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COLLABORATIVE TREND IN INDIAN TUBERCULOSIS RESEARCH: A SCIENTOMETRIC ANALYSIS

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Abstract

The collaborative trend in Indian research on Tuberculosis has been measured using the authorship pattern of the publications.. A total of 22,871 publications can be seen in Scopus, a multi discipline data based on "Tuberculosis" during the thirty years period of 1986-2015. Number of authors per publication has been calculated. Analysis on authorship pattern, yearwise authorship pattern, block yearwise authorship pattern, document type authorship pattern and collaborated countries have also been identified and same has been discussed. The solo research can be seen only 6.8%. The collaborated research works out to 93.2%. Further that more than Six and authors have contributed more publications (25.7%) followed by four authors (19.1%) and three authors (18.6%). 22871 publications were authored by 1,11,638 with an average of 4.88 authors per paper. This shows that Indian Tuberculosis research output has collaboration in nature which has a minimum of four to five authors per paper. Their exist collaborative research among the scientists throughout the globe.

Keywords: *Collaborative Trend, Tuberculosis Research, Indian Research Output, Scientometric Study, Authorship Pattern*

1. Introduction

Tuberculosis (TB) remains a major global health problem, responsible for ill health among millions of people each year. TB ranks as the second leading cause of death from an infectious disease worldwide, after the human immunodeficiency virus (HIV). The latest estimates included in this report are that there were 9.0 million new TB cases in 2013 and 1.5 million TB deaths (1.1 million among HIV-negative people and 0.4 million among HIV-positive people). These totals are higher than those included in the 2013 global TB report **.** In India, each year, approx. 220, 000 deaths are reported due to Tuberculosis. Between 2006 and 2014, India bears a disproportionately large burden of the world's tuberculosis rates, as it continues to be the biggest health problem in India. Working association between physicians; private sector; religious bodies; and other local nonprofit organizations, e.g., Lions Club, Rotary International, has already strengthened for better dissemination of awareness about diagnosis, management, control of this disease and research activities. Existing diagnostic laboratories has further strengthened with routine training/refresher courses for the involved personnel for better utilization of these already scarce resources. This study not only analysis growth of Indian Tuberculosis research output also examines the collaboration nature of research output by the Indian authors.

2. Bibliometrics

The bibliometrics has emerged as a thrust area of research, incorporating different branches of human knowledge. Bibliometric analysis, the application of statistical and mathematical methods to books and other communication, has been employed by researchers to study the publication trend of a particular subjects or institutions or country etc. A common research tool is a bibliometric method which has already been widely applied in scientific production and research-trend studies in many disciplines of Science and Engineering (Almind& Ingwersen, 1997[1]; Cronin, 2001[2]; Moed, Debruin, & Vanleeuwen, 1995[3]). The popularity in the adaptation of bibliometric techniques in various disciplines stimulated stupendous growth of literature on bibliometrics and its related areas.There are famous Laws of Bibliometric i.e. Lotka's law (1926) of scientific productivity, Bradford's law (1934) of scattering and Zips law (1949) on frequency of words. But the Bibliometric studies started in late sixties.

Authorship pattern for the literature in Tuberculosis research has also been administered. The study of authorship pattern or productivity is one of the important aspects in the scientometric analysis. It is necessary to concentrate on authorship pattern to assess the research contributions in any field and Genetic Engineering is not an exception.

Author collaboration can be through in the following indicators:

- Authorship pattern i.e. Single, Multiple authors Frequency
- Collaboration Index (CI)
- Degree of collaboration (DC)
- Collaborative Coefficient (CC)

- Modified Collaborative Coefficient (MCC)
- Pattern of Co-authorship Index (CAI)

3. Review of Literature

Number of quantitative studies have been conducted and reported based on bibliometric parameters to measure the research output of individual scientists, universities, research institutes, and research areas. Bibliometric parameters, viz., authorship pattern, citations received per paper, highly cited journals, international collaborations, h-index, etc., were used in these studies.

