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Scientometric Study on Immunology at National Level Through Web Of Science Database

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Abstract

This study reveals that research productivity of Immunology in India during the year 1993-2017 (25 years). The Web of Science (WoS) database was used in the data reclamation. The explore term used was “Immunology” and considered as a vital keyword of the topic discussed. Source and highly cited articles based on data obtained on Immunology beginning Web of Knowledge. It is found that the Country is India together contributed 397 articles during 1993-2017. The study mainly focused that year wise, Language wise publications, Document type publications, Authorship pattern, Subramaniam’s degree of collaboration and H- index score for highly productive authors, Source wise distributions, Keywords wise distributions, Applicability of Zipf’s law method, Page wise and Subject wise Publications was tested. This downloaded, transferred to Bibexcel, VoS viewer, and MS-Excel files for further scrutiny.

Keywords: Scientometric, Immunology, VoS viewer, Zipf law, Bibexcel tool, Co-Authorship Index, H-Index

1. Introduction

Immunity, or resistance, is a state in which a person, either naturally or by some acquired mechanism, is protected from contracting certain disease or infections. In the 15th century, cured attempts were made by the Chinese and the Turks to induce immunity. The report suggests that dried crusts derived from smallpox pustules were inhaled or inserted into the cuts in the skin. The ability to resist disease may be innate (nonspecific), or it may be acquired (specific) when the disease state is emulated in the host. Immunological processes underlying the reaction of the body to infectious agents, to tumors, to transplanted tissues and organs have been well understood and great advances have been made in the immunological techniques.

The antibodies power has a decisive role in immunity and this actuality was reinforced by Jules Border who discovered flattering remark in 1899. The stimulation of a antibodies to a particular

pathogen is known as adoptive or acquired immune response, because it is required during the life time of an individual as an adoptive response to a specific pathogen.

2. Review of Literature

Gupta, Kaur & Bala (2011) analyze the research output in diabetes during 1999-2008 on numerous parameters, as well as its growth, rank and global publications share, citation impact, the overall share of international collaborative papers, and share of major collaborative partners. They also analyze the individuality of most productive institutions, authors, and highly-cited papers. The publications output, impact and collaborative publication share of India are also compared with that of China, South Korea, and Brazil.

Vanitha A et.al (2017) this research concentrated on earthworm analysis. The records are collected from the web of science database for the period of 2007-2016. The total number of publications collected for this study was 3939. In the authorship productivity, the highest number of articles was developed by a three authors 771. The highest number of publications that is 491 was produced in the year 2016. The application Zipf law in the earthworm search, the “Soil” is a keyword used frequency of 526 times. The vermin composting used soil has a lot of nutrition than in a normal soil. And compare to the harmful pesticides, the earthworm vermin composting gives the natural breath to the soil and crops.

3. Objectives of the study

- ✓ To study the Indian research output and Relative Growth Rate of Immunology research
- ✓ To analyze the Language wise publications
- ✓ To find out the Document type publications
- ✓ To determine the Authorship pattern, Degree of Collaborations
- ✓ To investigate H- Index score for highly productive authors
- ✓ To identify the most productive Journals and Keywords wise publications
- ✓ To study the broad Subject areas and Page wise publications
- ✓ To examine the Collaborative Country wise publications
- ✓ To find out the Abstract wise distributions of immunology publications

4. Methodology

The data for this study was downloaded from the Web of Science database for the keyword “immunology”. This may be considered as central keywords of the topic discussed. Therefore, the maximum retrieves may be expected by using this term. A total 397 of unique records spanning over the year 1993-2017 has been downloaded and saved. The downloaded data have been analyzed with Bibexcel, VoS viewer and MS-Excel files for further analysis.

5. Data analysis and interpretation

Table 5.1 - Year of publications

Research output on Immunology in India during the period 1993-2017 (25 years), inclusive of both years extracted from Web of Science database. The World level output of the immunology research was 34259, out of world output only Indian publications (397) were selected. Out of 397 articles, it is seen that the largest number of an article published in the year 2016 with 49 research articles (ACPP 1.69), however 35 (23.71ACPP) and 35 (21ACPP). The lowest number of article published in the year 1993 and 1994 records were 2 and the total citation was 38 (19ACPP) in the year of, total citation was 51 (25.5ACPP) in the year of 1994 respectively.

