CHAPTER II

REVIEW OF LITERATURE

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2.1. INTRODUCTION

A comprehensive review of literature is an integral part of any research endeavour, as it helps to identify the gap in research and aids the investigator or researcher in designing and analyzing the research work. A literature review is a summary of a set of related research papers. It serves the purpose of distinguishing what has been done from what needs to be done, to identify the variables relevant to the study, to rationalize the importance of the problem and to identify the methodologies and research techniques that have to be adopted. It selects information from the papers and organizes and integrates it into a logical justification for the proposed research in order to provide basis for interpretation and discussion of findings. The studies reviewed and the inferences drawn are grouped under the following headings.

- Studies based on Global Research Output
- Studies based on National Research Output
- Studies based on Databases
- Studies based on Institutional Research Output
- Studies based on Individual Journal Output
- Studies based on Individual Researcher Output
- Studies based on Medical Subjects Research Output
- Studies based on Non-Medical Subjects Research Output
- Studies based on Citation Analysis

2.2. STUDIES BASED ON GLOBAL RESEARCH OUTPUT

Okhovati, Zare, Zare, Bazrafshan and Bazrafshan (2015) analyzed the trends in global assisted reproductive technologies research output from MEDLINE database for USA, UK, France, Germany, Canada, Italy, Japan (G7 countries), Brazil, Russia,
India, China (BRIC countries), Egypt, Turkey, Israel and Iran. The absolute number of publications for each country from 1998-2014 ranged from 75-17453 with a median of 2024. Among the research domains of assistive reproductive technologies, Cryopreservation and IVF were the emerging research subjects. 96739 articles were published on ART during the study period. Semantic word mapping technique was implemented to identify the subject areas using the VOSviewer software. G7 countries were the major contributors of ART research in the world. The research productivity was registered by USA was 21.82%, UK 9.78%, Italy 7.98%, Turkey 5.19% and China was 4.33% during the study period.

Alvi, Vinitha and Ravanjan (2014) attempted to study the world literature on Hepatitis C virus research, its growth, authorship pattern, collaborative nature, communication channel and productive authors / institutions / countries based on Scopus data for the period 1999-2013. Out of 60434 documents, articles were dominating (41442). USA was ranked 1st with 15837 papers followed by Japan with 5063 papers and Italy with 4853 papers. India occupied 13th position in global share. “Journal of Hepatology” was the most productive journal in the field.

Bandboni, Ramezani and Langooudi (2014) compared the scientific production in the field of reproductive medicine in Iran and Middle East Countries during 1996-2012 using data collected from SCOPUS database. Iran (660 articles) was in 11th rank in global share up to 2012 and was ranked 1st among the Middle East countries. H-index of the scientific literature in the field of reproductive medicine was 14 between the Middle East Countries whereas it was 4 for Iran. There were 24 journals in the field of reproductive medicine which are indexed around the world and
out of them 4 belong to Iran. Iranian h-index indicated that there is a progress in the research activities and its influence of the scientific production in this field.

Chitra, Jeyshankar and Abu (2014) used scientometric indicators to analyze lung cancer research literature among G7 and BRIC countries for the period 2003-2012. It revealed that among the G7 countries, USA topped with 44.58% of publications followed by Japan with 17.37%. China had the highest growth rate of 12.65 among the BRIC countries. The publication activity has been increased in the BRIC countries (China, India and Brazil) than that of G7 countries. In terms of productivity and citation impact, G7 countries lead in lung cancer research than the BRIC countries.

Sagar, Kademani and Bhanumurthy (2013) studied the scientometric mapping of publications on dark energy during 1999-2011. The study reveals that Europe was the most productive continent with 3723 (41.15%) publications and 126,747 (39.88%) citations followed by Asia with 2614 (28.89%) publications and 63267 (19.90%) citations. Publications from North America received the highest average number of citations followed by Australia, Europe, South America, Africa and Asia. Canada had the highest PEI (346.51%) followed by Chile with 315.54%. The relatively higher CAI of England, Germany, Italy, Japan and USA indicated that scientists in those countries prefer to work in larger groups.

Shao, Yu, Bo and Duan (2013) analyzed the oncology research literature published during 2001-2010 qualitatively and quantitatively. Documents published in 30 representative oncology journals were retrieved from the Web of Science (2001-2010). Knowledge domain visualization, co-citation analysis and social network analysis methods were employed. It identified the primary research centres, including the top 20 institutions and countries, the 4 major oncology research fronts and 36 most collaborative academic communities. Multiple myeloma, angiogenesis and acute
lymphocytic leukemia were found to be the focuses of collaborative research in oncology. Over the past 10 years, America had led oncology research, while China was the sole developing country to be ranked in the top 10.

**Bala and Gupta (2012)** had quantitatively analyzed world publications on Measles research during 2001-2010 by retrieving the data from Scopus database. The study findings showed that the world’s publications output on measles research was increased from 4701 to 5128 papers from 2001-2005 to 2006-2010. The international collaborative share of various countries varied from 15.70% to 60.65%. The largest number of collaborative links was between USA and UK (148) followed by USA and Switzerland (112), USA and Canada (70), USA and Germany (65) and Germany and UK (58). The study identified the necessity to improve the policy-making and delivering strategies of measles vaccine in the developing countries.

**Cantos-Mateos, Vargas-Quesada, Chinchilla-Rodríguez and Zulueta (2012)** undertook a study to identify the main research areas of stem cell research with Keyword plus (1997-2007). Data was extracted from Science Citation Index (SCI) database and the Journal Citation Report (JCR) of Thomson Reuters about scientific output and the impact factor of the journals where Spanish researchers had published their findings in the respective field of study. There was a clear rise in the production of stem cell research. The authorship pattern and productivity indicators reflected a coherent relation and a stable growth in the study period. Bilateral collaboration was found dominant than other lateral relationships. The subject “hematology” accounted for 42% of total publications. Maximum number of publications was received from the journal “Bone Marrow Transplantation and Blood”.

**Lewison and Roe (2012)** evaluated the Indian cancer research output published during 1990-2010 and indexed in Web of Science and from Indian Journals. Nine
largest Indian States and Union Territories were contributed more research publications on cancer. Out of 35 states, New Delhi, Maharashtra and Tamil Nadu were positioned in the 1st, 2nd and 3rd places. In India, cancer research was flourishing with doubling of literature over 20 years. India appeared to be on a much smaller scale than the cancer charities in Europe. There was a striking correlation between the research level and funding received for chemotherapy.

Chen and Guan (2011) investigated of research performance in emerging nano-biopharmaceuticals (1991-2008) from the data sets of WoS, MEDLINE and BIOSIS reviews were found. The structural and intellectual bases of research front were identified using Cite Space. Using visual mapping structures, it identified that drug development for improving bio-distribution, bio-availability and pharmacokinetics, and the drug delivery for improving delivery of existing drugs were the focused research areas. The cross-country comparisons showed that USA was the leading contributor in terms of productivity and impact share. China was the only country whose publications and citation share were increasing during the same period. It was identified that nano-pharmaceuticals scientific research as emerging as a pioneering and multidisciplinary domain from nano-biotechnology.

Garg, Kumar, Bhatia, Ramasubramanian, Kumar and Kumari (2011) explored a study on plant genetics and breeding research during 2005-2009. Out of 32574 papers published, USA was leading in contributions followed by China. Indian contributions were originated from 1806 institutions located in different parts of the country. Indian Council of Agricultural Research and the Council of Scientific and Industrial Research were the major contributors of the research output. International Centre for Genetics Engineering and Biotechnology, New Delhi and International Crop
Research Institute for Semi Arid and Tropics located in India had the highest research impact. International collaboration among the authors was steady at that time. Some of the countries concentrate their research on one sub domain. India’s major research area was varietal improvement / conventional breeding to abiotic stress and marker assisted selection. Publications from India in this field had appeared in 611 journals originated from abroad, especially from USA, Netherlands and England and 41 journals originated in India.

Gupta and Bala (2011) described the research literature in medicine during 1999-2008. It was observed that the maximum Indian research output on medicine came from cancer, followed by cardiovascular diseases, diabetes, AIDS, hepatitis, malaria, diarrheal diseases and pneumonia. Organ-wise analysis shows that the maximum research output was about heart followed by skin, brain, kidney, eye, muscle and artery. The Indian productive medical institutions were included 31 medical colleges, 23 hospitals, 15 research institutes, 16 universities and 11 research foundations. The research impact of medical colleges was the highest followed by research institutes, foundations, universities and hospitals. The highest h-index was achieved by research institutes followed by medical colleges, universities, hospitals and foundations.