Hazarika and others[4] state in their paper on Bibliometric analysis of Indian Forester: 1991-2000, the multiple authorship is predominant in forestry and team research has always been favoured by scientists. These observations clearly state that research work is collaborative in nature. Kalyane and Sen [5] in their work on the Journal of Oilseeds Research observed that the authorship pattern in various fields as agriculture, anthropology, business and economics, medicine, etc show consistently increase in the number of two or more authored papers. Dhiman[6] evaluated "Ethnobotany Journal" for authorship pattern, year-wise distribution of articles, institution and country-wise distribution and range of references cited. Shokeen and Kaushik[7] in their study of Indian Journal of Plant Physiology, revealed that journal articles are predominant with more than two thirds of total citations. Jena [8] made an exhaustive bibliometric study of Fibre and Textile Research and unfolded the publication trend of this Indian journal from 1996 to 2004. Bharvi et al.[9] analyzed 1,317 papers published in the first fifty volumes from 1978 to 2001 of the international journal Scientometrics and found that the US share of the papers is constantly on the decline while that of the Netherlands, India, France and Japan is on the rise and that the scientometric output is dominated by the single-authored papers. Zainab et al.[10] in their bibliometric study of Malayasian Journal of Computer Science, reported their findings regarding the article productivity, authorship collaboration, and journal impact factor of MJCS. Serenko et al.[11] conducted a bibliometric analysis of a body of literature contained in 11 major knowledge management and intellectual capital peer-reviewed journals and revealed the institutional and individual productivity, co-operation patterns, publication frequency, and other related parameters. Hussain and Fatima[12] evaluated the characteristics of the Chinese Librarianship: an International Electronic Journal from 2006 to 2010 through a bibliometric analysis.

4. Objectives

1. To find out the authorship pattern;
2. To identify the chronological growth of authorship pattern.
3. To calculate the degree of collaboration;
4. To identify the document type that has more collaboration
5. To identify the country that has collaborated with Indian authors on the research output.

5. Hypotheses

1. There exist collaborative research in Indian Tuberculosis research;
2. Collaborative research can be seen only during the last decade.
3. Majority of the countries collaborated with Indian authors in the research output.
4. Journal article are the most preferred document type by the Indian authors;
5. Collaborative research persists in all document types.
6. To identify the country that has collaborated with Indian authors on the research output.

6. Methodology

The term 'Tuberculosis" has been used as a search term, for retrieving literature from a multidiscipline international indexing and abstracting database 'SCOPUS'. The search string used for searching the database is as follows:

> Query for Indian Output: (ALL (Tuberculosis) AND PUBYEAR > 1985 AND PUBYEAR < 2016 AND (LIMIT-TO(AFFILCOUNTRY,"India")))

A total of 308800 records were identified in the field of tuberculosis worldwide during the period 1986-2015. Similarly the Indian output on tuberculosis seems to be 22871. The collected data has been classified by using Excel and the same has been loaded in to SPSS (statistical package for social sciences) for the purpose of analysis. Number of authors per publication has been calculated. Analysis on authorship pattern, yearwise authorship pattern, block yearwise authorship pattern, document type authorship pattern and collaborated countries have also been identified and same has been discussed.

7. Analysis

The analysis has been presented on the following

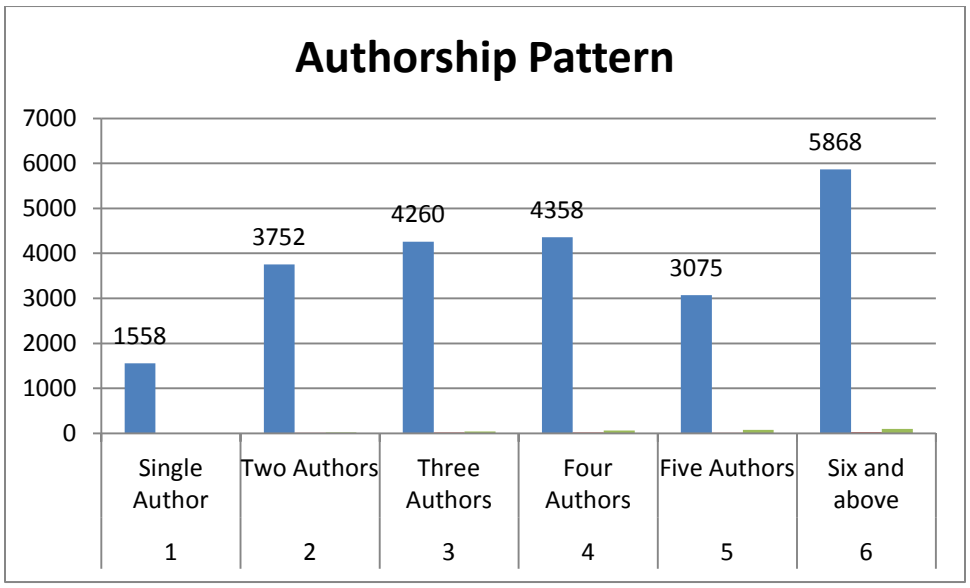
- authorship pattern,
- yearwise authorship pattern,
- block yearwise authorship pattern,
- Collaboration – coefficient and Index
- document type authorship pattern and
- collaborated countries

Authorship Collaboration

The author collaboration in nature were classified as single, two, three, four, five, more than five and anonymous authors. The total publications, percentage, and cumulative percentage are shown in Table 1 and Figure 1.

