrics, three dimensional evaluation, indicators, consistency, citation, dengue

1. INTRODUCTION

The incidence of dengue has grown dramatically around the world in recent decade. The actual numbers of dengue cases are underreported and many cases are mis-classified. One recent estimate indicates 390 million dengue infections per year (95% credible interval 284–528 million), of which 96 million (67–136 million) manifest clinically (with any severity of disease). Another study, of the prevalence of dengue, estimates that 3.9 billion people, in 128 countries, are at risk of infection with dengue viruses.[1-3] Most cases occur in tropical areas of the world, with the greatest risk occurring in the Indian subcontinent, Southeast Asia, Southern China, Taiwan, The Pacific Islands, The Caribbean (except Cuba and the Cayman Islands), Mexico, Africa, Central and South Africa (except Chile, Paraguay, and Argentina).

Recently Garg[4], *et al*. analyse 2074 papers published on different aspects of Japanese Encephelitis (JE) during 1991 to 2010 and indexed by *Science Citation Index*-Expanded.Various studies have also been done on evaluation of research performance on dengue fever. Kavitha and Kavitha[5] studied the International research output on dengue during 2003-2012 by using *PUBMED* database and discuss authorship pattern and degree of collaboration. Zyoud[6] studied the publications on dengue research for worldwide and for Arab, data for this study was taken from SCOPUS database for the period 1872-2015. Bharadwaj[7] did scientometric assessment on dengue research for the period 2001 to 2012 and data for this study was taken from Scopus database. Ho[8], *et al*. examined the relationship between the burden of dengue and scientific publications and quoted that there was little information on the bibliometric trend and patterns of dengue research globally by using SCI- Expanded database for the period 1991-2014.

Dutt[9], *et al*. studied global dengue research between 1987 and 2008. Data downloaded for this study from web of science. 80% of the papers were published by scientists based (in decreasing rank order) in the United States, the United Kingdom, the Netherlands, France, and Germany.

Earlier, Prathap[10-11] had used simple heuristic model using 2D quantity (productivity in terms of number of publications) and quality (the citation per paper). Further he extended his work to 3D model by adding third dimension called consistency (η). This 3D evaluation tools enhance the information production process[12]. Number of papers (P) denotes quantity and citation per paper (C/P) denotes quality (or impact i) where, C is the citation that received by papers (P). The new third dimension, consistency (η) describes the variability in the quality of the individual papers in the publication set or the shape of the distribution curve. The accurate calculation of consistency (η) requires the complete citation sequence, (i.e., the distribution curve) for country, organisation, author or journal. Leydesdorff and Shin[13] for the first time applied the new method for the fractional attribution of citations to the study of a grouping such as universities as institutional units of analysis. They harvested publication data (2005-2007) and citation data (2009) for seven Korean research universities from the *Science Citation Index-Expanded*, the *Social Science*

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Citation Index (*SSCI*), and the *Arts & Humanities Citation Index* (*A&HCI*) combined at web-interface of the *ISI-Web of Science* (*WoS*).

By using all the three components quantity, quality and consistency, Prathap[12] calculated a z-index with the help of composite indicator named Zynergy.

$Z= \eta X= \eta^2 E$ as $z=Z^{1/3}$

X= Exergy

E= Energy

This approach based on 'thermodynamic' considerations that can quantify research performance using an exergy term defined as X = iC, where i is the impact and C is the number of citations, where fractionalised counting of citations is used instead of integer counting and Energy defined as $E=\Sigma C_j^2$.

This study is an attempt which shows 3-D evaluation of dengue research output published in scholarly journal listed by Web of Science database for the period 1989 to 2015. Web of science provide facility to refine the research output on various scales like publications year, countries, organisations, authors and journals (source titles) etc. In this study author examined the leading countries, leading organisations, leading authors, leading subfield, leading journals of dengue research by following 3D evaluations tools (Quality, Quantity and Consistency).

2. QUALITY, QUANTITY AND CONSISTENCY INDICATORS

In this performance evaluation age it is topic of debate that which indicators show performance precisely of scientific output of an individual or an entity. The journal impact factor is now symbolised as a proxy or indirect measure of the quality or scholarly influence of a journal. Scientific performance of individual or an entity can be measured by using different parameters.

2.1. Quantity

Number of papers/articles 'P' published during a prescribed window will be called publication window (for this study the window is from 1989 to 2015).

