CHAPTER V

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5.1 INTRODUCTION

The present study is carried out to identify the scientometric characteristics of the publications output on Infertility research during 1985-2014 as indexed in Scopus database. This chapter presents the findings of the study under four broad headings and offers both findings-specific and general suggestions to improve the research productivity in infertility literature with a special reference to India. This chapter also directs the future researchers on what can be studied in the similar line. The chapter ends with deliberate discussions and conclusive words.

5.2 MAJOR FINDINGS OF THE STUDY

5.2.1. QUANTITATIVE ANALYSIS

Growth and Development of Scientific Productivity on Infertility: A Temporal Evolution: It is found that 2012 is the most productive year with 4141 (5.51%) publications followed by 2013 with 4121 publications. The least number of 1193 documents were published in 1986 (1.59%). While first 20 years (1985-2004) contributed 52.17% (39181) of documents, the last 10 years (2005-2014) contributed 47.83% (35917) of documents. We can witness an increasing trend during 2001-2012 and 1987-1993, while fluctuation is visible in other periods of study (Table 4.1 and Figure 4.1).

It is also noticed that the block 2010-2014 is the most productive block with 25.55% of publications followed by the block 2005-2009 with 22.28%. The first block 1985-1989 is the least productive block with 6745 documents. There is a constant increase in the cumulative publications in all the blocks. This shows that the overall
research output on infertility literature is an increasing slope. The average publication per block is 12516.33 documents (Table 4.2, Figure 4.3 and 4.4)

**Ratio of Growth (RoG) and Compound Annual Growth Rate (CAGR):** It is discovered that The Ratio of Growth fluctuates from 0.83 to 1.14. While 2002 saw the highest ROG of 1.14 (the number of publications are 1.14 % more than that of 2001), 2014 witnessed the lowest ROG of 0.83. The Ratio of Growth with the base year 2000 shows a steady rise from 2002 to 2012. It was increased from 1.11 in 2002 to 1.78 in 2012. While comparing the publication productivity of infertility literature of 2000 with other years, 2012 showed 1.78 times of growth. The Compound Annual Growth Rate (CAGR) shows 3.44 times of growth in infertility publications (Table 4.3 and Figures 4.5 and 4.6).

The block 1990-1994 has the highest RoG of 1.32 followed by 2005-2009 with 1.28 and 2000-2004 with 1.25. The least RoG is registered in the block 2010-2014. The CAGR ranges from -1.12 to 6.45 during the study period (Table 4.4 and Figure 4.7).

**Annual Growth Rate (AGR) and AAGR:** It is found that the AGR is the highest in 1993 (14.39) followed by 2002 (13.83) and 2000 (13.05). The AGR is the lowest in 2007 (0.36). There is a fluctuation in the AGR of infertility research output during the study period. When 2000 is taken as the base year, 2012 saw the highest AGR of 0.78 followed by 2013 with 0.77 and 2011 with 0.68. The Annual Average Growth Rate of infertility research output during the study period is 3.57 (Table 4.5 and Figures 4.8 and 4.8a).
The block 1990-1994 witnessed AGR of 0.32 and the block 2010-2014 had 0.15, the lowest AGR among the rest. The AGR varies from 0.15 to 0.32 during the study period (Table 4.6).

**Relative Growth Rate (RGR) and Doubling Time (Dt):** It is unearthed that the lowest relative growth rate (RGR) for infertility literature was in 2014 with RGR of 0.05 and the highest was in 1986 with RGR of 0.66. The RGR ranged from 0.66 in 1986 to 0.21 in 1990 whereas it was between 0.10 and 0.18 during 1991-1997. It was 0.09 and less than that in all the successive years i.e. from 1998 onwards. The RGR shows a decreasing trend throughout the study period whereas it was constant during a block of years. Eg. RGR was same in 1992 and 1993 (0.16), 1994 and 1995 (0.13), from 2001 to 2006 (0.08) and same for the years 2009-2013 (0.06). (Table 4.7).