Table 1 AUTHORSHIP PATTERN

S.No.	Authorship	No. of Authors	Percent	Cumulative Percent
1	Single Author	1558	6.8	6.8
2	Two Authors	3752	16.4	23.2
3	Three Authors	4260	18.6	41.8
4	Four Authors	4358	19.1	60.9
5	Five Authors	3075	13.4	74.3
6	Six and above	5868	25.7	100.0
	Total	22871	100.0	



The solo research can be seen only 6.8%. The collaborated research works out to 93.2%. Further it can be seen from the table 2 and figure 2 that more than Six and authors have contributed more publications (25.7%) followed by four authors (19.1%) and three authors (18.6%).

Yearwise authorship collaboration

Further the authorship pattern has been calculated based on yearwise as well as block years which can be seen from Tables 2 and 3

Table 2 Year Vs Author Collaboration

S.No	Year	Single Author	Two Authors	Three Authors	Four Authors	Five Authors	Six and above	Total

1	1986	11	.0%	22	.1%	34	.1%	20	.1%	6	.0%	12	.1%	105	.5%
2	1987	8	.0%	31	.1%	27	.1%	21	.1%	8	.0%	19	.1%	114	.5%
3	1988	7	.0%	33	.1%	26	.1%	20	.1%	19	.1%	24	.1%	129	.6%
4	1989	26	.1%	33	.1%	21	.1%	26	.1%	20	.1%	15	.1%	141	.6%
5	1990	29	.1%	45	.2%	38	.2%	32	.1%	23	.1%	16	.1%	183	.8%
6	1991	18	.1%	44	.2%	18	.1%	26	.1%	24	.1%	23	.1%	153	.7%
7	1992	13	.1%	29	.1%	38	.2%	24	.1%	21	.1%	28	.1%	153	.7%
8	1993	31	.1%	38	.2%	39	.2%	29	.1%	26	.1%	21	.1%	184	.8%
9	1994	17	.1%	35	.2%	27	.1%	26	.1%	22	.1%	26	.1%	153	.7%
10	1995	14	.1%	27	.1%	37	.2%	35	.2%	18	.1%	29	.1%	160	.7%
11	1996	29	.1%	30	.1%	42	.2%	40	.2%	31	.1%	45	.2%	217	.9%
12	1997	29	.1%	44	.2%	51	.2%	48	.2%	31	.1%	39	.2%	242	1.1%
13	1998	26	.1%	42	.2%	69	.3%	59	.3%	34	.1%	32	.1%	262	1.1%
14	1999	33	.1%	55	.2%	63	.3%	69	.3%	38	.2%	60	.3%	318	1.4%
15	2000	36	.2%	57	.2%	82	.4%	66	.3%	46	.2%	57	.2%	344	1.5%
16	2001	29	.1%	78	.3%	72	.3%	77	.3%	45	.2%	73	.3%	374	1.6%
17	2002	40	.2%	88	.4%	95	.4%	94	.4%	62	.3%	97	.4%	476	2.1%
18	2003	62	.3%	102	.4%	116	.5%	108	.5%	74	.3%	110	.5%	572	2.5%
19	2004	60	.3%	127	.6%	115	.5%	107	.5%	80	.3%	161	.7%	650	2.8%
20	2005	43	.2%	115	.5%	134	.6%	181	.8%	122	.5%	158	.7%	753	3.3%
21	2006	67	.3%	128	.6%	175	.8%	165	.7%	112	.5%	225	1.0%	872	3.8%
22	2007	76	.3%	141	.6%	176	.8%	172	.8%	143	.6%	241	1.1%	949	4.1%
23	2008	47	.2%	192	.8%	213	.9%	154	.7%	143	.6%	280	1.2%	1029	4.5%
24	2009	100	.4%	168	.7%	231	1.0%	218	1.0%	181	.8%	301	1.3%	1199	5.2%
25	2010	91	.4%	252	1.1%	267	1.2%	311	1.4%	203	.9%	405	1.8%	1529	6.7%
26	2011	119	.5%	312	1.4%	328	1.4%	374	1.6%	279	1.2%	518	2.3%	1930	8.4%
27	2012	133	.6%	345	1.5%	416	1.8%	448	2.0%	297	1.3%	591	2.6%	2230	9.8%
28	2013	128	.6%	386	1.7%	412	1.8%	447	2.0%	306	1.3%	669	2.9%	2348	10.3%
29	2014	118	.5%	398	1.7%	447	2.0%	496	2.2%	333	1.5%	778	3.4%	2570	11.2%
30	2015	118	.5%	355	1.6%	451	2.0%	465	2.0%	328	1.4%	815	3.6%	2532	11.1%
Total		1558	6.8%	3752	16.4%	4260	18.6%	4358	19.1%	3075	13.4%	5868	25.7%	22871	100.0%

