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Tuberculosis (TB) research in India during 2004-2013: a bibliometric analysis

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Abstract: The present study is a bibliometric analysis of all Indian tuberculosis publications over the past 10 years, in the national/ international journals of repute. Utilizing the *Scopus* database, 7945 documents of Indian researcher's publications data on tuberculosis research were used for the study, with an average of 794-795 documents per year and majority of them were research articles (76.56%). *International Journal of Tuberculosis and Lung Disease*; All India Institute of Medical Sciences (AIIMS) and D. Sriram were the most favoured research journal; major contributing organization/ institution and most prolific contributor. Article, Human and Humans were the most frequently used keywords.

Keywords: Tuberculosis, Bibliometrics, Scopus, India, WHO.

Introduction

Bibliometrics is the term used by Pritchard (1969) and it is defined as “the application of mathematical and statistical methods to measure quantitative and qualitative changes in different media”. Quantitative analysis can measure the growth, scattering of articles in different journals or to measure the obsolescence of literature in different disciplines. Bibliometrics techniques are being used for a variety of purposes like determination of various scientific indicators, evaluation of scientific output, selection of journals for libraries and even forecasting the potential of a particular field. The popularity in the adaptation of bibliometric techniques in various disciplines stimulated stupendous growth of literature on bibliometrics and its related areas (Hood and Wilson, 2001). Number of quantitative studies based on bibliometric, scientometric technique etc.

have been reported to evaluate the research productivity of individuals, institutions/ organizations, countries etc. (Rahman et al., 2005). Studies are also available to verify the fitness of classic laws of bibliometrics, factors of productivity and impact of research conducted in various countries. During the last few decades more information closer to the research itself, such as distribution of different words in the title (Xie et al., 2008; Li et al., 2009), keywords and key-word plus (Chiu and Ho, 2007) and words in abstracts (Zahang et al., 2009).

Tuberculosis (TB) remains a major global health problem. It causes ill-health among millions of people each year and ranks as the second leading cause of death from an infectious disease worldwide, after the Human Immunodeficiency Virus (HIV). In 2012, an estimated 8.6 million people developed TB and 1.3 million died from the disease (WHO, 2013). Most of these TB cases and deaths occur among men, but the burden of disease among women is also high. According to the WHO report 2012, there were an estimated 2.9 million cases and 410000 TB deaths among women as well as an estimated 530000 cases and 74000 deaths among children. The number of TB deaths is unacceptably large given that most are preventable if people can access health care for a diagnosis and the right treatment is provided. The purpose of this study is to bibliometrically analyze the literatures of Indian researchers on tuberculosis (TB) which were indexed in *Scopus* during 2004 to 2013. These documents were analyzed and evaluated according to publication year, most contributing organization/ institution, author, prolific journal, frequently used keywords etc.

Objectives

The major objectives of the study are:

- mapping the growth and development of TB research in India during 2004-2013;
- to identify the TB affected countries of the world;
- to find out the most affected Asian countries with their world rank;
- to find out the most favoured research area identified by *Scopus*.;
- to find out the core research journals with their IF, SJR & SNIP and
- to identify the most contributing Indian researcher and research organization/ institution.

Literature review

Various studies on author collaboration have been analyzed by various authors in various fields. Maharana (2014) studied the Malaria research in India during 2003-2012 and discussed the institutional affiliation, most prolific contributor, favoured research journal, h-index etc. Arunachalam and Gunasekaran (2002) have mapped tuberculosis research in India and China and identified institutions and cities active in research, journals used to publish the findings, use of high impact journals, and extent of international collaboration. Khatun and Ahmed (2011) in a bibliometric analysis of diarrhoeal disease research in Bangladesh discussed the authorship pattern, literature growth, author productivity etc. Kennedy et al. (2013) using the MEDLINE database analyzed Ireland's contribution to orthopaedic literature.

Methodology

The documents used in the present study were taken from *Scopus* (officially known as *Sciverse Scopus*). *Scopus* is a bibliographic database containing abstracts and citations for academic journal articles. It covers nearly 21,000 titles from over 5,000 publishers, of which 20,000 are peer-reviewed journals in the scientific, technical, medical, and social sciences (including arts and humanities). It is owned by Elsevier and is available online on subscription basis. For retrieval of information “tuberculosis” was used as topic/ subject; “India” was used as authors or contributors address/ affiliation country and “2004-2013” was used as the time span for the present study. As a result 7945 documents retrieved and matched with the query. Finally, the documents were entered into MS-Excel in a logical order and various statistical techniques were used for further analysis. The literature growth percentage (r) in TB research by the Indian researchers was calculated with the help of following formula:

$$r = \frac{p_1 - p_0}{p_0} \times 100$$

Where, r = Annual literature growth in percentage,
p₀= Number of research papers produced in the base year,
p₁= No. of research papers produced in the year for which r% is to be calculated.