Surwase, Kademani and Vijaikumar (2008) attempted to highlight the growth and development of world literature of pulsed laser deposition research during 1982-2006. Out of 8534 papers produced by 84 countries, the highest number of papers was published in 2005. USA was the leading country with 2014 papers followed by Japan with 1553 publications. 97.70% of the publications were multi-authored and 2.30% was single authored papers. Tata Institute of Fundamental Research, Mumbai and Indian Institute of Science, Bangalore was found as the most productive Indian institutes.
**Basu and Lewison (2005)** studied the characteristics of the world astronomy research during the last decade using Science Citation Index. Potential citation impact was determined from journal citation scores, and multiple regression analysis was used to evaluate leading countries. The study found that Indian astronomy output increased in potential impact partly through greater international co-authorship and partly through indigenous collaboration. Potential impact increased with more authors per paper from various institutions. Potential impact was greater for papers from Canada, UK and USA and lesser for papers from China, India and Russia.

**Karki and Garg (1999)** assessed the research performance on organic chemistry in India using the scientometric tools and identified the potential of the scientific research activities. The study revealed that the literature appeared in international journals has larger visibility and wider readership possibility, hence it reflected higher potential connectivity compared to that appeared in Indian journals. India had poor main stream connectivity in organic chemistry research. The mean impact factor and relative quality index were found to be 1.4 and 8.26 respectively.

**2.3. STUDIES BASED ON NATIONAL RESEARCH OUTPUT**

**Ahmed, Gupta and Gupta (2014)** examined the Indian publications in cataract research during 2002-2011. The global publication share of top 15 countries in cataract research varied from 1.29% to 24.08%. USA topped with 24.08% of global share followed by UK with 9.66%, China with 8.16%, Japan with 6.11% and Germany with 5.71%. India had published 1293 papers in cataract research during 2002-2011. Indian publications had increased from 87 to 195 in 2002 to 2011, witnessed an annual average growth rate of 10.03%, and registered a citation impact per paper of 3.26 during 2002-2011. India was ranked at 6th position among the top 15 most productive countries in
cataract research, with global share of 4.78%. The international collaborative share of India in cataract research was 21.58% during 2002-2011, which has increased from 20.08% during 2002-2006 to 22.61% during 2007-2011. Among the India’s internationally collaborated countries (45) in cataract research, the largest collaborator was United States (45.52% share) followed by Australia (17.56% share) and UK (15.77% share). The study suggested that the government should encourage the decision makers and ophthalmologists and allied persons involved in ophthalmic services by increasing the R&D, strengthening national and international collaboration and improve the existing training programs for ophthalmologic professionals.

Jeyshankar, Rao and Vellaichamy (2014) analyzed the food and nutrition research literature in India during 1960-2011. The growth of publications showed an increasing trend after 1987 and this field has been getting evolved in different regions of India. The data were highly scattered in different institutions and states in India. Scientists from Delhi, Andhra Pradesh, Karnataka and Tamil Nadu were producing the papers regularly. Affiliated institutes were analyzed under helix model and found that R & D institutes were contributing at the highest level. Time series analysis has been used to predict the development of research activity in food and nutrition field and found that it would be in an increasing trend.

Vellaichamy and Jeyshankar (2014) described the anemia research output, 1993-2013 using Scopus database. Out of 5085 publications were published during the study period, least number of papers was published in the year 1996 and they received more citations (3245). Among the top 15 institutions, All India Institute of Medical Sciences, New Delhi led with 373 papers followed by Post Graduate Institute of
Medical Education and Research, Chandigarh (268 papers) and Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow with 121 papers.

**Goel, Maurya and Desai (2013)** explored the research and development indicators in solar energy research in India. It was observed that USA has been the major producer of solar photovoltaics followed by India. In terms of publications of solar energy output, India on per capita basis continues to be approximately one fourth that of the world and was one among the five leading countries. Basic research was mainly conducted by Universities and Academic institutions while applied research was carried out by R & D centres and Labs. There was a strong correlation between the R & D input and technological growth. It is suggested to have international collaboration to improve the research performance.

**Sooryamoorthy (2013)** investigated the scientific research publications in the field of natural science in South Africa. The study found that the majority of authors were from universities while the research institutes were the 2nd major contributor in terms of publications. Like South African researchers in the natural sciences, foreign partners originated mostly from universities and research institutes. The only difference between South African authors and their foreign partners affiliated to universities was that South African researchers had partners from government and industry, but, for foreign partners, government and industry partnerships were relatively negligible. Collaboration with foreign scientists was remarkable in the natural sciences in South Africa. Introduced in 1987, the funding system for universities made an impact on research and research output in South Africa. Funding agencies that support research opt for inter-regional or inter-national collaborative projects rather than individual projects located in a single institution or in a single country.
Yucheng, Wah Hen, Piew Tan and Fai Fok (2013) analyzed the collaboration pattern of the research publications in Malaysia and concluded that out of 65% of domestically produced papers, 41% were produced as domestically intra-institution and 24% with local researchers from other institutions within Malaysia. More than three-quarters of the publications were the result of collaboration with academics from different universities, while co-authorship with researchers from public research institutes and industry was insignificant. A distribution map indicated that Malaysian researchers were engaged in collaborative research with researchers from almost every corner of the globe. The study insisted the importance of establishing international collaboration as well as university-industry collaboration for academic research.

Eghbal, Ardakani and Asgary (2012) did a comparative study on endodontic articles published in Iran with the neighbouring countries. Among the number of endodontic articles published from 29 countries, Turkey stood first with 962 articles followed by Israel, Iran, Jordan and Saudi Arabia. The rate of science production (GI; growth index) from 1980-1994 to 1995-2009 at the country level had the fastest growth in Iran (GI of 14.4). Iran has experienced a considerable growth in PubMed-indexed endodontic articles with a total of 82 and 54 endodontic articles in 2010 and 2011 respectively. Though, Iran was amongst the top countries in 2010, it stood behind Turkey in 2011 with a significant difference.

Gupta (2012) examined the Pakistan’s science and technology research output for the period 2001-2010 to comprehend its growth pattern, scientific communication channel and research priority areas. This study identified five high priority subject areas of Pakistan viz. medicine, agricultural & biological sciences, engineering, chemistry and physics. Pakistan’s collaborating papers share was highest with G-8 countries
followed by 18 developing countries. It had average annual growth rate of 20.86%. The study emphasized that Pakistan needs to increase its research output and improve the quality of the research efforts by investing more in R & D, deploying more manpower, increasing international collaboration and by strengthening its infrastructure.

**Sinha and Joshi (2012)** undertook a research to analyze Indian solar photovoltaics research output to identify the research profile of Indian institutes and Indian authors, their collaboration pattern and impact of their research output. Published literature was originated from 33 countries and from 481 journals. Only 10% was published in Indian journals and the rest of 90% was from foreign journals. Among these, highest number of papers in journals originated from USA, followed by England and the Netherlands. Bilateral collaborative papers were high rather than that of any other collaboration. And there seems to be a balance between the domestic and international collaboration in Solar PV research in India.

**Shari, Haddow and Genoni (2012)** had done a bibliometric / webometric analysis on bio-technology related journals and websites affiliated to Malaysian universities. Biotechnology research outputs published by Malaysian researchers from 2005 to 2010 indexed in the Web of Knowledge were searched and resulted 784 articles related to “biotechnology and applied microbiology” were analyzed. Collaboration behaviour was assessed in terms of intra-institutional versus inter-institutional; national versus international collaboration; and by type of institution collaboration according to the triple helix model. The two-way collaboration counting technique was adopted to measure the institution, category of institution, and country collaboration. Twenty most cited papers had citations ranging from 44 to 154. All papers were collaborative with
authors ranging from two to seven; intra-departmental collaboration was found high. There were five countries involved in collaboration other than Malaysia.

**Gupta and Bala (2011)** explored the performance on malaria research in India during 1998-2009. It revealed that India ranked 4th among the top 20 most productive countries in malaria research with its global share of 6.47%. Indian international collaborative papers were 409 during the study period. Eighteen countries have published two or more collaborative papers with India. USA was the major collaborating partner of India followed by United Kingdom, Switzerland, Germany, Australia and France (between 5%-9% share). Indian research output in malaria was published in nine broad subjects. Universities and colleges, and institutes of national importance group witnessed the rise in publication share of 4.63% and 1.48% respectively.