Table 3 Block Year Vs Author Collaboration

S.No	Block Year	Single Author		Two Authors		Three Authors		Four Authors		Five Authors		Six and above		Total	
1	1986-1995	174	.8%	337	1.5%	305	1.3%	259	1.1%	187	.8%	213	.9%	1475	6.4%
2	1996-2005	387	1.7%	738	3.2%	839	3.7%	849	3.7%	563	2.5%	832	3.6%	4208	18.4%
3	2006-2015	997	4.4%	2677	11.7%	3116	13.6%	3250	14.2%	2325	10.2%	4823	21.1%	17188	75.2%
Total		1558	6.8%	3752	16.4%	4260	18.6%	4358	19.1%	3075	13.4%	5868	25.7%	22871	100.0%

It can be seen from table 2 that there exist consistency in the case of solo research during the study period. Growth of collaboration can be seen more from 2010 onwards. Nearly 70.8% of collaboration can be seen during the block period of 2006-2015. Consistency on collaboration can also be seen in every block years.

Collaboration – coefficient and Index

In order to identify the level of collaboration, Collaboration coefficient and collaboration index were calculated. In this study Collaboration Index, Collaboration coefficient, Degree of collaboration and Modified Collaboration Coefficient has been employed.

Collaboration Index (CI)

The simplest of the indices presently employed in the literature is the collaboration index, (CI) which is to be interpreted merely as the mean number of authors per paper(APP).

$$CI = \frac{\sum_{j=1}^{A} jf_j}{N}$$

'j' is the number of co-authored papers appearing in a discipline; 'N' is the total number of papers in the discipline over the same time interval, and 'k' the greatest number of authors per paper in a discipline. As pointed out by Ajiferuke et al (1988)[4] this is to be interpreted merely as a mean, for in the absence of an upper limit there is no way of interpreting the numbers generated and secondly the method imputed a non-zero weight to single authored papers. To overcome this index referred to as the degree of collaboration is introduced where single-author papers have zero-weight.

Degree of Collaboration (DC)

Subramaniyam (1983)[5] proposed a mathematical formula for calculating author's degree of collaboration in a discipline. The degree of collaboration among authors is the ratio of the number of collaborative publications in the total number of publications published in a discipline during certain period of time. The values of degree of collaboration can be calculated both for publications and citations. It is expressed mathematically as:

$$DC = \frac{N_m}{N_m + N_s}$$

Where g = Group Coefficient of a discipline
N_m = Number of multiple authors during a specific period in a discipline
Ns = Number of single authored works in a discipline during a given period of time.

Collaborative Coefficient (CC)

The index CC given to overcome the disadvantages of collaborative index and makes it possible to draw a comparison between different sub-disciplines. In order to make a relevant comparison, consider the collaboration coefficient. The patterns of co-authorship among different countries have been examined by making use of Collaborative Coefficient (CC) suggested by Ajiferuke (1988)[6]. The formula used for calculating CC is given below:

$$CC = 1 - \left| \sum_{j=1}^{k} (1/j) Fj / N \right|$$

Where as

Fj = the number of authored papers
N = total number of research published; and
k = the greatest number of authors per paper

Modified Collaborative Coefficient (MCC)

It is lightly modified that the new measure is almost the same as that of CC, as given in Ajiferuke et al. (1988). Consider that every paper takes with it a single "credit" and this credit being shared with the collaborated authors. Thus if a paper has a single author, the author receives one credit similarly with 2 authors, each author receives 1/2 credits and, in general, if a publication has X authors, each receives 1=X credits (it was the same as that of the idea of fractional productivity defined by Price and Beaver as the score of an author when he is assigned 1=n of a unit for one item for which n authors have been credited.)