S. No	Publication period	TP	%	TC	ACPP
1	1993	2	0.50	38	19
2	1994	2	0.50	51	25.5
3	1995	4	1.00	29	7.25
4	1996	4	1.00	47	11.75
5	1997	7	1.76	125	17.85
6	1998	5	1.25	11	2.2
7	1999	6	1.51	228	38
8	2000	5	1.25	103	20.6
9	2001	3	0.75	14	4.67
10	2002	12	3.02	120	10
11	2003	6	1.51	176	29.33
12	2004	6	1.51	222	37
13	2005	5	1.25	146	29.2
14	2006	6	1.51	118	19.67
15	2007	18	4.53	297	16.5
16	2008	13	3.27	239	18.38
17	2009	24	6.04	707	29.45
18	2010	32	8.06	823	25.71
19	2011	35	8.81	810	23.14
20	2012	35	8.81	735	21
21	2013	33	8.31	520	15.76
22	2014	28	7.05	701	25.03
23	2015	29	7.30	110	3.79
24	2016	49	12.34	83	1.69

25	2017	28	7.05	9	0.32
	Total	397	100	6462	452.79

Table 5.2 - Relative Growth Rate and Doubling Time

This table shows that Relative Growth Rate of total output and also the Doubling Time for publications. It is observed that the Relative Growth Rate for all sources of output has decreased from the first Five years of 1993-1997 (0.45) last Five years 2012-2017 (0.11) respectively. The mean doubling time for the period first five years 1993-1997 (1.04), and last five years 2012-2017 (6.73) respectively. The whole study period has witnessed a a doubling time for total contribution at 22.6. In general in the Relative Growth Rate of publication output has shown a decline trend, Where as a Mean Doubling time for publication has shown increasing trend.

S. No	No. of Articles	Cumulative Articles	Log (W1)	Log (W2)	R (a) (W2-W1)	Mean (a)	Doubling Time Dt (a)	Mean Doubling Time
1993	2	2	-	0.69	-	0.45	-	1.04
1994	2	4	0.69	1.38	0.69		1.00	
1995	4	8	1.38	2.07	0.69		1.00	
1996	4	12	2.07	2.48	0.41		1.69	
1997	7	19	2.48	2.94	0.46		1.50	
1998	5	24	2.94	3.17	0.23	0.194	3.01	4.36
1999	6	30	3.17	3.40	0.23		3.01	
2000	5	35	3.40	3.55	0.15		4.62	
2001	3	38	3.55	3.63	0.08		8.67	
2002	12	50	3.63	3.91	0.28		2.48	
2003	6	56	3.91	4.02	0.11	0.12	6.3	6.55
2004	6	62	4.02	4.12	0.1		6.93	
2005	5	67	4.12	4.20	0.08		8.67	

2006	6	73	4.20	4.29	0.09		7.7	
2007	18	91	4.29	4.51	0.22		3.15	
2008	13	104	4.51	4.64	0.13	0.18	5.33	3.92
2009	24	128	4.64	4.85	0.21		3.3	
2010	32	160	4.85	5.07	0.22		3.15	
2011	35	195	5.07	5.27	0.2		3.47	
2012	35	230	5.27	5.43	0.16		4.33	
2013	33	263	5.43	5.57	0.14	0.11	4.95	6.73
2014	28	291	5.57	5.67	0.1		6.93	
2015	29	320	5.67	5.77	0.1		6.93	
2016	49	369	5.77	5.91	0.14		4.95	
2017	28	397	5.91	5.98	0.07		9.9	
Total	397					1.054		22.6

Relative Growth Rate (RGR) is the measure to analyze the increase in terms of number of literature output of a particular period of time whereas Doubling Time (DT) is the period of the required for a quantity to double in size of value.

Table 5.3 - Language wise publications

It is forever helpful for the canvasser and the in sequence, scientists to know the language(s) in which objects of their area of specialty is available. The majority of the articles were published in English 396 (99.75%). The succeeding grade taken by Polish was 1 (0.25%) only.

Name of the Language	TP	TC
English	396	6462
Polish	1	0
Total	397	100
TP = Total Papers; TC = Total Citation		

Table 5.4- Document type wise distributions

The analysis of the “Immunology” is published in 10 types of document. Out of 397 references, 285 (71.78%) are from Articles, followed by Review with 71 (17.88%), Editorial Material 22 (5.54%) and so on. The remaining was produced below 10 publications.