**Nwagwu and Egbon (2011)** analyzed the publications of Nigeria’s social science literature indexed in the Arts and Humanities Citation Index and Social Science Citation Index to understand the research publications dynamics. Although there were about 98 universities and 30 research institutes in Nigeria who conduct research and publish them in primary journals, there was hardly a coordinated national system of science. There was no single national database of university researchers, neither any national database of research outputs. Even at the institutional level, there was hardly any coordinated expression that researchers’ outputs require to be managed in order to benchmark research both in the institutions and in the national system of science. This study evidenced that Nigerian social science and arts and humanities literature has penetrated the international social science community.
Sagar and Kademani (2011) assessed the growth and impact of S & T research in Madhya Pradesh. Data was collected from WoS expanded version and grouped under 12 broad subject areas based on WoS subject categories. The highest number of publications was published in the subject “Clinical Medicine” followed by “Chemistry’. Among the international collaborating partners, USA was ranked 1st followed by England (2nd rank) and Germany (3rd rank) whereas in national collaboration, Chhattisgarh was ranked 1st and Uttar Pradesh 2nd. Collaboration trend varied from one subject to another; from one branch to another of same subject. Impact of collaboration on scholarly research resulted in an increase in productivity. It could be seen that more intensive collaboration trend was observed as papers with as many as 52 authors were identified.

Zhu (2011) conducted a bibliometric analysis of the development of Chinese research in superconductivity and to compare Chinese research with that of its international competitors. The research has grown steadily over the period with noticeable citation rate since 2001. All the countries have collaborated with each other, normally most strongly with the USA; the only exception is Russia, which has Germany as its closest partner. Other countries that were heavily involved in collaborations include Canada, Italy, The Netherlands and Switzerland. A cluster analysis suggested that the bibliometric characteristics of Chinese high-temperature superconductivity research currently resemble most closely with those of England, France and Russia.

Bala and Gupta (2010) described the research output of Indian neuroscience research during 1999-2008. India’s global share was 0.99% (4503 papers) with an average annual growth rate of productivity and its average citation per paper was 11.37% and 4.21 respectively. India was ranked 21st among the top 26 countries in
neuroscience research. India shared 17.34% of international collaborative papers. Among the international collaborators, 15 countries have published more than 10 collaborative papers with India during 1999-2008. USA was the major collaborating partner by contributing 60.95% publications share in India’s total international collaborative papers followed by United Kingdom, Germany, Australia, Canada and Japan and so on. India was far behind in terms of research output, its impact and international collaboration when compared to other countries.

**Albrecht (2009)** did a bibliometric analysis of research output funded by Cancer Association of South Africa (CANSA) during 1994 – 2003 to unveil the relationship between the quantitative aspects of research grants made by the CANSA and the quantity and quality of the research output in terms of number of publications and impact factor of publications over a 10 year period. The projects funded by CANSA were divided into ascending hierarchy of categories to ascertain main focus areas of research and found that more than two third of projects concerned about cancer biology and therapy. The quality of the research publications of the researchers funded by CANSA was found favourable with impact factor of the oncology publications in oncology journals in the US and the European Union. This study made a great foundation for the area of research to be focused in future and funding policies in accepting projects and providing grants against cancer research in South Africa and the world.

**Rajendiran and Parihar (2007)** studied about the laser literature in India, 1995-2005 and measured the quantitative distribution of literature source-wise and author-wise and degree of collaboration among authors. The journal distribution fits the typical Bradford S-shape curve. The degree of collaboration among authors was 0.94.
Majority of authors contributed only one article (65.04%) which was larger than the 60% of original Lotka’s data. Literature was scattered into eight different disciplines.

**Gupta, Dhawan, Bose and Mishra (2002)** undertook a research to trace out India’s collaboration with Australia in Science and Technology. Co-author analysis was used to identify the mode, extent and directions of collaborations between the countries in science and technology. This collaboration mainly took place through bilateral efforts and account for 62.11% of the total collaborated papers. Clinical medicine, Chemistry, Physics and Earth & Space sciences were the priority areas for collaborative research. A total of 124 Indian and 76 Australian institutions were involved in joint collaborative research during the period under study.

**Rodrigues, Fonseca and Chaimovich (2000)** identified the performance indicators for the Brazilian cancer, cardiovascular and malaria research during 1981-1995. It was found that there was an increase in publication growth and contributing authors of the scientific productivity. There was a growing trend in cancer and cardiovascular research and decreasing trend in malaria research. Brazilian periodicals played a crucial role in increasing the international visibility of science produced in the country. Malaria research was more evenly distributed across the country. Cancer and cardiovascular research were concentrated in the South eastern and Southern regions of Brazil.

### 2.4. STUDIES BASED ON DATABASES

**Fu, Zhang, Zhao, Huang and Chen (2011)** analyzed the documents published on acupuncture research during 1980-2009 and indexed in SCI expanded. Though Letters were the 2nd preferred document type, trend of its publications and citations
were decreasing entirely. The publications of all core journals of acupuncture showed an increasing trend. Europe, with 2303 papers was the largest contributor accounting for 33.53% of all documents with a high h-index value of 66, followed by North America and East Asia with 2,284 (33.26%) and 2,089 (32.53%) papers respectively. USA not only took 1st place in the number of papers and citations, but also showed a significant rising trend over 3 decades, as do England and Germany. The 2000s was the most productive decade for acupuncture related researches. Proportions of single author contributions have presented a decreasing trend in all the countries / regions, while collaboration paper showed increasing trend worldwide and percentage shares of national collaborations were the highest.

Mooghal (2011) made a quantitative analysis on scientometric research literature using bibliographic records from the Social Science Citation Index, Science Citation Index, and Arts & Humanities Citation Index. The study revealed that out of 691 articles in the field of Scientometrics, the top ten authors together contributed 183 articles (26.48%) during 1980 to 2009 by the top ten authors. It also identified that researchers of several nationalities were working on the scientometric themes, with a predominance of USA researchers with almost 14.62% publications. USA was the first collaborator of Iranian authors in their research. Hungarian Academy of Sciences was the most productive institution in the field of Scientometrics contributed 40 records (5.71%). The scientific production in the field of Scientometrics showed a mild increase from 1980 to 2009. The most prolific journal in this field was “International journal of Scientometrics”. 67.87% of the scientometrics literature was published from the area of Library and Information Science.
Kademani, Sagar, Kumar and Gupta (2007) attempted to analyze science and technology literature in India from SCI during 1990-2004. The study analyzed the features of Indian S&T by focusing on publication growth pattern, research quality, institutional productivity, collaboration, and subject areas of interests. Among top 10 countries, USA topped the list followed by Japan. India was ranked 15th in total contributions. Most of the contributions were in the low impact journals. The subject area chemistry was the interesting subject followed by Physics, Basic Science, Engineering, Clinical Medicine and so on. India’s international collaboration was increased from 12.55 % to 21.11%. India’s major collaborator was USA. In European countries, India’s major collaborator was Germany followed by England.

Ramakrishnan and Rameshbabu (2007) presented a bibliometric analysis of the literature output for the period 1984-2003 in the field of Hepatitis covered by the databases namely MEDLINE, CINAHL and IPA. There were 79312 records covered by these databases on hepatitis during the study period after the removal of duplicate records. The percentage of publications on hepatitis was 0.84% in 1984 and 1.08% in 2003 in MEDLINE database; 0.39% in 1984 and 0.65% in 2003 in CINAHL and 0.57% in 1984 and 1.30% in 2003 in IPA. 82.6% of records were articles followed by letters (5.3%) and comments (3.04%). Papers with more than five authors were significantly higher followed by single authored papers. 85.17% of contributions were out of collaborative research with different degree of collaboration. Higher level of degree of collaboration was identified in Hepatitis research.

Tsay and Yang (2005) investigated the growth of Randomized Controlled Trial (RCT) literature based on the MEDLINE database and explored the various features of the literature using well-established bibliometric methods. The study summarized that
the RCT literature from 1965 to 2001 grew exponentially, indicated that the growth of the literature using RCTs maintains a constant rate for the period of the study; the yearly growth rate was about 11.2%. Journal article (98%) was the single most common form of publication covered in MEDLINE. The subject areas that employed RCT methods the most include drug therapy for hypertension, therapeutic use of combined antineo plastic agents and drug therapy in asthma. Using Bradford zone analysis and the Bradford-Zipf plot, core journals (42) (containing 25% of the RCT literature) have been identified. Most of the core journals dealt with anesthesia, pharmacology and pharmacy, cardiac and cardiovascular systems, and general and internal medicine. The journals with impact factor greater than ten are related to general and internal medicine.