Hence the average credit awarded to each author of a random paper is E[1=X], a value that lies between 0 and 1. Since the value 0 is corresponding to single authorship, it can be defined as the Modified Collaborative Coefficient (MCC).

$$MCC = \frac{A}{A-1}\left\{1 - \frac{\sum_{j=1}^{A}(1/j)f_j}{N}\right\}$$

Where as

A = Total number of papers of particular year
N = All total number of authors in collection
j = the collaboration of number of authors like two, three, four etc.
f_j = all the authors in the collaboration

Co-Authorship Index (CAI)

Co-Authorship Index is obtained by calculating proportionately the publications by single, two and multi authored papers. The following formula is suggested by Garg & Padhi (2002)[7] and used by Guan & Ma (2007)[8] for Co-Authorship Index has been employed.

$$CAI = \frac{N_{ij} / N_{io}}{N_{oj} / N_{\infty}} \times 100$$

Where,

N_{ij} = Number of papers having authors in block i

N_{io} = Total output of block i

N_{oj} = Number of papers having j authors for all blocks

N_{oo} = Total number of papers for all authors and all blocks

CAI = 100 implies that a country's co-authorship effort for a particular type of authorship corresponds to the world average, CAI > 100 reflects higher than average co-authorship effort and CAI < 100 lower than average co-authorship effort by that country for a given type of authorship pattern.

Table 4 Author Collaboration – DC, CC, MCC, CI

S.No	Year	Single Author	Two Authors	Three Authors	Four Authors	Five Authors	Six and above	Total	DC	CC	MCC	CI
1	1986	11	22	34	20	6	12	105	0.90	0.40	0.41	3.23
2	1987	8	31	27	21	8	19	114	0.93	0.37	0.39	3.41
3	1988	7	33	26	20	19	24	129	0.95	0.35	0.36	3.64
4	1989	26	33	21	26	20	15	141	0.82	0.44	0.46	3.18
5	1990	29	45	38	32	23	16	183	0.84	0.43	0.45	3.13
6	1991	18	44	18	26	24	23	153	0.88	0.40	0.41	3.41
7	1992	13	29	38	24	21	28	153	0.92	0.36	0.37	3.62
8	1993	31	38	39	29	26	21	184	0.83	0.43	0.44	3.24
9	1994	17	35	27	26	22	26	153	0.89	0.38	0.40	3.52
10	1995	14	27	37	35	18	29	160	0.91	0.36	0.37	3.64
11	1996	29	30	42	40	31	45	217	0.87	0.38	0.39	3.69
12	1997	29	44	51	48	31	39	242	0.88	0.38	0.40	3.52
13	1998	26	42	69	59	34	32	262	0.90	0.37	0.38	3.49
14	1999	33	55	63	69	38	60	318	0.90	0.37	0.38	3.64
15	2000	36	57	82	66	46	57	344	0.90	0.37	0.38	3.58
16	2001	29	78	72	77	45	73	374	0.92	0.35	0.37	3.67
17	2002	40	88	95	94	62	97	476	0.92	0.35	0.36	3.72

18	2003	62	102	116	108	74	110	572	0.89	0.37	0.38	3.63
19	2004	60	127	115	107	80	161	650	0.91	0.36	0.37	3.77
20	2005	43	115	134	181	122	158	753	0.94	0.32	0.33	3.93
21	2006	67	128	175	165	112	225	872	0.92	0.33	0.34	3.92
22	2007	76	141	176	172	143	241	949	0.92	0.33	0.35	3.94
23	2008	47	192	213	154	143	280	1029	0.95	0.32	0.33	3.97
24	2009	100	168	231	218	181	301	1199	0.92	0.34	0.35	3.93
25	2010	91	252	267	311	203	405	1529	0.94	0.32	0.33	3.98
26	2011	119	312	328	374	279	518	1930	0.94	0.32	0.33	4.00
27	2012	133	345	416	448	297	591	2230	0.94	0.32	0.33	3.99
28	2013	128	386	412	447	306	669	2348	0.95	0.32	0.33	4.03
29	2014	118	398	447	496	333	778	2570	0.95	0.31	0.32	4.11
30	2015	118	355	451	465	328	815	2532	0.95	0.30	0.31	4.17
Total		1558	3752	4260	4358	3075	5868	22871	0.93	0.33	0.34	3.93

The Table shows that the degree of collaboration ranges between 0.82 and 0.95 and the average is 0.93. This indicates that there is existence of collaborative research in the field of tuberculosis research. The average of CI is 3.93 and the Collaborative coefficient is 0.33. The MCC value ranges between 0.30 and 0.46 and the average MCC is 0.34. Further it is observed from the table 4 that the authorship patterns are in increasing trends.