Analysis and discussion TB affected Asian countries

TB is an infectious disease caused by the bacillus *Mycobacterium tuberculosis*. It typically affects the lungs (pulmonary TB) but can affect other sites as well (extra pulmonary TB). The disease is spread in the air when people who are sick with pulmonary TB expel bacteria, for example by coughing. However, the probability of developing TB is much higher among people infected with HIV. TB is also more common among men than women, and affects mostly adults in the economically productive age groups (WHO, 2013). Table-1 gives an overview of TB affected Asian countries with their world rank and death rate. It shows India is the 58th world TB affected country and 13th in Asia. Timor-Leste is very badly affected with TB which keeps it 1st in Asia and 2nd in the World.

Table-1 TB affected Asian countries with death rate

Rank (in Asia)	World Rank	Country	Average Death rate per 100 000*	Deaths in 2012 per 100 000 [#]
1	2	Timor-Leste	145.9	74
2	5	Cambodia	125.4	63
3	21	Tajikistan	72.1	8
4	23	Bangladesh	69.3	45
5	25	Afghanistan	63.8	37

6	31	Pakistan	56.6	34
7	34	Philippines	52.8	24
8	36	Laos	51.5	22
9	43	Vietnam	38.9	20
10	49	North Korea	34.8	9
11	53	Indonesia	31.9	27
12	54	Nepal	31.9	20
13	58	India	28.8	22
14	59	Kyrgyzstan	25.6	10
15	61	Turkmenistan	24.4	8
16	62	Kazakhstan	23.4	8
17	66	Uzbekistan	22.0	2
18	70	Yemen	20.4	6
19	72	Bhutan	18.8	14
20	73	Thailand	18.5	14
21	76	Malaysia	17.8	5
22	82	Qatar	13.5	0
23	83	Azerbaijan	--	4
24	84	China	11.4	3
25	86	Armenia	11.1	6
26	87	Mongolia	10.8	7
27	90	Sri Lanka	10.1	7
28	101	South Korea	6.1	7
29	105	Georgia	4.9	5
30	112	Turkey	3.6	1
31	114	Maldives	3.7	2
32	115	Iran	3.6	3
33	119	Syria	3.3	2

* Source: World Life Expectancy report.

Source: World Health Organization, 2012.

Figure-1 shows TB affected countries of the world, which shows most of the African region is very badly affected by TB with most of the countries of Europe, Americas, Asia and Western Pacific.

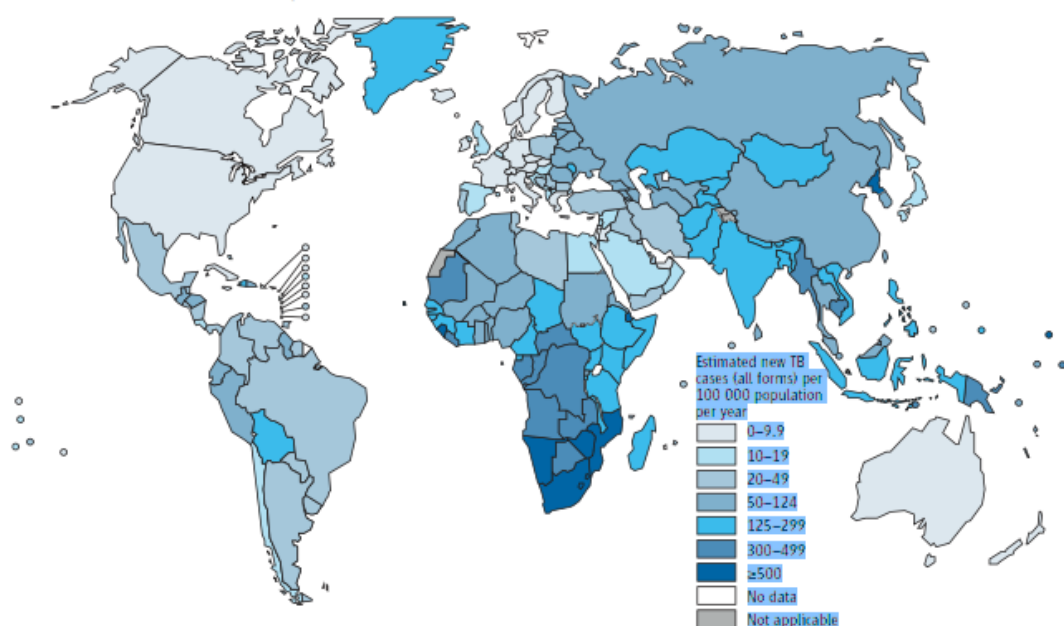


Figure 1 World TB affected countries*

*Source: WHO Report, 2013.