2.5 STUDIES BASED ON INSTITUTIONAL OUTPUT

Aswathy and Gopikuttan (2013) portrayed the publication growth of the universities in Kerala and examined the significance between the designation and experience with their quantity of publications. Lotka’s inverse square law using Pao’s method was applied to test the author productivity and it was verified by Kolmogorov-Smirnov goodness-of-fit method and found that productivity distribution does not follow Lotka’s inverse square law. Co-authored work was prevalent among the faculties of universities. There was no statistically significant difference between the designation and number of contributions in any universities but there was a significant relation between experience and contributions in the data set of University of Calicut.

Wani (2013) studied the research output of Indian Institute of Technology, Delhi as indexed in Scopus database during 1964-2010. The collected data was extracted under different subject areas. “Engineering” was the dominant subject area
followed by “Material sciences’. Research impact could be seen in the highly cited area of “Chemistry” with 14,264 citations. Since international collaboration was found to be very less, international collaboration with developed countries in the new areas of research was emphasized. There was a need to understand the national importance of the institutes and improve the infrastructure facilities to extend and promote the research activities.

Vatankhah (2012) evaluated the scientific research productivity of Zahedan University of Medical Sciences (ZAUMS) over the period of 36 years (1976-2011) using Scopus database. There was a significant correlation between the number of publications, citation rates and h-index scores. Department of Biochemistry and Infectious Disease was ranked 1st on the basis of scientific output. Most indexed scientific documents of ZAUMS in SCOPUS were in English (97%) and published in the form of research article (91.2%). The university h-index increased from 1 in 2000 to 19 in 2011 representing the growth of university scientific productivity from its establishment to the end of 2011. In recent years, association between co-authorship networks of organization was developed and collaboration network analysis became one of the scientometric indicators recommended on ZAUMS research productions to determine the collaboration features.

Burman and Sheela (2011) analyzed the citations of dissertations on Law submitted to University of Delhi to understand the subject relationships, author effectiveness, publication trends and core journals in the field. It has been identified that journal articles were the major source of information used by LLM students as 1/3 of the total citations were from journal articles. 69.78% of the journals were law journals and the most cited periodicals were from USA.
Jipa, Gorghiu, Dumitrescu and Oros (2011) applied different scientometric indicators to evaluate the scientific research performance in the Chemistry Department of the Faculty of Sciences and Arts from Valahia University of Targoviste. First 20 institutions involved in chemistry domain were ranked with the citation per paper. Among those institutions received 50000 or more citations, the first 9 ranks had taken by USA institutions. Harvard University had a value of 32.49 Citations Per Paper 9th rank was occupied by the Technical University of Munich, Germany with 15.60 Citations Per Paper.

Vasishta (2011) investigated the contribution and impact of research output of PEC University of Technology, Chandigarh to appraise the credibility of the faculty and the impact of its ability to deliver the quality education. The growth in the academic research output was analyzed during post-deemed university status and the study found that its contribution to engineering and technology literature steadily increased since then. Its comparison with the neighbouring NITs / engineering institutes insisted the need to improve the research output, research environment and infrastructure facilities of PEC University of Technology.

Bonilla-Calero (2008) described a scientometric analysis of the research output of institutional repository ‘Strathprints’ and revealed that scientific output recorded in ‘Strathprints’ has grown throughout 2000-2005 in terms of authors, centres and countries per document. The documents published in 2005 were the most cited and most downloaded. The study found a positive correlation between citations and the number of distinct countries that cite and download. The Strathprints documents covered by WoS have higher average numbers of citations. No relation was found between the
journals with the highest average number of citations in WoS per document and those with the highest number of citations in/from Strathprints.

Sevukan and Jaideep (2008) did a detailed analysis of the biotechnology literature published by 10 central Universities in India and indexed in two empirical databases namely PubMed and ISI *Web of Science*—SCIE during a period of 10 years from 1997-2006. It was found that Lotka’s law was applicable to the authorship productivity. Bradford’s law was not fitted to the biotechnology literature published in the study period. There was a steady increase in biotechnology literature. The trend of collaborative research publications especially by two and three authors was gaining momentum. Banaras Hindu University was the leading university having 42.55% of contributions with the consistent performance in its research.

Jeevan and Sen (2007) performed a scientometric analysis of publications from two accelerator-based research institutes / centres in India- the Nuclear Science Centre (NSC) and Tata Institute of Fundamental Research (TIFR)- based on the publication data obtained from the respective annual reports and impact factor values from JCR. Out of the three specializations in NSC, material science was more productive in terms of publications whereas higher percentage of qualitative papers originated from nuclear physics. Radiation biology has a very nominal presence, may be due to the small number of researchers pursuing accelerator-based life science research in the country. 85%-89% of papers of both the institutions were published in journals originated outside India. It showed that Indian scientists usually preferred to place their high quality papers in top-ranking journals of the world, which are invariably published from abroad.
Swarna, Kalyane and Vijaikumar (2002) investigated the technical reports of Bhabha Atomic Research Centre during 1990-99. Out of 554 technical reports produced in the study period, “Engineering and Technology” generated 207 technical reports followed by Chemistry, Materials and Earth Sciences. Conventional sources (85%) like journals, books, standards, manuals and patents were preferred as references. About 36% of self citations of the same institution were found in the total technical reports cited. Conference literature forms a vital communication link in the field of Engineering and Science. It was found that the technical reports were accepted as a medium of dissemination of technical data and information gathered through research efforts. This study was calculated the single and mingle divisional origin and the impact of collaboration with other R & D institutes in publishing technical reports.

2.6. STUDIES BASED ON INDIVIDUAL JOURNAL OUTPUT

Santhanakarthikeyan, Grace and Jeyshankar (2014) studied the scientific productivity of the journal “Indian Journal of Cancer”. The study found that 611 papers were published during the study period of which 244 (39.93 %) were research papers. The average number of articles per issue was 6 with an average of 24.4 papers per year. This demonstrated that cancer research was increasing in India with a marginal decrease in 2007, 2008 and 2012. Co-authorship index for single authored papers declined from 407 in 2008 to 194 in 2010. For four authored papers, co-authorship index increased from 83 to 119 during the study period. The average authors per publication (AAPP) were 5.47 and the average author productivity (APPA) was 0.18. After 2007, productivity per author increased slightly. Twenty two countries contributed 244 research papers during the study period. Of the 244 articles, 168 (68.85%) were published from India followed by 18 (7.37 %) from Iran. Among 22 countries, 8
countries collaborated with India in producing cancer literature. During the study period, the high level of collaboration was seen between the USA and India followed by India and China.

Rajendran, Jeyshankar and Elango (2011) carried out a scientometric analysis to explore the structure and growth of publications in “Journal of Scientific and Industrial Research”. Maximum number of publications (72.99%) was contributed by Indian authors. The pattern of co-authorship increased among the contributions of the journal but there was a very poor international collaboration. There was a fluctuation in authorship trend in contributing multi-authored papers. The journal seems to be a widely used communication channel for the international research community.

Shamim (2013) examined the efficacy of the journal “Journal of Forensic Dental Sciences” by evaluating publishing trend, subject relativity and authorship patterns. The forms of communications, sub domains of the subject and affiliated institutes were analyzed. Original research articles were the major contributions which showed a good indicator of the research activities in dental field. The articles were also checked for authorship trends according to the institution of the first author. The largest number of published articles was received from Meenakshi Ammal Dental College and Hospital, Chennai, Tamil Nadu.

LochanJena, Swain and Sahoo (2012) investigated the scholarly literature in “Journal of Financial Crime” during five years period (2006-2010) to understand its publication trend. The details with regard to each published article were recorded and analyzed. It revealed that majority of authors preferred to publish the research results in single authorship mode (75.48%) than the collaborative mode. Equal credit method was
employed for ranking of country productivity by scores. The analysis of the age of citations found that the citations of documents ranged from very recent year of publication to as old as documents of 358 years old and the half life of the cited documents was five years.

**Bontis and Serenko (2009)** ranked the academic journals using h-index and g-index to reflect the citation impact of the journals. Publish or Perish tool was used to obtain the citation data for the list of 20 journals from Google scholar. During the period (1994-2008), 2175 articles were published by 4236 authors. Out of them, 3109 unique authors were identified. However, for the 1994-2004 and 2005-2008 periods, there were 1.80 and 2.07 authors per article. A trend towards the publication of multi-authored works has been identified. Among 73 countries, USA, UK, Australia, Spain and Canada are placed in the decreasing order of productivity ranking. Out of 1450 unique institutions identified, 955 were academic organizations and 455 were non-academic.

**Kulkarni, Poshett, and Narwade (2009)** explored a study on “Indian Journal of Pharmaceutical Education and Research” (1996-2006). The study revealed that journals were the prime source cited followed by books. Majority of the scientists preferred to work as a team to publish their research papers in the field of Pharmaceutical Research.