The coauthorship index for single, two, three, four, five, more than five and anonymous authors were calculated on yearwise and the same is shown in the Table 5

TABLE 5 COAUTHORSHIP INDEX (CAI)

S.No	Year	Single	CAI	Two	CAI	Three	CAI	Four	CAI	Five	CAI	Six and above	CAI	Total
1	1986	11	153.79	22	127.72	34	173.85	20	99.96	6	42.50	12	44.54	105
2	1987	8	103.02	31	165.76	27	127.16	21	96.67	8	52.19	19	64.96	114
3	1988	7	79.66	33	155.94	26	108.21	20	81.37	19	109.55	24	72.51	129
4	1989	26	270.69	33	142.66	21	79.96	26	96.77	20	105.50	15	41.46	141
5	1990	29	232.63	45	149.89	38	111.48	32	91.77	23	93.48	16	34.08	183
6	1991	18	172.70	44	175.30	18	63.16	26	89.18	24	116.67	23	58.59	153
7	1992	13	124.73	29	115.54	38	133.34	24	82.32	21	102.09	28	71.33	153
8	1993	31	247.32	38	125.89	39	113.79	29	82.71	26	105.10	21	44.48	184
9	1994	17	163.11	35	139.44	27	94.74	26	89.18	22	106.95	26	66.23	153
10	1995	14	128.45	27	102.86	37	124.15	35	114.80	18	83.67	29	70.64	160
11	1996	29	196.18	30	84.27	42	103.91	40	96.74	31	106.25	45	80.83	217
12	1997	29	175.91	44	110.83	51	113.14	48	104.09	31	95.28	39	62.81	242
13	1998	26	145.68	42	97.72	69	141.39	59	118.18	34	96.52	32	47.60	262
14	1999	33	152.34	55	105.43	63	106.36	69	113.87	38	88.88	60	73.54	318

15	2000	36	153.62	57	101.00	82	127.98	66	100.69	46	99.46	57	64.58	344
16	2001	29	113.83	78	127.13	72	103.36	77	108.05	45	89.49	73	76.08	374
17	2002	40	123.36	88	112.69	95	107.15	94	103.64	62	96.88	97	79.43	476
18	2003	62	159.12	102	108.70	116	108.88	108	99.09	74	96.22	110	74.95	572
19	2004	60	135.51	127	119.10	115	94.99	107	86.39	80	91.54	161	96.54	650
20	2005	43	83.83	115	93.09	134	95.54	181	126.15	122	120.50	158	81.78	753
21	2006	67	112.79	128	89.48	175	107.74	165	99.30	112	95.53	225	100.57	872
22	2007	76	117.56	141	90.57	176	99.57	172	95.12	143	112.08	241	98.98	949
23	2008	47	67.05	192	113.74	213	111.13	154	78.54	143	103.36	280	106.06	1029
24	2009	100	122.43	168	85.41	231	103.44	218	95.42	181	112.28	301	97.85	1199
25	2010	91	87.37	252	100.47	267	93.75	311	106.75	203	98.75	405	103.24	1529
26	2011	119	90.51	312	98.54	328	91.24	374	101.70	279	107.52	518	104.61	1930
27	2012	133	87.55	345	94.31	416	100.15	448	105.43	297	99.06	591	103.29	2230
28	2013	128	80.03	386	100.21	412	94.21	447	99.91	306	96.93	669	111.05	2348
29	2014	118	67.40	398	94.40	447	93.38	496	101.29	333	96.37	778	117.99	2570
30	2015	118	68.41	355	85.46	451	95.63	465	96.38	328	96.35	815	125.46	2532
		1558	100.00	3752	100.00	4260	100.00	4358	100.00	3075	100.00	5868	100.00	22871

It is seen from the table 5 that there is an increasing trend in more than six and above authors (44.54 to 125.36) when compare to the other authorship pattern. The other authorship pattern is seen in a decreasing trend in 2010.

