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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.

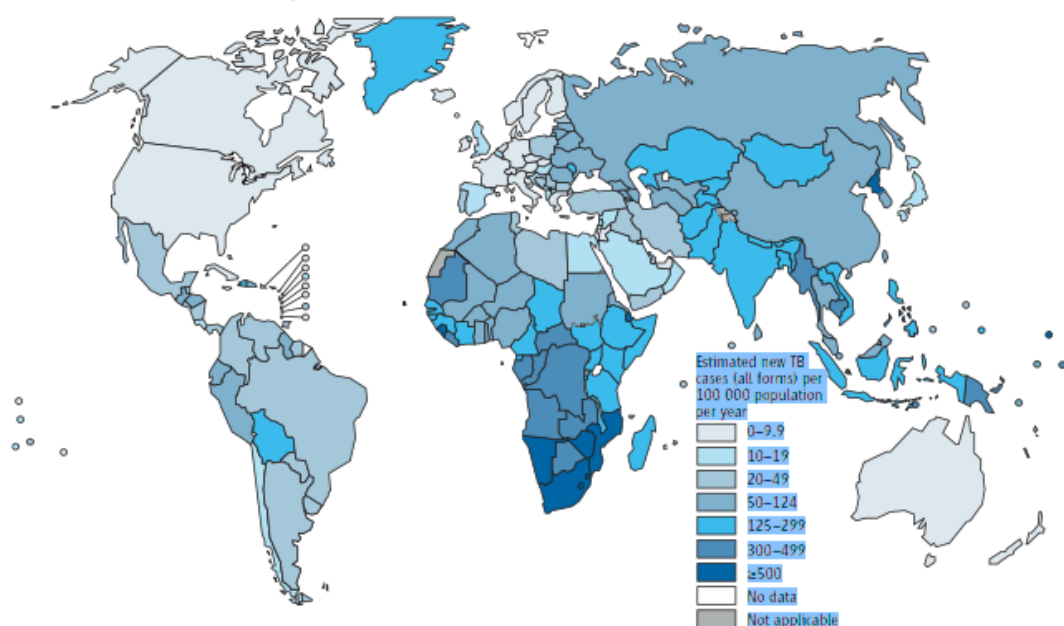


Figure 1 World TB affected countries*

*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) |
|---------|--------------|--------------------|--------------------|-----------|------------|-------------|
|---------|--------------|--------------------|--------------------|-----------|------------|-------------|

| | | | | | | |
|----|---|-----|--------------|-------|-------|-------|
| 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 (%) |
|------|-------------------------|-------------------------------|----------------|
|------|-------------------------|-------------------------------|----------------|

| | | | |
|----|--|-----|------|
| 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) |
|------|----------------------|-------------------------------|
|------|----------------------|-------------------------------|

| | | |
|----|----------------|-----|
| 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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