S. No	Name of the document	TP	%	TC	ACPP	H – Index
1	Article	285	71.78	4489	15.75	34
2	Review	71	17.88	1714	24.14	20
3	Editorial Material	22	5.54	198	9	5
4	Article; Proceedings Paper	9	2.26	58	6.44	3
5	Meeting Abstract	4	1.00	3	0.75	1
6	Letter	2	0.50	0	0	0
7	Reprint	1	0.25	0	0	0
8	News Item	1	0.25	0	0	0
9	Biographical-Item	1	0.25	0	0	0
10	Editorial Material; Book Chapter	1	0.25	0	0	0
Total		397	100			
TP = Total Paper; TC = Total Citation; ACPP = Average Citation Per paper						

Table 5.6 - Authorship pattern

Table 4 depicts that the authorship pattern of assistance by a more than seven authors 69 (17.38%). The contributions of three authors is 64 (16.12%), Five authors 56 (14.12%) and Two authors contributions is 52 (13.09%). The authorship pattern reveals a remarkable different between the number of single and multi authors. The study opined that team research is favored in Immunology research in Web of Science database.

S. No	No. of. Authors	Records	Cumulative Records	%	Cumulative %
1	Single Author	31	-	7.80	-
2	Two Authors	52	83	13.09	20.89
3	Three Authors	64	147	16.12	37.01
4	Four Authors	49	196	12.34	49.35
5	Five Authors	56	252	14.12	63.47
6	Six Authors	40	292	10.07	73.54
7	Seven Authors	36	328	9.06	82.6
8	> Seven Authors	69	397	17.38	100

Total	397		100	
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Table 5.7 - Degree of Collaboration

The year –wise degree of collaboration of authors is shown in Table 5. The extent of the degree of collaboration in Immunology research has been measured with the help of the formula devised by K. Subramaniam. Thos formula has been adopted to examine the extent of research collaboration in the study.

S. No	Authorship Pattern	Records	%
1	Single Author	31	7.80
2	Multi Authors	366	92.19
Total		397	100

The formula where; $DC = \frac{Nm}{Nm+Ns}$

DC = Degree of Collaboration Nm = Number of Multi Authors Ns = Number of Single Author

$$= \frac{366}{366+31} = \frac{366}{397} = 0.92$$

Table 5.8 H – Index score for Highly Productive authors (Top 10)

S. No	h-index	Author	Citation sum within h-core	All citations	All articles
1	7	Saha B	368	372	8
2	6	Singh S	118	143	16
3	6	Gupta S	121	126	9
4	5	Raghava GPS	308	308	5
5	4	Mishra GC	85	85	4
6	4	Bal V	37	37	4
7	4	Aggarwal A	94	95	6
8	4	Misra R	94	94	5
9	4	Bayry J	169	169	4
10	4	George A	37	37	4

Bibexcel tool used to identify h-index of authors. 1000 authors Research Productivity on Immunology in India during the year 1993-2017. The research output is 397. With the author field, the .doc file is created. The total number of times the articles are cited is identified with the command ‘tc’ and jn1 file

is created. Select .jnl file, type 2/3 'The Box' and run Edit out files / Select columns. The result is .col file. The command, 'Run Analyze / h-index' produced the outcome i.e. hdx file. This can be opened in excel format. Below table 10 shows that Saha, B published 8 articles, with the h-index of 7. The researcher received 368 citations of 7 articles. But his total citation for his 8 publication is 372. The highly prolific 10 scientist's h-index, citation counts, citation total sum of h-index are shown in table 10.

Table 5.9 - Source wise distribution (Top 20)

The source wise publications in the Immunology research during the year of 1993-2017. The most of the papers were published in the Journal of Immunology 57 (14.35%), and followed by the Journal of Immunology and Cell Biology 7 (1.76%).

S. NO	Name of the Source	Records	%
1	JOURNAL OF IMMUNOLOGY	57	14.35
2	IMMUNOLOGY AND CELL BIOLOGY	7	1.76
3	INDIAN JOURNAL OF MEDICAL RESEARCH	7	1.76
4	INDIAN JOURNAL OF ANIMAL SCIENCES	6	1.51
5	ANNALS OF ALLERGY ASTHMA & IMMUNOLOGY	6	1.51
6	RHEUMATOLOGY INTERNATIONAL	5	1.25
7	INDIAN JOURNAL OF BIOCHEMISTRY & BIOPHYSICS	5	1.25
8	FRONTIERS IN IMMUNOLOGY	5	1.25
9	HUMAN IMMUNOLOGY	5	1.25
10	VACCINE	5	1.25
11	CURRENT SCIENCE	4	1.00
12	CLINICAL AND EXPERIMENTAL RHEUMATOLOGY	3	0.76
13	JOURNAL OF LEUKOCYTE BIOLOGY	3	0.76
14	CELLULAR & MOLECULAR IMMUNOLOGY	3	0.76
15	BULLETIN OF THE WORLD HEALTH ORGANIZATION	3	0.76
16	INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES AND RESEARCH	3	0.76
17	INTERNATIONAL JOURNAL OF RHEUMATIC DISEASES	3	0.76
18	INDIAN JOURNAL OF EXPERIMENTAL BIOLOGY	3	0.76
19	JOURNAL OF CLINICAL AND DIAGNOSTIC RESEARCH	3	0.76
20	MEDICAL HYPOTHESES	3	0.76