In order to identify the priority status of research productivity index, the values are replaced with symbol (Benchmark) as suggested by Barre (1987), CAI has been further simplified as symbolic representation as CAI =100 for the normal average of co-authorship index then the value of more than 100 value is called above average as '++', less than 100 values called as below average of CAI as '- -' and the same is shown in Table 6.

TABLE 6 COAUTHORSHIP INDEX (CAI) IN CODED FORM

S.No	Year	Single CAI	Two CAI	Three CAI	Four CAI	Five CAI	SIX CAI	Total
1	1986	++	++	++	--	--	--	105
2	1987	++	++	++	--	--	--	114
3	1988	--	++	++	--	++	--	129
4	1989	++	++	--	--	++	--	141
5	1990	++	++	++	--	--	--	183
6	1991	++	++	--	--	++	--	153
7	1992	++	++	++	--	++	--	153

8	1993	++	++	++	--	++	--	184
9	1994	++	++	--	--	++	--	153
10	1995	++	++	++	++	--	--	160
11	1996	++	--	++	--	++	--	217
12	1997	++	++	++	++	--	--	242
13	1998	++	--	++	++	--	--	262
14	1999	++	++	++	++	--	--	318
15	2000	++	++	++	++	--	--	344
16	2001	++	++	++	++	--	--	374
17	2002	++	++	++	++	--	--	476
18	2003	++	++	++	--	--	--	572
19	2004	++	++	--	--	--	--	650
20	2005	--	--	--	++	++	--	753
21	2006	++	--	++	--	--	++	872
22	2007	++	--	--	--	++	--	949
23	2008	--	++	++	--	++	++	1029
24	2009	++	--	++	--	++	--	1199
25	2010	--	++	--	++	--	++	1529
26	2011	--	--	--	++	++	++	1930
27	2012	--	--	++	++	--	++	2230
28	2013	--	++	--	--	--	++	2348
29	2014	--	--	--	++	--	++	2570
30	2015	--	--	--	--	--	++	2532
								22871

It is observed from the Table 6 that the single author trend has been seen in the year between 1989 and 2004 besides 1986,1987, 2006,2007 and 2009 whereas more than six and above authors' trend is from 2010 to 2015. This table shows that more contributions of publication of this study period are by more than six authors.

Total authors of 22871 publications were calculated and the same has been shown in Table 7.

Table 7 Total authors

S.No	No. of authors	Publication	%	Total No. of Authors
1	1	1558	6.81	1558
2	2	3752	16.41	7504
3	3	4260	18.63	12780
4	4	4358	19.05	17432
5	5	3075	13.44	15375

6	6	2197	9.61	13182
7	7	1237	5.41	8659
8	8	793	3.47	6344
9	9	497	2.17	4473
10	10	287	1.25	2870
11	Others	857	3.75	21461
	Total	22871	100	111638

22871 publications were authored by 1,11,638 with an average of 4.88 authors per paper. This shows that Indian Tuberculosis research output has collaboration in nature which has a minimum of four to five authors per paper.

Document type and authorship pattern

Authorship pattern for document type were also identified and the same has been shown in Table 8

Table 8 Document type Vs Authorship Pattern

S.No	Document Type	Single Author		Two Authors		Three Authors		Four Authors		Five Authors		Six and above		Total	
1	Article	668	2.9%	2573	11.3%	3363	14.7%	3682	16.1%	2695	11.8%	5229	22.9%	18210	79.6%
2	Book	8	.0%	7	.0%	6	.0%	4	.0%	0	.0%	1	.0%	26	.1%
3	Book Chapter	50	.2%	84	.4%	53	.2%	24	.1%	17	.1%	24	.1%	252	1.1%
4	Conference Paper	69	.3%	91	.4%	94	.4%	55	.2%	38	.2%	53	.2%	400	1.7%
5	Editorial	149	.7%	77	.3%	17	.1%	3	.0%	4	.0%	11	.0%	261	1.1%
6	Erratum	0	.0%	1	.0%	6	.0%	4	.0%	3	.0%	7	.0%	21	.1%
7	Letter	210	.9%	296	1.3%	218	1.0%	232	1.0%	109	.5%	186	.8%	1251	5.5%
8	Note	86	.4%	60	.3%	43	.2%	40	.2%	16	.1%	29	.1%	274	1.2%
9	Review	269	1.2%	513	2.2%	442	1.9%	301	1.3%	185	.8%	312	1.4%	2022	8.8%
10	Short Survey	49	.2%	50	.2%	18	.1%	13	.1%	8	.0%	16	.1%	154	.7%
	Total	1558	6.8%	3752	16.4%	4260	18.6%	4358	19.1%	3075	13.4%	5868	25.7%	22871	100.0%