**Hong-Yeoh and Kaur (2008)** examined the “Journal of Research in Higher Education” from 2000-2005. The study showed that journals and books were the most relied upon source materials in research. Most of the cited journals were in the range of six to ten years of age and books / monographs were between 11-15 years old. The
highest percentage of citation age falls between six to ten years signifying the importance of back files purchase for journal subscription to cater to the research needs of practitioners.

**Kumar, Prakasan, Kalyan and Kumar (2008)** analyzed the journal “Pramana – Journal of Physics” and found that the collaboration rate of the articles published was 0.70. The present trend of more institutional collaborative papers was found in case of Pramana articles. As the journal is of Indian origin, institutes from India were on the top of the list of contributed institutes. University of Delhi, Delhi tops the list followed by Bhabha Atomic Research Centre, Mumbai; Physical Research Laboratory, Ahmadabad; Institute of Physics, Bhubaneswar; Indian Institute of Science, Bangalore; Tata Institute of Fundamental Research, Mumbai etc. The articles originated from India were three fourth of total articles published. The number of articles written in collaboration with authors from countries other than India has been increasing in the recent past.

**2.7. STUDIES BASED ON INDIVIDUAL RESEARCHER’S OUTPUT**

**Munnolli, Pujar and Kademani (2011)** undertook a study to understand the research career of the Nobel Laureate Harald Zur Hausen in his research field, the communication medium he adopted to publish his findings, his core collaborators, domains of his research filed, his research interest and yearly publications outputs. Normal count procedure was followed. His publication productivity was steady throughout the study period. His research was in multi-disciplinary domains. He preferred to work in a team rather than working individually.
Sangam and Manjunath (2007) examined the scientific contributions of “Ramaseshan” in various journals and some classic papers. He had published a total of 178 papers during 1944-2000 and collaborated with 47 eminent scientists and students. He published papers in different areas of interest in his field and it has been classified into four major areas such as Crystallographic studies, Magneto-optics and Optics, Solid State Physics and Miscellaneous topics. Ramaseshan, S has contributed papers in various subjects during his times at the Indian Institute of Science, University of Madras and the Raman Research Institute.

2.8. STUDIES BASED ON RESEARCH OUTPUT IN MEDICAL SUBJECTS

Grace and Jeyshankar (2015) examined the research performance on infertility based on PubMed database during 2004-2013 to highlight the growth and development of infertility literature and to make the quantitative and qualitative assessment of various features of the research activity. An analysis of world-wide scientific efforts in terms of publications on infertility research showed that globally 4641 papers were published. There was a sudden growth of publications in 2005 and afterwards there was a steady growth in research output during the study period. The publications peaked in 2012 with 731 publications. Multiple authored contributions were found; maximum numbers of articles were contributed by a team of 3-7 authors whereas single authorship papers were found to be less. The highest number of publications was from England through the journal “Human Reproduction” with 23.96 % of total global research output. More than 50% of the publications appeared only in 10 core journals. Among the countries, England led the world and contributed 23.96% share of global publications in infertility research.
Gupta and Bala (2013) analyzed the research output of India in Alzheimer’s disease research during 2002-11. India was ranked 16th with 900 papers among top 20 countries with a global publication share of 1.33% (raised from 0.39% in 2002 to 2.36% in 2011). The annual average publication growth rate was 31.92% and citation impact per paper was 5.81. Its’ international collaborative share was 24.00% during 2002-11. The study emphasized that India needs to frame effective policies, increase extra-mural funding for the Indian science agencies / departments and extend national and international collaborative research efforts.

Gupta and Bala (2013) analyzed the research efforts on bone marrow research in India and found that India was ranked 11th among the top 15 most productive countries in bone marrow research, with its global publication share of 2.34% during 2003-12. India’s global publications share increased from 1.86% during 2003-07 to 3.30% during 2008-12. The international collaborative papers share of India in bone marrow research was 11.56% during 2003-12 (increased from 10.43% during 2003-07 to 12.18% during 2008-12). Among the international collaborators, United States was the major collaborator with 47.35% share of international collaborative papers. The top 15 most productive Indian institutions involved in bone marrow research have together contributed 38.92% in the cumulative share, with an average productivity of 67.8 papers per institution.

Gupta and Bala (2013) carried out a research on India’s publications output of Epilepsy during 2002-11. The annual average publication growth rate was 15.31% during 2002-11. Its global publication share increased from 2.06% in 2002 to 4.65% during 2011; its international collaborative share was 12.32% during 2002-11. Its citation impact per paper was 2.77 during 2002-11, which decreased from 3.48% during
2002-06 to 2.41% during 2007-11. Its international collaborative publications share was 12.32% during 2002-11, which decreased from 12.45% during 2002-06 to 12.26% during 2007-11. It is suggested that India needs to share research data and stimulate national and international collaborative research, which will increase both the quantity and quality of research in epilepsy.

Jeyshankar and Ramesh Babu (2013) carried out a scientometric study on Leukaemia research output to evaluate various parameters of research publications during 1960-2011. The growth pattern, authorship pattern, relative growth rate and level of collaboration among authors, contributions by the Indian institutions and future trend in leukaemia research were analyzed. Time series analysis and straight line equation method which were used to know the research trend in future revealed that the development of leukaemia research will be in an increasing rate in India. R & D institutions were actively participating in this research area than the universities and colleges.

Kumar, Aravinda and Kalra (2013) explored the research output of endocrinology research of India based on PubMed indexed journals. The study was limited to research in clinical area and excluded the data pertaining to basic and molecular endocrinology. The publications were categorized under six broad areas based on the important glands of the human body. For the affiliation purpose, the first author was considered. A gradual rise in the publications in each year showed a healthy publishing trend. Original articles which took a major part in publications, shows a good sign in the research activity of endocrinology. Majority of publications come from three cities namely Delhi, Chandigarh and Lucknow. There was a lacuna of research
activities in certain areas of the study due to their peculiar nature and lack of affiliated institutes.

**Moghimi et al. (2013)** conducted a scientometric analysis of research output on breast reconstruction surgery to identify the publishing trend. It was found that Surgery was the most repeated subject in the publications because most of the articles introduce new techniques for this surgery and compare them. United States and United Kingdom were the predominant countries producing articles on breast reconstruction. Almost all of the highly cited articles were published in professional journals of surgery or cancer and just one highly cited article was published in a general journal. Belgium, with the highest prevalence of breast cancer of any country worldwide, had a very average number of citations per paper.

**Jazayeri, Alavi and Rahimi-Movaghar (2012)** conducted a study to evaluate the quantity and quality of medical research outputs of top 50 countries. A modified form of the Citation Per Publication (CPPm) and Publication Per Population (PPPm) were used to make indices comparable through different years and nations by normalizing the values according to the world average standards. United States and United Kingdom were the top two countries with the highest h-index (13) value. They were ranked 15th and 20th in CPPm and 16th and 9th in PPPm respectively. The study suggested that instead of using impact factor (IF) to assess the quality of a journal, Strike Rate Index (SRI) as introduced by Barendse may be used. It is suggested to reform policies to regulate the finance and manpower in producing outputs.

**Manimekalai and Amsaveni (2012)** analyzed the research publications and the authorship pattern and subject areas on Genetics from the articles listed in WoS, 1998-
2011. 871 records considered for the study and the pattern of productivity, author categories were identified. The collaborative publications have shown a systematic increase and the single author papers seemed to be in a decline in the proportion. To verify their goodness-of-fit in the publication data on the number of authors per publication in genetics from India, simple probabilistic distributions were employed.

**Raja (2012)** studied about the global “space neuroscience research” publication during 1999-2012. During the study period, a total of 486 papers were published by the scientists in the field of space neuroscience research. The average publications (in %) in a year was 34.7%. During the period of study, 70 was the highest number of publications produced in 2010. Rabinovich, M I and Spence, C were the most prolific authors with 6 papers each constituting 1.2% of total papers published in this field. USA registered the highest number of publications (199, 39.9%) and UAE registered lowest number of publications (1, 0.2%).

**Suradkar and Khaparde (2012)** studied about the citation pattern in “Journal of Documentation”. The mean of relative growth for the five year period showed a growth rate of 0.278 whereas the mean for doubling Time for the five year period was only 1.813. The productivity of authors was measured in terms of the number of times a particular author was cited during 2007 to 2011. The value of group co-efficient for a citation was 0.42. The average rate of citation per article was 10.37.

**Ahila, Nagarajan and Gopalakrishnan (2011)** analyzed the research publications indexed in Web of Science on “Pharmacology” during the period 1999-2010 (12 years). Totally, 22,065 research articles were found during the study period and the annual growth rate, global publication share and rank among 15 major countries
of the world, authorship pattern, high productive Institutions, Journals, etc. were analyzed.