Table 5.10 - Keywords wise distributions (top 10)

Application of the Zipf law

Zipf law explains that which keyword was used number of times total keywords used to explore in the Immunology 397. The “Immunology” is a keyword used frequently of 46 (2.87%) times to the Immunology and followed that “Infection” was used to explore 33 (2.06%) times. The keyword “Disease” used in 28 (1.75%) times. It takes the ninth place only. Application of Zipf law is shown in the below table.

S. No	Keywords	Records	%
1	IMMUNOLOGY	46	2.87
2	INFECTION	33	2.06
3	DISEASE	28	1.75
4	EXPRESSION	22	1.37
5	DENDRITIC CELLS	22	1.37
6	IN-VIVO	21	1.30
7	T-CELLS	20	1.25
8	ACTIVATION	19	1.18
19	IMMUNE-RESPONSE	19	1.18
10	IMMUNE-RESPONSES	18	1.12

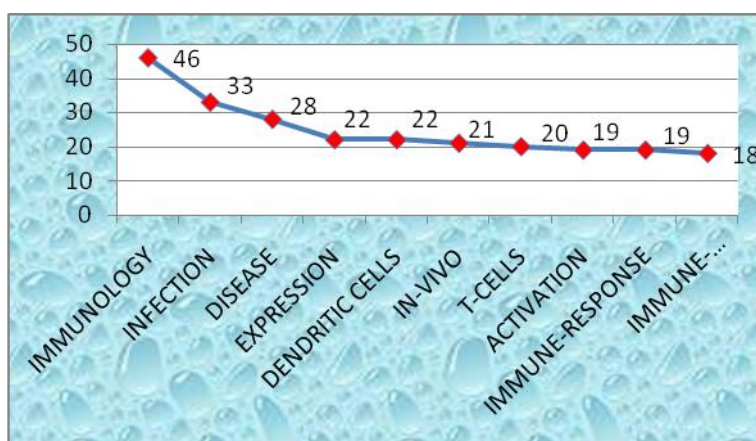


Fig 5.10.1

Table 5.11 - Cited References Top 12

Explains top 12 cited reference from India in Immunology research have received cited reference mostly used reference was Flynn JL, 2001, V19, P93, Annu Rev Immunol records were (12),

the second place of reference in Lowry OH, 1951, V193, P265, J Biol Chem (10) times and followed by the Mathur RK, 2004, V10, P540, Nat Med records were (8) respectively.

S. No	Cited References	Records	%
1	Flynn JL, 2001, V19, P93, Annu Rev Immunol	12	0.15
2	Lowry OH, 1951, V193, P265, J Biol Chem	10	0.12
3	Mathur RK, 2004, V10, P540, Nat Med	8	0.10
4	Cole ST, 1998, V393, P537, Nature	8	0.10
5	Van Crevel R, 2002, V15, P294, Clin Microbiol Rev	7	0.08
6	Kaufmann SHE, 2001, V1, P20, Nat Rev Immunol	7	0.08
7	Flynn JL, 1995, V2, P561, Immunity	6	0.07
8	Awasthi A, 2003, V197, P1037, J Exp Med	6	0.07
9	Laemmlli UK, 1970, V227, P680, Nature	6	0.07
10	Haldar JP, 1983, V42, P702, Infect Immun	6	0.07
11	Sakaguchi S, 1995, V155, P1151, J Immunol	6	0.07
12	Walport MJ, 2001, V344, P1058, New Engl J Med	6	0.07

Table 5.12 - Page wise Publications

This table shows page rages ad mean page of length of papers published during the year of 1993-2017 (25 Yrs) in the central Keyword of “**Immunology**” out of 397 papers, 49 papers (11.61%) had between 396 pages in the year of 2016, 35 papers (10.79%) had between 368 pages in the year of 2012. Followed by 2011 papers are 35 (9.83%) 335 pages. The minimum number of papers published in the year of 1993, 1994 papers are 2 (0.35%) 12 pages respectively.