2.2. Quality

Quality denotes citation per paper, calculated as C/P where C is the number of citations during a prescribed citation window. The quality measurement needed two separate windows, the publication window and the citation window.

In 3D evaluation of performance measurement after computing quantity P and quality í parameters, it is possible to derive other indicators by following these sequences.

$P= í^0P$ (Zeroth indicator)

$C= í^1P$ (First order indicator)

$X= í^2P = í^1C = í$ (Second order indicator)

$C = \Sigma c_j, \quad j = 1 \text{ to } P$

C is derived from complete citation sequence, c_j of the citation of each paper in a publication portfolio of P papers as the total number of citations, $C=\sum c_j$, for j=1 to P. Both P and C serve as indicators of performance in their respective ways. As C=íP may be assumed as the first order indicator for performance. Pratap mentioned the exergy indicator $X=í^2P$, is energy like quantity which explained as second order indicator of performance. This model leads to trinity of energy- like terms.[12,14]

$X = í^2P$, $E = \Sigma c_j^2$, $S = \Sigma (c_j - í)^2 = E-X$.

Wheres

$P= \Sigma p_j$, $C= \Sigma c_j$, $í=C/P$

The h-index is observed by ordering the citation in a decreasing sequence[15]. Highly cited papers are seen to be concentrated in a small region, possibility of huge variation in the quality of papers in the publication set. Accordings to Prathap[10], in case of high skews, the product $X=iC=i^2P$, which is a second-order indicator is a better proxy for performance than C itself. Apart from X, an additional indicator E also appears as a second-order indicator as seen above. The existence of both proxies X and E allows to introduce third proxy named as consistency (variability) η=X/E. When X=E, i.e., η=1, the condition indicates for the perfect consistency means uniform performance (all papers have the same number of citations, c_j=c). The inverse of consistency gives the concentration of best work in few papers of extraordinary impact. Thus, for a complete 3-D evaluation of publication activity, one needs P, i, and η. These are the three primary components of a quantity-quality-consistency landscape.

3. METHODOLOGY

Scientific output on the Dengue fever searched on *Web of Science* (a Thomson Reuters Product). Data extracted on topic=(Dengue fever) for the period 1989-2015 covering Science Citation index –Expanded, Social Science Citation Index, Art and Humanities Index in this study. Data downloaded in Excel sheets according to various parameters needed for study. From all the related articles P and Citation C are computed for this study. Then all the indicators quality, quantity, consistency for leading countries, leading institution, leading authors, leading journal are counted on excel sheets.

By using all the three indicators together, z index can be calculated from an energy like term ($Z=\eta X= \eta^2 E$). This z index is the combination of quantity, quality and consistency (or efficiency), provide truly 3D evaluation of scholarly publications. It may be assumed P, í and η as primary indicators and h and z index are secondary, composite indicators.

4. RESULTS AND DISCUSSIONS

A total of 7411 records are retrieved. These records included all types of documents like articles, article proceedings, letter, review, note, book review, corrections,

editorial materials, discussions, meeting abstract, news items, reprints, review, books and books article. The total 6886 records covering articles, article proceedings, letter, and reviews are taken in this assessment. The strategy was extended with refine selection for various particular countries, author, journal, organisations.

4.1. Growth

Figure 1 clearly indicates the rising trend of dengue research as the need of time. Dengue research with 10 publications in 1989 gradually increases and becomes 796 publications in 2015. It is observed that paper published during the period 1989-1998 was less than 100 every year. Table 1 shows the variation of the world's publications and citations with publication year. Table 1 shows maximum 501 papers published in 2011 interminted. The list with the year 2011, as articles, articles proceedings, reviews, letter and notes of more recent origin would not have had enough time to collect a reasonable number of citations. A five-year citation window is considered to be reasonable from this point of view.