**Gupta and Bala (2011)** analyzed the research performance of India on asthma and found that Indian scientists had published 862 papers in asthma research during 1999-2008 and registered an average citation per paper of 3.43. The cumulative papers witnessed a growth rate of 58.86% for the papers from 1999-2003 to 2004-2008 with the h-index of 33. India was ranked 15th among the top 23 countries in asthma research, with global share of 1.27% and international collaborative share of 10.09%. USA was the major collaborative partner with the publications of 51.72%. The 396 publications from 13 most productive Indian institutions in asthma accounted for 45.94% share of country’s output with an average impact of 3.75 and an average h-index of 6.69. The 14 most productive Indian authors together accounted for 31.90% share in national output and with an average citation impact of 4.18 and an average h-index of 6.14. The top 100 highly cited papers had the citation range of 14-373 and have received 3372 citations, with an average of 33.72 citations per paper. The top 100 most-cited papers included 24 with international collaboration (14 bilateral and 10 multilateral) and 21 with national collaboration. The authors of these most-cited papers were affiliated to 44 Indian institutions which appeared in 76 journals.

**Gupta, Kaur and Bala (2011)** described that India’s total publications output was 4824 in diabetes research compared to China’s (7413 papers), Brazil’s (3235 papers) and South Korea’s (3069 papers) during 1999-2008. India’s cumulative publications output increased from 1534 papers to 3290 papers from 1999-03 to 2004-2008. The average annual growth rate of Indian publications in diabetics was 13.71%. India was positioned at 11th rank among the top 18 countries in diabetes research,
compared to China (7\textsuperscript{th} rank), Brazil (15\textsuperscript{th} rank) and South Korea (16\textsuperscript{th} rank). India’s global publications share was 1.92\% compared to China’s (2.95\%), Brazil’s (1.28\%) and South Korea’s (1.22\%). India’s global share in this research area increased from 1.36\% in 1999 to 2.41\% in 2008 and its rank increased from 12\textsuperscript{th} to 10\textsuperscript{th}. The citation impact of India’s publications output in diabetes was 4.29 compared to China’s (3.38), Brazil’s (6.45) and South Korea’s (7.79) during 1999-2008. India’s citation impact as reflected in average citations per paper has increased from 3.99 to 4.42 from 1999-2003 to 2004-2008.

Gupta, Kaur and Kshitig (2011) reported that among the top 20 most productive countries in dementia research, India was ranked 16\textsuperscript{th} (1109 papers) with a global publication share of 1.24\% and an annual average publication growth rate of 25.58\% during 2002-11. Its global publication share has increased from 0.54\% in 2002 to 2.20\% during 2011. Its citation rate per paper was 5.11 during 2002-11 which decreased from 7.29 during 2002-06 to 4.33 during 2007-11. Its international collaborative publications share was 24.54\% during 2002-11 which was also decreased from 28.57\% during 2002-06 to 23.07\% during 2007-11. India’s publications efforts were quiet low considering that to 3.7 million people suffering from dementia in India. The top most productive Indian Institution involved in dementia research was NIMHANS, Bangalore with 67 papers followed by University Institute of Pharmaceuticals sciences, Punjab University, Chandigarh with 61 papers and AIIMS, New Delhi with 51 papers.

Gupta, Bala, Baidwan, Chadhha and Cheema (2011) portrayed the research performance on typhoid research in India. Indian scientists together have published 940 papers in typhoid research in 2000-2009, compared to 322 papers each by China and
Brazil during the same period. India was ranked 3rd among the top 21 countries with its global publication share of 5.61% in 2000-2009. Compared to India, China and Brazil were ranked 13 and 14 with global publication share of 1.92% each in 2000-2009. India has witnessed an increase in its global publications share, rising from 3.89% in 2000 to 7.27% in 2009. India’s annual average publication growth rate was 15.07%, compared to 36.23% for China and 15.12% for Brazil. The average citation rate of Indian publications during 2000-2009 was 2.36 which was lower than China (3.7) and Brazil (3.47). The share of international collaborative publications (115 papers) in India’s typhoid output accounted for 12.23% in 2000 - 2009, compared to China (31.06%) and Brazil (21.74%).

Gupta, Bala and Kaur (2011) reported that India was ranked at 12th position among the top 20 countries in HIV / AIDS research and its global publication share (2.07%) was higher than Brazil (1.74%), but lower than China (2.24%) and South Africa (2.52%). The average annual publication growth rate of India was higher than that of Brazil, but lower than that of China and South Africa. But India’s international collaborative publication share was lower than other developing countries in top 20. Citation quality as reflected in citations per paper for South Africa and Brazil was found to be higher than that of India.

Khatun and Zabed (2011) studied the literature on diarrhoeal disease research in Bangladesh. The study revealed that there was a steady growth in the number of papers over the study period (1980-2009). The authorship collaboration has steadily increased since the 1980s. In fact, no single authored paper appeared during 2007-2009. The authorship data does not follow Lotka’s law. Among the core journals identified,
only one journal ‘Journal of Health, Population and Nutrition’ (JHPN) was published in Bangladesh.

Raja, Ramkumar and Viji (2011) analyzed the word wide research output of thyroid cancer based on web of science database during 1991-2010. The highest productivity in thyroid cancer was seen in 2006 and 2007 in the study period. The annual average number of publications was 10.78%. Fifty countries were involved in the research field. USA was the top most productive country with 140 publications followed by Italy with 44 publications. National Cancer Institute was the most productive institution with 15 publications. Thyroid topped the list with 273 publications followed by cancer with 131 publications and carcinoma with 112 publications.

Zhang, Huang and Li (2011) examined the research output on oncologic nursing using PubMed database. It was found that US, UK and Canada were the three largest producing countries in this field. Though a stable growth was found in cancer nursing output, the limited amount of publications from developing countries indicated that the field was still in progress. Co-word cluster analysis was used to extract frequently used MeSH words and these were classified into (1) nursing practice (2) nursing evaluation and education (3) nursing-related social support.

Al-Mutawakel, Scutaru, Shami, Sakr, Groneberg and Quarcoo (2010) investigated the world-wide research efforts on Leishmaniasis. Out of 19277 articles, only 3747 articles were internationally collaborative papers (19.43%). Among 140 countries which contributed papers, 134 countries had collaborations. 80.09% of the articles (3000) had collaboration between only 2 countries, 18.91% (596) among 3
countries and 2.88% (108) among 4 countries. The majority of publications were published in English and it was difficult for non-English journals to be included in the data bases. Therefore, numerous scientific publications in non-English languages were not accessible. Thus, English speaking countries such as the US, Canada and UK had an advantage.

**Glynn, Scutaru, Kerin and Sweeney (2010)** undertook a bibliometric and density equalizing analysis on breast cancer research output based on Web of Science database and revealed that out of 155 different countries which contributed in this research field, United States produced the highest output. There was a parallel increase in the number of citations with the increase in publications. United States which plays the lead role in the cancer research spent enormous amount in breast cancer management annually and had international cooperation with other countries involved in this research field. Many nations involved in breast cancer research reflected its global burden. The study showed a need for focusing research activities in ‘cost effectiveness in diagnosis and management of breast cancer’.

**Kaur and Gupta (2010)** had done a research on India’s research output during 1999 - 2008 on dental science. It was inferred that India hold 14th rank among the top 20 productive countries of the world in dental sciences with its global share of 1.66%, as computed from cumulative world publications output data for 1999-2008. India has shown rise in its global publications share which increased from 0.56% in 1999 to 2.86% in 2008. Correspondingly India’s world ranking was improved from 18th in 1999 to 9th in 2008.
Shahbodaghi and Sajjadi (2010) investigated the qualitative and quantitative developments of medical informatics articles in Iran from 1987 to 2009, based on ISI Citation databases. This study showed that there were no publications from Iranian scholars on this subject area till 1999 and the year 1999 was the beginning of the entry of Iranian scholars in the field of medical informatics publications. It was found that the greatest number of article was published in 2007 and there were fluctuations in the number of articles published during the study period but the overall publishing trend indicated the rising pattern. English was the dominant language in ISI citation database, so the articles written in Parsi language lose the chance of being indexed in the database. Content analysis of the articles based on medical subject headings was done to identify the subject orientation of the Iranian medical informatics articles.

Ahmed and Rahman (2009) examined the validity of Lotka’s law to authorship distribution in the field of nutrition research of Bangladesh. The result depicted that author productivity distribution predicted in Lotka’s generalized inverse square law was not applicable to nutrition research of Bangladesh. Using Least Square Method excluding the highly productive authors and Maximum Likelihood (ML) method, Lotka’s law was found to be applicable to nutrition research of Bangladesh.