S. No	Publication Period	Records	Number of Pages	%
1	1993	2	12	0.35
2	1994	2	12	0.35
3	1995	4	33	0.97
4	1996	4	26	0.76
5	1997	7	45	1.35
6	1998	5	13	20.93
7	1999	6	40	10.17
8	2000	5	30	0.88
9	2001	3	24	0.70
10	2002	12	79	2.32

11	2003	6	23	0.67
12	2004	6	50	1.46
13	2005	5	46	1.35
14	2006	6	34	0.99
15	2007	18	137	4.02
16	2008	13	126	3.69
17	2009	24	209	6.13
18	2010	32	339	9.94
19	2011	35	335	9.83
20	2012	35	368	10.79
21	2013	33	256	7.51
22	2014	28	273	8.01
23	2015	29	248	7.27
24	2016	49	396	11.61
25	2017	28	254	7.45
Total		397	3408	100

Table 5.13- Subject wise Publications Top 20

Among the Subject wise distribution in India publications from “Immunology” publications take in top 20 subjects only. The largest share in the subject was Immunology 91 (22.92%), followed by the Science & Technology – Other Topics 14 (3.52%) and Allergy Immunology 13 (3.27%), Rheumatology 13 (3.27%) and Agriculture 10 (2.51%).

S. No	Subject wise top 20	Records	%
1	Immunology	91	22.92
2	Science & Technology - Other Topics	14	3.52
3	Allergy; Immunology	13	3.27
4	Rheumatology	13	3.27
5	Agriculture	10	2.51
6	Pharmacology & Pharmacy	9	2.26
7	General & Internal Medicine	8	2.01
8	Cell Biology; Immunology	8	2.01
9	Ophthalmology	8	2.01
10	Immunology; General & Internal Medicine; Research & Experimental Medicine	7	1.76

11	Oncology	7	1.76
12	Biochemistry & Molecular Biology; Biophysics	7	1.76
13	Life Sciences & Biomedicine - Other Topics	6	1.51
14	Microbiology	6	1.51
15	Dermatology	5	1.25
16	Veterinary Sciences	5	1.25
17	Immunology; Research & Experimental Medicine	5	1.25
18	Pediatrics	5	1.25
19	Public, Environmental & Occupational Health	5	1.25
20	Research & Experimental Medicine	5	1.25

Table 5.14 - Country collaboration top 30

This study of joint country research increasing. Here this Immunology investigates in the year of 1993-2017 (25 Yrs). And 104 countries involved in collaborative research, India has highly collaborated with USA in the number of (66) times and UK (19) times. India has done a collaborated research in Germany (17), France (13), and Spain (10) Switzerland (8). This study was paper taken in collaboration with other country. The top 30 collaborative Countries are given below;

S. No	Name of the Country		Records
1	India	USA	66
2	India	UK	19
3	Germany	India	17
4	India	Japan	13
5	France	India	13
6	UK	USA	11
7	India	Spain	10
8	Germany	USA	9
9	France	UK	8
10	India	Switzerland	8
11	France	USA	8
12	Australia	India	7
13	Brazil	India	7
14	Germany	UK	7
15	Spain	USA	7
16	India	Italy	7

17	Japan	USA	7
18	Italy	USA	6
19	Australia	USA	6
20	Brazil	USA	6
21	Canada	India	6
22	France	Spain	6
23	Spain	UK	6
24	India	Peoples R China	6
25	Peoples R China	UK	5
26	Denmark	USA	5
27	Denmark	UK	5
28	France	Germany	5
29	France	Italy	5
30	Switzerland	UK	5