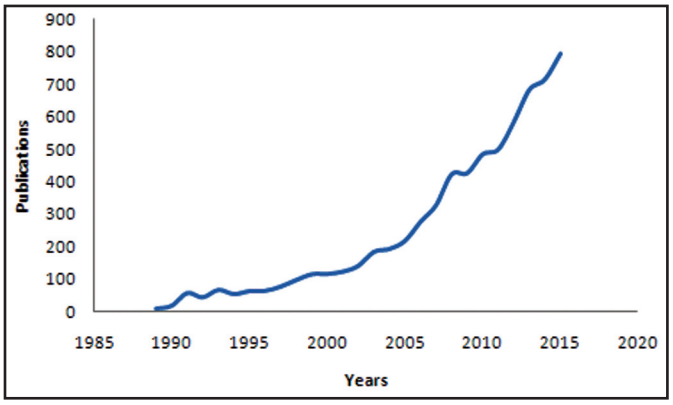

Figure 1. Yearly growth of publications on dengue fever.

4.2. Leading Countries

Table 2 shows the leading countries publishing maximum papers on dengue research. USA has maximum papers and received maximum citations among the listed countries. The table shows that the Vietnam has the highest impact (quality) while India has the lowest impact among the countries in the list. It also indicates that Taiwan has a higher variability 0.41 (consistency η), whereas Germany has a lower consistency. In terms of h-index and z-index USA has a highest rank, whereas P R China has lowest rank in the listed countries. Fig. 2. summaries the performance of these countries in h-z map. it also shows a very good correlation between z- and h-index.

4.3. Prolific Institutions

Table 3 shows the leading organisations publishing maximum papers on dengue research. United States Department of Defense (USA) has maximum papers and received maximum citations among the listed organisations. The also shows that the Walter Reed Army Institute

Table 1. Yearly world's publications and number of citation in dengue research

Year	P	C
1989	10	77
1990	19	62
1991	58	685
1992	45	349
1993	68	466
1994	55	368
1995	64	489
1996	65	407
1997	78	871
1998	98	1140
1999	116	1395
2000	117	1363
2001	124	1754
2002	142	2330
2003	185	2706
2004	194	2845
2005	219	3719
2006	278	4373
2007	329	5991
2008	424	6526
2009	428	6461
2010	486	8452
2011	501	8671

Table 2. Values of three primary bibliometric components and the h- and z- indices for leading countries which have published on dengue fever

Countries	P	C	i	η	h	z
USA	2172	90218	41.54	0.24	134	96.41
Brazil	798	13905	17.42	0.18	52	35.40
India	622	6854	11.02	0.30	38	28.22
Thailand	571	20148	35.29	0.23	74	54.69
France	526	16121	30.65	0.27	65	51.15
UK	542	19898	36.71	0.20	75	52.85
Singapore	334	10074	30.16	0.13	49	33.95
Australia	333	11800	35.44	0.26	56	47.53
Taiwan	299	8308	27.79	0.41	51	45.44
Germany	246	7936	32.26	0.10	41	29.70
Japan	243	4281	17.62	0.40	35	31.05
P R China	236	3283	13.91	0.28	29	23.29
Malaysia	215	3589	16.69	0.24	33	24.39
Mexico	178	3930	22.08	0.19	35	25.53
Vietnam	169	7728	45.73	0.15	49	37.29

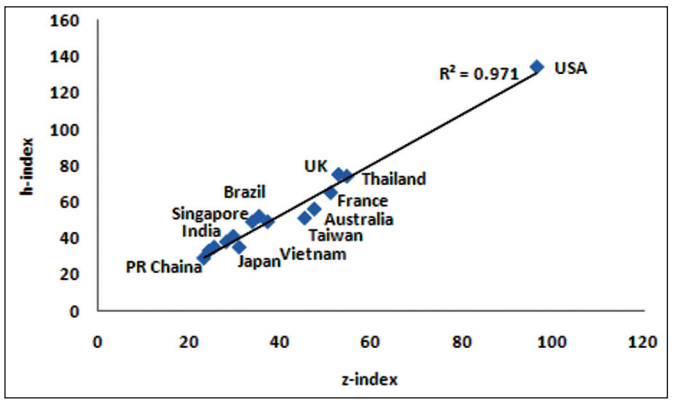

Figure 2. A 2-D z-h map of leading countries of world in dengue research.

of Research WRAIR of USA has the highest impact (quality) while Universidade DE Sao Paulo of Brazil has the lowest impact among the organisations in the list. University of Texas Medical Branch Galveston (USA) has a highest consistency 0.33, whereas University of Massachusetts System (USA) has a lowest consistency (0.03). The less difference between highest and lowest consistency indicates that there are few papers having good impact. However, University of Massachusetts System (USA) has some best work in few papers of extraordinary impact. In terms of h-index and z-index United States Department of Defense (USA) has a highest rank, whereas University of Malaya, Malaysia has lowest rank in the listed countries.