Annual distribution and growth of publication

To obtain an overview of tuberculosis research, the annual number of documents published during 2004-2013 was displayed in Table-2, which shows a variation in research productivity. A total of 7945 documents published with the annual average growth rate percent of 10.14. A positive growth in scientific production was observed from the 2005 to 2012 and the number of publication was increased nearly thrice from 2004 to 2012.

Table-2 Annual distribution of publication

Year	No. of publication	Percentage (%)	Annual average growth percentage (%)
2004	459	5.78	--
2005	513	6.46	11.77
2006	574	7.22	11.89
2007	597	7.51	4.01
2008	635	8	6.37
2009	732	9.21	15.28
2010	923	11.62	26.1
2011	1111	13.98	20.37

2012	1235	15.54	11.17
2013	1166	14.68	-5.59
Total	7945	100	Average 10.14

Published document types

The 7945 documents published by the Indian researchers during 2004 to 2013 on TB research included 10 document types. Articles were the most dominant document type comprising of more than one third to the total documents; followed by reviews (719, 9.05%); letter (637, 8.02%); editorial (141, 1.78%) Conference paper (139, 1.75%) etc.

Table-3 Types of document published

Rank	Types of document	No. of papers	Percentage (%)
1	Articles	6083	76.56
2	Reviews	719	9.05
3	Letter	637	8.02
4	Editorial	141	1.78
5	Conference Paper	139	1.75
6	Note	105	1.32
7	Article in Press	40	0.5
7	Short Survey	40	0.5
8	Book Chapter	26	0.33
9	Erratum	12	0.15
10	Book	03	0.04
Grand Total		7945	100

Major research areas

The 7945 documents were published in 26 subject disciplines which were related to TB research with one undefined subject category (Table-4). Further, it shows Medicine (71.86%) is the most preferred research area among the Indian researchers. Biochemistry, Genetics and Molecular Biology; Pharmacology, Toxicology and Pharmaceutics and Immunology & Microbiology with 22.45%; 12.86% and 11.63% stood with the 2nd, 3rd and 4th positions.

Table-4 Major research areas

Sl. No.	Rank	Research Areas	No. of papers (n=7945)	Percentage (%)
1	1	Medicine	5709	71.86
2	2	Biochemistry, Genetics and Molecular Biology	1783	22.45
3	3	Pharmacology, Toxicology and Pharmaceutics	1021	12.86
4	4	Immunology and Microbiology	924	11.63

5	5	Chemistry	631	7.95
6	6	Agricultural and Biological Sciences	345	4.35
7	7	Neuroscience	159	2.01
8	8	Chemical Engineering	115	1.45
9	9	Veterinary	90	1.14
10	10	Computer Science	80	1.01
11	11	Physics and Astronomy	79	0.99
12	12	Engineering	63	0.8
13	13	Health Professions	58	0.74
14	14	Environmental Science	56	0.71
15	14	Social Sciences	56	0.71
16	15	Multidisciplinary	52	0.66
17	16	Materials Science	40	0.51
18	17	Dentistry	39	0.49
19	18	Mathematics	31	0.39
20	19	Nursing	27	0.34
21	20	Psychology	14	0.18
22	21	Earth and Planetary Sciences	9	0.12
23	22	Arts and Humanities	8	0.11
24	23	Energy	5	0.07
25	24	Economics, Econometrics and Finance	4	0.06
26	25	Business, Management and Accounting	1	0.02
27	25	Undefined	1	0.02

Favoured research journal

Table-5 lists the top 20 most productive journals with their *Impact Factor (IF)*, *SCImago Journal Rank (SJR)* and *Source-Normalized Impact per Paper (SNIP)*. The Impact factor (IF) of a journal is a measure reflecting the average number of citations to recent articles published in the journal; *SJR* is a measure of scientific influence of scholarly journals that accounts for both the number of citations received by a journal and the importance or prestige of the journals where such citations come from and *SNIP* is the ratio of a source's average citation count per paper and the citation potential of its subject field. *International Journal of Tuberculosis and Lung Disease* was the most favoured research journal among the Indian researchers with 2.610 *IF*, 1.34 *SJR* and 1.202 *SNIP* followed by *Indian Journal of Medical Research* and *Plos One* with *IF* of 2.061 and 3.730 respectively. *Journal of Biological Chemistry* which consist 52 papers and stood at the 20th position was the most weighted journal during the period under study with 4.651 *IF* and 2.723 *SJR*. It also shows among the top 20 journals 12 are Indian journals.