Out of 79.6% of articles, only 2.9% were solo research. Remaining 76.7% were collaborative research. Six and above authors publications were more comparing to other collaborative authorship pattern. In the case of books, out of 28 publications eight publications were of single authors. Seven were two authors, six were three authors, four were four authors and one has more than six authors. Even in letter form of document type, out of 1261 publications only 210 were single author publications. Remaining 1051 publications were collaboration in nature.

Collaborated countries

The countries that are collaborated with Indian authors in the tuberculosis research output has been identified. The country that has collaborated more than ten times were identified and the same has been shown in table 9.

Table 9 Country collaborated

S.No	Country	No. of papers
1	United States	1829
2	United Kingdom	648
3	South Africa	274
4	Canada	271
5	France	268
6	Switzerland	255
7	Germany	237
8	Australia	231
9	Italy	185
10	Sweden	164
11	Netherlands	150
12	Japan	148
13	Saudi Arabia	142
14	Malaysia	139
15	China	136
16	Belgium	133
17	Brazil	119
18	South Korea	115
19	Singapore	98
20	Spain	94
21	Denmark	88
22	Norway	86
23	Pakistan	69
24	Indonesia	64
25	Thailand	64
26	Mexico	57
27	Nepal	57
28	Philippines	57
29	Hong Kong	55
30	Taiwan	54
31	Kenya	51
32	Argentina	50

33	Turkey	48
34	Bangladesh	46
35	New Zealand	46
36	Portugal	44
37	Luxembourg	42
38	Austria	41
39	Iran	39
40	Nigeria	37
41	Ireland	36
42	Finland	35
43	Morocco	35
44	Viet Nam	35
45	Uganda	34
46	Egypt	32
47	Ethiopia	31
48	Peru	31
49	Sri Lanka	31
50	Poland	30
51	Russian Federation	30
52	Chile	28
53	Colombia	28
54	Greece	28
55	Malawi	28
56	Israel	27
57	Oman	26
58	Zimbabwe	25
59	Zambia	24
60	Ghana	23
61	Slovakia	21
62	Hungary	20
63	Kuwait	20
64	Cambodia	19
65	United Arab Emirates	19
66	Botswana	18
67	Bulgaria	17
68	Czech Republic	17
69	Tunisia	16
70	Gambia	15
71	Papua New Guinea	14
72	Cameroon	13

73	Cote d'Ivoire	13
74	Estonia	13
75	Fiji	13
76	Serbia	13
77	Slovenia	13
78	Uruguay	13
79	Lebanon	12
80	Bahrain	11
81	Iceland	11
82	Jordan	11
83	Tanzania	11
84	Ukraine	11

It can be seen from the table that nearly 84 countries were collaborated in tuberculosis research with Indian authors. The United States (1829) has major collaborated countries. It is followed by United Kingdom (648) and South Africa (274) .

8. Conclusion

Indian has a substantial research output on tuberculosis and stands third position in Global research output. The analysis reveals that collaborative research persist . This attempt of collaboration analysis of Indian research output on Tuberculosis shows the linear trend. 22871 publications were authored by 1,11,638 with an average of 4.88 authors per paper. This shows that Indian Tuberculosis research output has collaboration in nature which has a minimum of four to five authors per paper. Out of 79.6% of articles, only 2.9% were solo research. Remaining 76.7% were collaborative research. Six and above authors publications were more comparing to other collaborative authorship pattern. In the case of books, out of 28 publications eight publications were of single authors. Seven were two authors, six were three authors, four were four authors and one has more than six authors. Even in letter form of document type, out of 1261 publications only 210 were single author publications. Remaining 1051 publications were collaboration in nature. 84 countries were collaborated in tuberculosis research with Indian authors. The United States has major collaborated countries. It is followed by United Kingdom and South Africa. This study also confirms the finding of Hazarika and others[4] Kalyane ,V L and Sen, B K (1995), Dhiman, A K (2000) and Shokeen, A., and Kaushik, S. K. (2004).

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