Kaliyaperumal and Natarajan (2009) examined the growth pattern as well as overall trend in literature output on retina during 2002-2007. Secondary data collected from a set of retrieved bibliographic records in the field of retina from the CD-ROM sources of MEDLINE was studied. The results indicated variability in the authorship pattern. English language was the major medium in literature output for retina. USA’s contributions were higher in this subject in comparison to other countries of the world.
Krishnamoorthy, Ramakrishnan and Devi (2009) studied the literature on diabetes (1995-2004). It revealed that since the relative growth rate was found decreasing throughout, the doubling time was increased every year. USA was the largest contributor of literature on diabetes research, when the journals were ranked based on research output. Bradford’s Law of Scattering was fit for the research productivity of diabetes during the study period.

Ortiz, Calo, Suarez-Balseiro, Maura-Sardo, and Suarez (2009) identified the characteristics and trends of cancer publications in Puerto Rico’s biomedical journals and their relationship with the island’s cancer mortality. This study showed that most cancer-related publications in the PRHSJ and the BAMPJ, two Puerto Rican biomedical journals, from 1903 to 2005 were original articles written in English, and authors were affiliated to academic institutions. Epidemiologic studies were the dominant and the most studied cancers were digestive and gynaecologic. With regard to publication trends, the growth observed in cancer publications in these journals for the complete study period did not parallel the increase in the cancer proportional mortality in Puerto Rico. It is recommended to evaluate the local scientific materials such as monographs, books, dissertations / theses as well as articles published in journals outside Puerto Rico by authors affiliated with Puerto Rican institutions to understand the total spectrum of cancer research. It is also suggested that citation analyses should be included for authors affiliated with Puerto Rican institutions as an important consideration to evaluate research quality.

Vitzthum, Mache, Quarcoo, Scutaru, Groneberg and Schoffel (2009) examined the research output on Scoliosis. The majority of data originated from the U.S.A., the U.K. and Canada. Sweden had the highest citation impact. Comparing the
number of published items and international cooperation, the average citation rate for Australia and Sweden appeared disproportionately high. Further analysis revealed the tendency towards high self-citation rates in these two countries, which was also found for the USA, U.K and Finland. Moreover, increasing number of self-citations lead to high average citation rates and to the distortion of further qualitative research assessment.

Krishnamorthy and Amudhavalli (2008) scrutinized India's R&D emphasis on Biochemistry among the top three sub-disciplines as its Activity Index (AI) was found to be 136 compared to General Medicine and Pharmacology with 109 and 87 as AI respectively. However, India's published literature was quantitatively larger in General Medicine (6016) than in Biochemistry (1091). With the AI found to be more than 100 in General Medicine and Biochemistry, these two subfields seem to reflect higher activities than the world's average efforts. Pharmacology's AI was found to be lower than the world's average efforts.

Ugolini, Puntoni, Perera, Schulte and Bonassi (2007) carried out a bibliometric study to identify the publishing trend and compare the production in the field of cancer molecular epidemiology with the data downloaded from PubMed. This study showed that highest scientific production in field of cancer molecular epidemiology was found in Europe and USA. During the first 8 years of observation, the number of papers focused on cancer molecular epidemiology constantly increased all over the world. It also emphasized the additional need for characterizing the whole discipline, with formal definition and operative definition.
Nejatisafa et al. (2006) portrayed the status and trends of child and adolescent mental health research activity in Iran during 1973–2002. Of 883 articles published in this period, more than 90% appeared in domestic journals. Currently 23 journals in the field of mental health were published in Iran which was not indexed in international databases. A study on scientific productivity of Iran as measured by the number of papers indexed in ISI revealed that the production rose from 0.03% of the world's scientific output in 1991 to 0.3% in 2003, which indicated a ten-fold increase in less than fifteen years. There was a paucity of research about substance related disorders in children and adolescents, mental health service research and relative longitudinal studies. IranPsych, the most comprehensive database was the source of the articles for mental health research in Iran. It is projected that from now on, the rate of publications would increase much higher as the formal academic field of child and adolescent psychiatry was just established in 1997. Iran's overall share of child and adolescent mental health research has increased in the past decade.

Patra and Bhattacharya (2005) did a bibliometric study on cancer research output in India. Bradford’s law of scattering and Lotka’s law were employed to identify the core journals which published the cancer literature and to study the scientific productivity of the authors and the institutes in India which are actively participating in cancer research. The study also identified how many Indian journals were the core journals in this research area and which one has high impact factor. All India Institute of Medical Science (AIIMS), Delhi has produced maximum papers on cancer research followed by Tata Memorial Hospital, Mumbai.

2.9. STUDIES BASED ON RESEARCH OUTPUT IN NON-MEDICAL SUBJECTS
Belter (2013) conducted a bibliometric analysis of NOAA’s office of Ocean Exploration and Research (OER) from 2002 to 2012. Bibliometric mapping identified six major research areas of OER-supported publications: “Corals and Coral Reefs”, “NW Atlantic Ecosystems”, “Undersea Geophysics”, “Hydrocarbon seeps”, “Arctic Ocean Ecosystems” and “DNA analysis”. Percentile analysis found that a higher than expected i.e. over 20% of OER articles in the subjects of Oceanography and Marine and Freshwater Biology were ranked in the 90\textsuperscript{th} percentile for their subjects and years of publication. A lower than expected (around 35%) percentage of these articles were ranked in the <50\textsuperscript{th} percentile.

Meena, Kumar and Jain (2015) explored the publication and growth pattern of Chickpea research in India based on CAB (Common Wealth Agricultural Bureau International’s database) direct online database from the year 2000 to 2014. Lotka’s law was applied to verify the author productivity and observed that it was not fitted for the number of authors in this study. It was identified that ‘plant production’ was the most preferred research area and ‘Legumes research’ was the core journal in this field. The relative growth rate of the productivity has decreased and doubling time has increased during the study period. The study revealed the growing trend of productivity among the Indian scientists in chickpea research in comparison to world productivity.

Grace, Santhanakarthikeyan, Padma and Ravikrishnan (2014) analyzed the aeronautical research output during 2003-2012 using IEEE explore database. The author pattern, geographical distribution, reference count, publisher distribution, citation range and highly cited articles were identified. The study concluded that economic position of the country is not a barrier for research activity. India must take effort to collaborate
with leading countries and sufficient finance must be provided so that developing countries can create their own unique identity in this field.

Sagar, Kademani and Bhanumurthy (2013) attempted to study the characteristics of agricultural science research based on WoS database. The domain wise, country wise, continent wise publications and impact factor, specialization index and publication efficiency index were analyzed. The study revealed an exponential growth of literature except in 2012. There have been a significant growth in publications and research impact in various countries. The contributions from the Asian countries were significant in productivity but not in terms of impact.

Chang (2012) explored the characteristics and trends of scientometric research authored by researchers in Taiwan based on journal articles and theses. The findings indicated that after the first article on scientometrics published in 1987, an increasing trend was observed in the number of scientometric-related publications after 2000, indicating that scientometric research received more attention in recent years. The various academic backgrounds of scientometric researchers suggested that further investigation is warranted concerning the selection of research topics by authors.

Biglu et al. (2011) studied literature on nanotechnology in medicine during 2001-10. Data on patent applications was obtained from WIPO Statistics Database. Database of Science Citation Index Expanded (SCIE) was selected from Web of Science to obtain publications indexed under the topic “nanotechnology”. The study revealed that the number of publications in 2010 was 84 times greater than those in 2001. English language consisting of 98% of total publications was the most dominant language of publications. Based on Bradford’s scattering’s law, the journal of
“Nanoscience and Nanotechnology” distributing 12.8% of total publications was the most prolific journal. USA was the most productive country contributing 39% of world’s publications followed by China (10%), Germany (6%), Japan (6%), Korea (5%) and UK (4%). The majority of world’s publications (70%) were produced by these six countries.

Deshmukh (2011) did a citation analysis of “Annals of Library and Information Studies” during 1997-2010 to discover various forms of sources used to support their findings, identifying core journals and life period of journal and book citations. During study period, 56 issues were published with a total of 326 articles which had a total of 4141 references. Journals (54.34%) were identified as the most cited sources among the 4141 cited documents followed by books, websites, conference proceedings, institute publications, dissertations in order. Half life period of journals and books were found increased from 8 to 9 and 12 to14 years respectively.