Table-5 Top 20 most favoured research journal

Sl. No.	Source title	No. of publication	Publishing Country	IF (2012)	SJR (2012)	SNIP (2012)
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1	International Journal of Tuberculosis and Lung Disease	232	France	2.610	1.34	1.202
2	Indian Journal of Medical Research	189	India	2.061	0.513	1.126
3	Plos One	182	UK	3.730	1.512	1.063
4	Indian Journal of Tuberculosis	176	India	--	0.308	0.733
5	Indian Journal of Medical Microbiology	124	India	.907	0.372	1.034
6	Bioorganic and Medicinal Chemistry Letters	119	Amsterdam	2.427	0.913	0.92
7	Lung India	117	India	--	0.227	0.817
8	Indian Journal of Pediatrics	102	India	0.715	0.306	0.642
9	Indian Pediatrics	91	India	1.036	0.367	0.907
10	Journal of Association of Physicians of India	86	India	--	0.216	0.573
11	Journal of the Indian Medical Association	86	India	--	0.138	0.249
12	European Journal of Medicinal Chemistry	84	Amsterdam	3.499	1.062	1.884
13	BMJ Case Reports	81	London	--	--	0.044
14	Indian Journal of Pathology and Microbiology	79	India	--	0.232	0.79
15	Tuberculosis	76	Amsterdam	3.033	1.077	1.08
16	Medicinal Chemistry Research	67	New York	1.612	0.343	0.848
17	Journal of Clinical and Diagnostic Research	62	India	0.14	0.144	0.267
18	Indian Journal of Dermatology Venereology and Leprology	54	India	1.206	0.389	1.002
19	National Medical Journal of India	54	India	0.91	0.212	0.503
20	Journal of Biological Chemistry	52	United State	4.651	2.723	1.234

Major contributing institution/ organization

Table-6 shows the contribution of the 20 most productive institution/ organizations to TB study & research in the country. All India Institute of Medical Sciences (AIIMS) with 7.19% of contributions is the most productive institution/ organization, followed by Postgraduate Institute of Medical Education and Research (PIMER) with 386 (4.86%) number of contributions. Tuberculosis Research Centre; Indian Council of Medical Research (ICMR) and Indian Institute of Sciences (IISc.) with 244 (3.08%); 204 (2.57%) and 173 (2.18%) contributions stood at the 3rd, 4th and 5th position.

Table-6 Major contributing institution/ organization

Rank	Institute/ organization	No. of contributions (n=7945)	Percentage (%)
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1	All India Institute of Medical Sciences (AIIMS)	571	7.19
2	Postgraduate Institute of Medical Education and Research (PIMER)	386	4.86
3	Tuberculosis Research Centre	244	3.08
4	Indian Council of Medical Research (ICMR)	204	2.57
5	Indian Institute of Science (IISc.)	173	2.18
6	Christian Medical College, Vellore	162	2.04
7	Chhatrapati Shahuji Maharaj Medical University, Lucknow	156	1.97
8	Central Drug Research Institute, Lucknow	137	1.73
9	Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow	133	1.68
10	P.D. Hinduja National Hospital and Medical Research Centre, Mumbai	104	1.31
11	University College of Medical Sciences, Delhi	101	1.28
12	National JALMA Institute of Leprosy and other Mycobacterial Diseases, Agra	97	1.23
13	Maulana Azad Medical College, New Delhi	93	1.18
14	Birla Institute of Technology and Science, Pilani	90	1.14
15	Vardhman Mahavir Medical College & Safdarjung Hospital, New Delhi	87	1.1
16	National Institute of Immunology, New Delhi	85	1.07
17	Government Medical College & Hospital, Chandigarh	80	0.99
18	National Institute of Pharmaceutical Education and Research	79	0.98
19	Institute of Genomics and Integrative Biology, Delhi	78	0.97
20	Institute of Microbial Technology, Chandigarh	77	0.97
20	Mahatma Gandhi Institute of Medical Sciences	77	0.97
20	Ministry of Health and Family Welfare, Govt. of India	77	0.97

Most prolific contributor

Table-7 gives a detailed list of most prolific Indian contributors in TB research during the period under study. Here the contributors with having contributions of 44 or more were considered for analysis, which shows D. Sriram with 112 contributions stood in the 1st position. P. Yogeewari; V.M. Katoch; S. Swaminathan and P.R. Narayan with 106; 89, 85 and 83 contributions hold the 2nd, 3rd, 4th and 5th positions respectively.