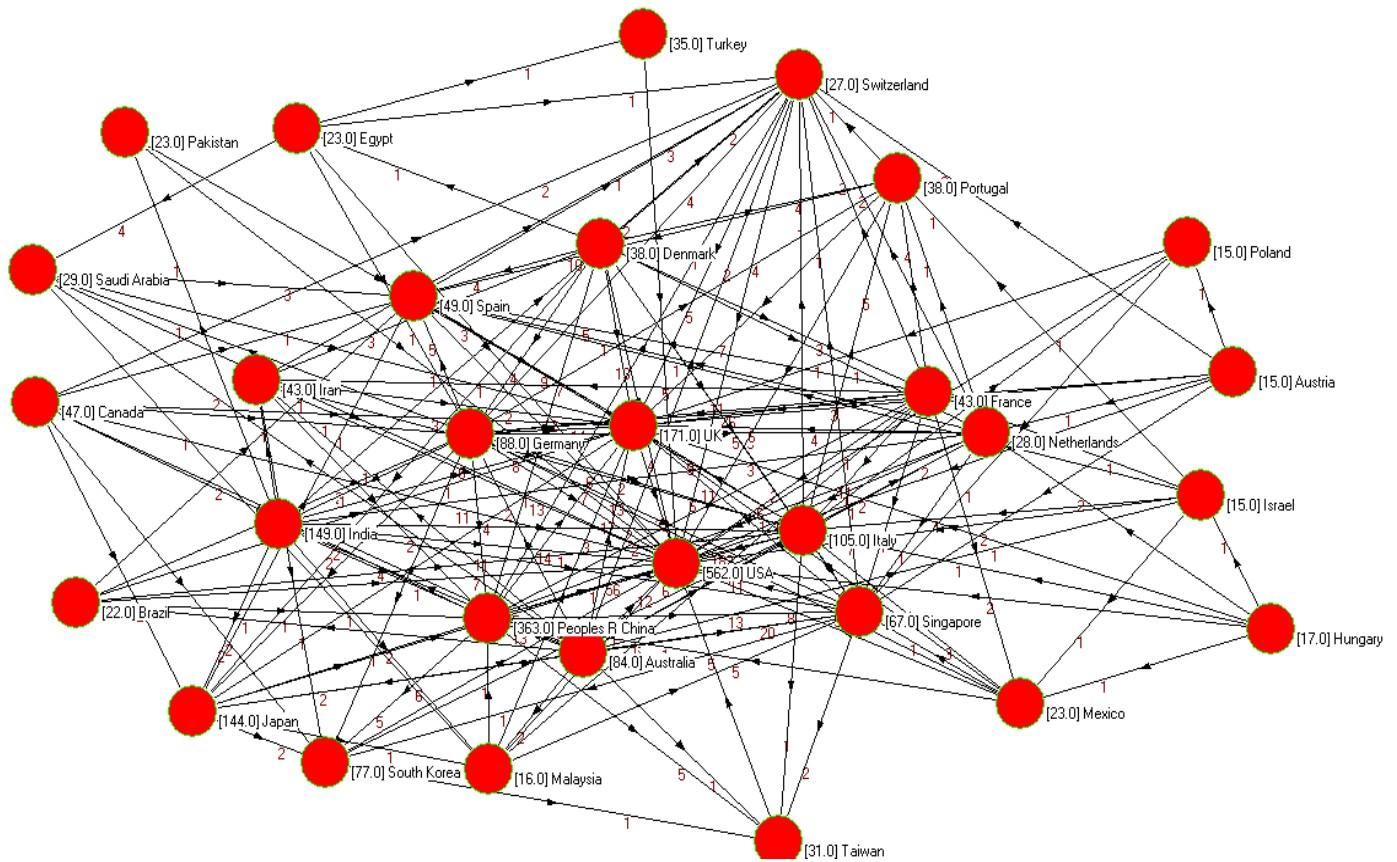


Fig 5.14.2

- ✓ The H – Index Score for highly productive authors in top 10. The maximum H – Index score for highly productive author in **Saha, B (H-Index 7)**, Citation h- core 368, and followed by the author was **Singh S (H- Index 6)** Citation h- core 118
- ✓ The degree of collaboration was 0.92
- ✓ This study was used keywords are “**Immunology**” 46 times
- ✓ The maximum subject, covering in this study was Immunology

Conclusion

One of the possible confines of this study was its spotlight on the keywords was “Immunology” research in India within the moment in time span of (25Yrs) 1993-2017. This study was conducted using data from the Web of Knowledge database. During this time a total of 49 papers were published 2013 being the years, which result in the maximum number of publications. The whole study period records the mean relative growth rate of 0.954 and means doubling time for publications at the aggregate level has been designed as 22.6 in the total years. Single authored work is less than that of the multiple authored contributions. The Degree of Collaboration (using Subramanian’s formula) indicates that there exists a high degree of collaboration. The articles were most of the published in the English language records were 396 (99.75%) respectively. The immunology emerged as being the most common keyword with a recurrence rate of 46 (2.87%). In the 104 countries involved in collaborative research, India has highly collaborated with USA in the number of (66) times and UK (19) times. India has done a collaborated research in Germany (17), France (13), and Spain (10) Switzerland (8).

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