Micheli (2011) carried out a study to assess the cancer performance in the European Union from 2000 to 2008. 143 oncology journals were examined by journal citation reports accessing them via Scopus. USA held a clear lead in 2006-2008 in number of publications whereas the EU27 held the lead previously. The gross domestic expenditure on research and development spent by EU27 from 2002 to 2007 was increased by 28% only. The study suggested that the new findings to be considered by the policymakers in Europe and other countries when developing policies for cancer control.

Varaprasad and Ramesh (2011) examined the contribution of different institutions and sub-specialties in Chemical Sciences using Activity Index for the world
and India. It was observed that universities and research institutions were the primary centres of scientific research in India. Indian Institute of Chemical Technology occupied first place in organic chemistry followed by National Chemical Laboratory and University of Delhi, whereas in inorganic chemistry, Jadavpur University scored top position followed by Indian Association for the Cultivation of Science and Indian Institute of Technology, Bombay. In case of applied chemistry, National Chemical Laboratory was in first position followed by Indian Institute of Technology, Madras and Bhabha Atomic Research Centre. In case of miscellaneous chemistry, Bhabha Atomic Research Centre was the topper among the ten institutions. 70% of the highly productive institutions have given importance to both organic and inorganic chemistry and 60% institutions have given importance to applied chemistry.

Serenko (2010) analyzed 11 major ‘knowledge management’ and ‘intellectual capital’ peer reviewed journals to identify scientific productivity in terms of country, institution and individual, cooperation pattern among the countries, institutions and individuals. Based on the findings, importance of collaboration between the practitioners and academics in research projects was emphasized. With respect to co-authorship patterns, multi-authored manuscript was observed as a publication trend. No single institution generated the most research publications; it was a cumulative effort of large variety of individuals from academic and non-academic organizations.

Zell et al. (2010) explored a comparative study on the research output of air pollution based on the data from Web of Science and PubMed databases as a comparative study. The preferred medium for publishing research literature on air pollution was the articles and the major contributions were made by US. UK and Germany were ranked 2nd and 3rd. Out of ten most publishing journals, nine dealt with
the environmental subject matters and one with epidemiology. Analysis of subject areas revealed that among the top ten areas, only two involved medical issues. The total number of publications was used as a distinguishing mark for the research quantity. The average citation rate was introduced to evaluate the nation’s research quality.

**Davarpanah and Asleka (2008)** conducted a scientometric study to analyze the publication productivity of the LIS journals. The Social Science Citation Index was used to extract the data from 56 LIS journals. It was observed that English was the dominant language in publishing research findings. Subject areas were analyzed and found that communication and information technology topped with 29.7% of publication. Most of the contributions were from USA and UK. The publications brought by the universities were higher than that of non-academic institutions. The latest articles were most cited by the LIS researchers. Citation indicator became quite stable in a period of 3-5 years after publication. It is concluded that when analyzing scientific journals, citation rates alone cannot assess the quality of a paper and so both citation analysis and expert surveys are to be used.

**Glanzel and Urs (1999)** made an analysis of reference literature in the sciences and social sciences based on three indicators namely the percentage of references to serials, the mean references age, and the mean reference rate. While about 80% of all science journals cited more than 70% of all references to serials, the same percentage of all social science journals referred less than 70% references in serials. In the sciences, journals citing more recent references were concerned with life sciences as well as with physical sciences and engineering. The comparison of the mean age of references in serials and that in non-serials showed that there was an extremely strong relationship between these variables. It means that for both science and social science journals, the
age of serial references corresponds to that of the non-serial references, which the age of serial references proportionally increased and decreased with that of the references in non-serial literature. The calculation of the mean number of references showed that two of the core disciplines in the social sciences (Psychology and Psychiatry and Sociology) had a similarly high number of references: 31.0 and 32.7 references on an average, respectively.

2.10. STUDIES BASED ON CITATION ANALYSIS

Sangwal (2013) scrutinized the data collected from Journal Citation Report (JCR) (2008-2011) to identify the growth trend of recent scientific publishing in India and its citation characteristics. Bibliometric data about the journals published in India, their publishers, IF2 with and without journal self cites, IF5 and journal self citations were analysed. In contrast to 55% of top journals, only 15% of bottom journals have their IF5. 70% of the top journals were published by dominant publishers Medknow, IAS, NISCAIR and ICMR in 2011. The IF2 for non self citation for most of the journals differ no more than 30% from their corresponding IF2. The study identified that IF2 of the top journal increased in successive years from 1.884 in 2008 to 2.722 in 2011. It identified that IF5 > IF2 for about 75% journals in 2009 and about 51% journals in 2011. With their increasing publications duration, IF2 and IF5 of the top journals increase whereas those of the bottom journals decrease.

Reza Davarpanah and Amel (2009) investigated the author self-citation behaviour in four disciplines: electronic engineering, general and internal medicine, organic chemistry and plant sciences. The findings showed that the four disciplines had significant differences in citation patterns, either self-citations or other citations. The share of author self-citations in the four disciplines comprised 41.25% of all citation to
articles published in 2004-2006. On average 60% of the articles in the four disciplines literature contained at least one self-citation. The greatest frequency of self-citation was found in organic chemistry. The share of self-citations decreased and the chance of receiving other citations increased with growing citation window. There was a strong positive correlation between the number of self-citations and the number of citations and number of co-authors of the publications. It is concluded that co-authorship style influences self-citation patterns.

2.11. SUMMARY AND INFERENCES

Totally 108 research publications on Scientometrics both from India and other countries were reviewed in term of various variables and inferences drawn. It is evident that the bibliographic databases were used in many studies as the source of data. More scientometric studies on the medical subjects like diabetes, cancer, hepatitis, dental science, asthma, stem cell, leukemia, malaria, measles, diarrheal disease, medicine, and endocrinology etc were done. The country wise distributions of research data, the application of Lotka’s law, Bradford’s Law were also studied. USA and UK were of the countries having high productivity and high self citation rates (Vithum, K 2009).

The reviewed literature revealed that the collaboration research is higher than that of solo research (Manimekalai, et. al. 2012). The various databases used as a major source of data were Scopus, Web of Science, SCI, PubMed etc. (Sangwal, 2013), (Mooghali, 2011), (Kademani et. al., 2007) and (Fu et. al., 2012). Individual journals, doctoral theses and dissertations were also used as sources of data for various studies (Rajendran et. al., 2011), (Shamim, 2013), (Thanuskodi et. al., 2013) and (Swain et. al., 2011). The publication formats, application of Bradford’s Law (Patra et. al., 2005), application of Lotka’s law (Aswathy and Gopikuttan, 2013), (Sevukan and Jaideep,
the growth rate, the degree of collaboration, the citation age and citation scores by source of format (Hong Yeoh, and Kaur, 2008), the country collaboration, activity index and publication efficiency index (Gupta et. al., 2002), (Sagar et. al., 2014) are the various bibliometric indicators used in various studies.

**Document types of reviews:** Out of 108 papers reviewed by the researcher, 107 are journal articles and one is a conference paper.

**Year-wise Analysis of the reviews:** While 40 papers were published during 1950-2010, the remaining 68 papers were published between 2011 and 2015. A maximum of 23 papers were published in 2011 followed by 16 papers each in 2012 and 2013. There is no review paper from the year 2001 and 2004. 50 % (55) of the papers reviewed by the researcher were published between 2011 and 2013.

**Authorship Pattern of the reviews:** Single author pattern has contributed just 14 papers. 87.03 % (94) of the papers were contributed in joint-authorship style. While there are 41 two-authored papers, 31 are three authored and 10 are four authored papers. While 7 author style contributed 2 papers, six author style contributed 4 papers. Thus, joint-authorship pattern is dominant among the review papers.

**Grouping of Reviews:** While 33 papers documented the metric studies of medical subjects, 19 described the national productivity of individual countries. 15 papers analyzed the global research output on various fields of study and 13 papers examined the quantitative aspects of non-medical subjects. 10 papers investigated the research output of individual institutions whereas 9 papers elaborated the literature output found
in journals. Two papers each talked about individual researchers and citations. 9 papers examined the quantitative aspects of Indian journals.

There is no previous publication which analyzed the research output of infertility both in India and abroad. The present analysis of infertility research literature in terms of productivity, continent wise & country wise distribution, author and country collaboration, growth rate and the trend of citing and citation scores is the first comprehensive scientometric analysis on the subject “Infertility”.

2.12. CONCLUSION

This chapter has given brief reviews of related literature collected by the researcher in the field of Bibliometrics/ Scientometrics. These reviews have hinted the researcher on various dimensions of research like sources that can be used for data, indicators that can be used for analysis, the tool and techniques that can be used for drawing inferences and the ways of presenting the interpretations. The next chapter will give an overview of the subject ‘Infertility’.

REFERENCES