Table-7 List of most prolific contributors with 44 or more contributions

Rank	Name of Contributors	No. of Contributions (n=7945)
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1	D. Sriram	112
2	P. Yogeeswari	106
3	V.M. Katoch	89
4	S. Swaminathan	85
5	P.R. Narayanan	83
6	S.K. Sharma	82
7	G.K. Khuller	60
8	N. Selvakumar	53
9	D. Behera	52
10	S.E. Hasnain	51
11	M. Pai	49
12	P.G. Gopi	47
13	A.K. Tyagi	46
14	C. Rodrigues	45
15	L.S. Chauhan	44
15	V. Kumar	44

International collaboration

Domination in publication was not surprisingly from a small number of countries since this pattern has occurred in most scientific fields (Mela et al., 1999). The international collaboration of TB research by the Indian researchers is shown in Table-8, which shows a list of top-20 collaborative foreign countries. According to the research collaboration, United States with 607 (7.65%) collaborative papers is the most preferred country by the Indian researchers followed by United Kingdom (195, 2.46%). Mexico, Pakistan and Indonesia with 18 (0.23%) research collaboration stood at the 20th position.

Table-8 International collaboration

Rank	Country	No. of contribution (n=7945)	Percentage (%)
1	India	7945	100
2	United States	607	7.65
3	United Kingdom	195	2.46
4	France	108	1.36
4	Switzerland	108	1.36
5	Canada	98	1.24
6	South Africa	87	1.09
7	Germany	69	0.87
8	Australia	65	0.82
9	Sweden	52	0.66
10	Italy	51	0.653
11	Malaysia	41	0.52
12	Netherlands	40	0.51
13	Belgium	37	0.47

14	Saudi Arabia	36	0.46
15	Singapore	33	0.42
16	Denmark	32	0.41
16	Norway	32	0.41
16	China	32	0.41
16	Japan	32	0.41
17	Nepal	29	0.37
18	Brazil	26	0.33
18	Spain	26	0.33
19	South Korea	21	0.27
20	Mexico	18	0.23
20	Pakistan	18	0.23
20	Indonesia	18	0.23

Keywords used

Table-9 lists the 20 most often used keywords during 2004 to 2013. 'Article' was used 5621 times, followed by 'Human' (5543 times), 'Humans' (3947 times), Tuberculosis (3880 times), 'Mycobacterium tuberculosis' (3257 times). 'Male'; 'Adult'; 'Female'; 'Priority journal' and 'Controlled study' were appended 2950; 2850; 2749; 2654 and 2241 times and stood at the 6th, 7th, 8th, 9th and 10th positions respectively.

Table-9 Top 20 most frequently used keywords

Rank	Keyword	No. of times appended
1	Article	5621
2	Human	5543
3	Humans	3947
4	Tuberculosis	3880
5	Mycobacterium tuberculosis	3257
6	Male	2950
7	Adult	2850
8	Female	2749
9	Priority journal	2654
10	Controlled study	2241
11	Nonhuman	2195
12	Tuberculostatic agent	1876
13	Isoniazid	1727
14	India	1661
15	Rifampicin	1652
16	Case report	1637
17	Lung tuberculosis	1407
18	Major clinical study	1381

19	Anti-tubercular Agents	1298
20	Unclassified drug	1265

Conclusion

The present study has emphasized the perspective of the research activities of Indian researchers in TB research. So, far 7945 documents were published during the period under study which were indexed in *Scopus* out of which 6083 were research articles. Furthermore, based on the publication pattern, it can be calculated that the number of documents in 2012 will be nearly thrice than that in 2004.

TB is the second largest or dangerous infectious disease which causes high morbidity throughout the world. India is the 58th affected country in the world and 13th in Asia. The research productivity of Indian researchers' on TB research shows their awareness and cautiousness. Initiatives taken by Indian government institutions/ organizations to eradicate TB completely from the country is quite appreciated. Nationwide involvement of government and private medical colleges, research centers, universities will yield better research output and helps to check and prevent TB.

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