Table 3. Values of three primary bibliometric components and the h- and z- indices for leading institutes which have publications on dengue fever

Organisations	P	C	i	ɳ	h	z
United States Department of Defence, USA	304	15913	52.35	0.31	68	63.64
Mahidol University, Thailand	288	9792	34	0.26	55	43.96
Fundacao Oswaldo Cruz, Brazil	271	6157	22.72	0.21	41	30.63
Centres for Disease Control and Prevention, USA	252	13537	53.72	0.18	59	51
Le Reseau International Des Institutes Pasteur RIIP, France	231	9811	42.47	0.24	53	46.66
University of Oxford, England	200	11599	58	0.21	60	52
University of California System, USA	194	11288	58.19	0.20	53	51.07
National University of Singapore, Singapore	184	5762	31.32	0.09	36	25.21
Universidade DE Sao Paulo, Brazil	165	2827	17.13	0.13	27	18.47
Armed Forces Research Institute of Medical Sciences, Thailand	158	8949	56.64	0.30	52	53.31
National Institute of Health, USA	154	8763	56.90	0.20	49	46.18
University of Texas Medical Branch Galveston, USA	136	4564	33.56	0.33	38	37.10
University of Massachusetts System, USA	135	8995	66.63	0.03	52	26.80
Walter Reed Army Institute of Research WRAIR, USA	130	8693	66.87	0.31	51	56.25
University of Malaya, Malaysia	125	2233	17.86	0.23	24	20.82

Table 4. Values of three primary bibliometric components and the h- and z- indices for leading authors who have published on dengue fever

Author	P	C	i	ɳ	h	z
Guzman MG, Pedro Kouri Tropical Research Institution, Havana, Cuba	90	4520	50.22	0.24	35	37.86
Nisalak A, Armed Forces Research Institute of Medical Sciences, Thailand	84	6963	82.89	0.36	46	59.16
Rothman AL, The University of Rhode Island, USA	81	5906	72.91	0.34	42	52.46
Horris E, University of California, Berkeley	72	3857	53.57	0.46	36	45.66
Kurane I, National Institute of Infectious Disease, Japan	67	2420	36.12	0.43	30	33.61
Gubler DJ, Duke-NUS Graduate Medical School, Singapore	64	7102	110.97	0.24	37	57.77
Vaughn DW, Walter Reed Army Institute of Research, USA	62	6616	106.71	0.44	46	67.89
Kalayanarooj S, Queen Sirkit National Institute of Child Health, Thailnad	60	4604	76.73	0.31	38	48.03
Ennis FA, University of Massachussets, USA	57	5492	96.35	0.41	41	59.88
Nogueira RMR, Fiocruz Mato Grosso do Sul, Brazil	55	1733	31.51	0.26	23	24.23
Simmons CP, University of Oxford, England	52	3685	70.87	0.14	33	33.26
Halstead SB, Uniformed Services University of the Health Sciences, USA	50	3825	76.5	0.27	32	43.01
Endy TP, SUNY Upstate Medical University of Newyork, USA	50	4110	82.2	0.32	31	47.57
Lin YS, National Cheng Kung University, Taiwan	50	2091	41.82	0.53	26	35.91
Gibbons RV, Armed Forces Research Institute of Medical Sciences, Thailand	50	1687	33.74	0.31	24	26.13

4.4. Prolific Authors

Table 4 shows the list of leading authors working in the field of vital disease dengue. M.G. Guzman topped the list with 90 papers whereas, A. Nisalak received maximum citation in all. D.W. Gubler came in light whose work had highest impact. List clearly indicates Y.S. Lin was the most consistent performer. The secondary indicators h and z index were noticed maximum for A. Nisalak, D.W. Vaughn (h-index 46 each) and D.W. Vaughn (z index 67.89).

4.5. Sub-Disciplines

Dengue research are enormously scattered in various subdisplines. Table 5 indicates top leading subfields with their no of publications, citations, all the three indicators quantity, quality, consistency with h index and z index. It shows that as obvious infectious disease (1380) is on the first rank followed by tropical medicine (1338) and Virology (1185), whereas impact wise distribution of this table gives the first rank to virology. Subfield Biotechnology and Applied Microbiology shows maximum consistency in given list. Virology has maximum h and z-index.

4.6. Preferred Journals

Table 6 indicates list of leading journal that preferred by author to publish result on dengue research. Out of fifteen journals, seven were published from USA, 4

Table 5. Values of three primary bibliometric components and the h- and z- indices for leading subfields having publications on dengue fever

Subfields	P	C	i	η	h	z
Infectious disease	1380	32000	23.19	0.22	76	54.74
Tropical medicine	1338	28693	21.44	0.34	75	59.18
Virology	1185	44945	37.93	0.37	105	85.94
Public environmental and occupational health	1163	26405	22.70	0.30	75	56.51
Immunology	845	28900	34.20	0.31	80	67.51
Parasitology	678	12408	18.30	0.35	55	42.86
Microbiology	525	23351	44.48	0.21	76	60.56
General internal medicine	448	10070	22.48	0.11	46	29.46
Science technology other topics	381	12114	31.80	0.12	50	36.25
Biochemistry molecular biology	370	12734	34.42	0.23	57	46.37
Biotechnology applied microbiology	308	6735	21.87	0.43	43	39.92
Research experimental medicine	283	8761	30.96	0.17	47	35.84
Entomology	259	6297	24.31	0.25	42	33.67
Pharmacology pharmacy	216	5947	27.53	0.30	44	36.60
Pediatrics	162		11.31	0.30	24	18.31

Table 6. Values of three primary bibliometric components and the h- and z- indices for leading journals which preferred more by authors to publish results on dengue fever

Journals	P	C	i	η	h	z
American Journal of Tropical Medicine and Hygiene, USA	392	14011	35.74	0.41	66	58.98
Plos Neglected Tropical Disease, USA	304	5870	19.31	0.44	39	36.90
Plos One, USA	235	2987	12.71	0.29	28	22.33
Journal of Virology, USA	234	15386	65.75	0.55	76	82.07
Virology, USA	127	7422	58.44	0.41	50	56.22
Emerging Infectious Disease, USA	114	4800	42.11	0.40	42	43.18
Vaccine, Netherlands	106	3494	32.96	0.51	36	38.94
Journal of General Virology, UK	104	3331	32.03	0.59	34	39.82
Transactions of the Royal Society of Tropical Medicine and Hygiene, UK	100	2136	21.36	0.47	28	27.80
Journal of Infectious Diseases, UK	89	5896	66.25	0.30	41	49.01
Journal of Medical Virology, USA	86	2747	31.94	0.53	32	36.04
Tropical Medicine International Health, UK	84	1966	23.64	0.52	25	28.95
Memorias Do Instituto Oswaldo Cruz, Brazil	79	1467	18.57	0.38	22	21.76
Journal of virological Method, Netherlands	77	1634	21.22	0.42	25	24.36
Journal of Clinical Virology, Netherlands	75	1428	19.04	0.39	24	22.05

from UK, 3 from Netherlands and one published from Brazil. *American Journal of Tropical Medicine* and *Hygiene*, scores highest publications (392) on dengue followed by *PLOS Neglected Tropical Disease* (304) and *PLOS One* (235). *Journal of Virology* had published 234 publications received highest citation (15386) in this list. *Journal of Infectious Diseases* has highest impact whereas higher consistency has shown by *Journal of General Virology*. In terms of hand z-index *Journal of Virology* has highest rank.

5. CONCLUSIONS

To the best of the author's knowledge, this kind of 3-D bibliometric profiling has never had been tried before on dengue fever. This three dimensional strategy divided the scholarly outcomes into three components-quality, quantity and consistency. With the help of these three indicators and two additional secondary indicators, the h-index and z-index, identify the leading countries, leading organisations, leading authors, leading subfields and leading journals in the area of dengue research. Number of publications increases 70 folds in given time span during 1989-2015. Vietnam has the highest impact (quality) while India has the lowest impact among the leading countries. Taiwan has a higher variability 0.41 (consistency η), whereas Germany has a lower consistency. Walter Reed Army Institute of Research WRAIR of USA has the highest impact (quality) while Universidade DE Sao Paulo of Brazil has the lowest impact among the organisations in the list. University of Texas Medical Branch Galveston (USA) has a highest consistency 0.33, whereas University of Massachusetts System (USA) has a lowest consistency (0.03).

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