The doubling time was the highest in 2014 (14.90) and the lowest in 1986 (1.05). It was less than 5.00 since 1993, it was between 6.00 and 10.00 from 1994-2007 and it went past 10.00 since 2008. The doubling time of infertility literature output during the study period shows an increasing trend (Table 4.7).

There is a gradual decrease in the relative growth rate from 0.84 in 1990-1994 to 0.30 in 2010-2014. Correspondingly the table shows an increase in doubling time from 0.83 in 1990-1994 to 2.35 in 2010-2014. The doubling time is the lowest during 1990-1994 (0.83) and the highest during 2010-2014 (2.35). (Table 4.8 and Figure 4.9).

**Document Types:** It is found that the most popular document type in Infertility Research literature is articles (66.53%) followed by reviews (17.56%), conference proceedings (4.20%), letters (3.17%), notes (2.45%), editorials (2.26%) and short
surveys (1.99%). Other types of documents like article in press, erratum, book series and book chapter were all below 1% of total publications. Majority of the scientists in infertility literature have published journal articles. Review is the next preferred document type for publication. Conference proceedings and letters are in the 3rd and 4th position respectively in the list of desired document types used by the researchers for publishing their research output (Table 4.9 and Figure 4.10).

**Language-wise Distribution of Published and Cited Papers:** It is discovered that of the total 75098 papers, 62743 (83.55%) are published in English language, followed by 3230 papers (4.30%) in French, 2322 papers (3.09%) in German, 1168 papers (1.56%) in Spanish, 1005 papers (1.34%) in Chinese, 754 papers (1%) in Japanese and the rest in 31 other languages. While 91.13% of publications in English language were cited, 2.90 % of publications in French and 1.75 % of publications in German were cited. Though the documents are published in more than 30 languages, the papers published in English language are cited more than the papers published in other languages (Table 4.10 and Figures 4.11 and 4.12).

**Size of Research Team Vs. Number of Contributions:** It is unearthed that research publications are done by the authors working together with their peers in the same field. The researchers worked as a small team (5-10 authors) contributed more number of papers (26203, 34.89%) than other research teams. Very small research team (3-4 authors) contributed 20166 publications (26.85%) (Table 4.11).

**Ranking of Most Dominant Authors:** It is found that top 25 authors together have published 4414 papers with an average contribution of 176 papers per author. Check, J
H who belongs to University of Medicine and Dentistry of New Jersey, United States tops the list with a DF of 0.91 followed by Aiken, R J who belongs to MRC reproductive Biology unit, United Kingdom with a DF value of 0.48. Out of these 25 productive authors, authors from academic institutions (18) are more than that from hospitals (7) and research institutions (0) (Table 4.12).

**Document Type Vs. Author Pattern of Published Papers:** It is identified that mega authored articles (written by more than 3 authors) are relatively higher than the single authored, two authored and three-authored articles. Mega authored conference papers are higher than single, double and three authored conference papers. Two authored reviews (3884) are higher than other co-authored Reviews. Single authored contributions are higher in “Short surveys”. Mega authored documents are more (37314) than single authored documents. (14105). Single authored documents are more than two and three authored documents (Table 4.13).

The blocks 1985-1989 and 1990-1994 have more single author papers (1646) and the blocks 1995-1999, 2000-2004, 2005-2009 and 2010-2014 have more mega authored papers. While single author contributions were dominant in the first two blocks, mega authored contributions are dominant in the last 4 blocks (Table 4.14 and Figure 4.13)

**Co-Authorship Index (CAI) for Published Documents:** It is noticed that CAI of single authored documents which goes on decreasing shows that solo research style has been declining in the study period. CAI of two authored documents is > 100 in four blocks and < 100 in 2 blocks showing a fluctuating trend though it is decreased greatly
in the recent block. CAI of three authored papers is > 100 in first three blocks and < 100 in the next three blocks showing a declining trend. CAI of mega authored papers shows an increasing trend. It moves from 75.70 in 1985-89 to 116.38 in 2010-14. The relatively higher CAI (>100) of mega authored papers indicates that scientists prefer to work in larger groups in the recent years (Table 4.1 and Figure 4.1).

**Collaborative Measures of Published Documents**: It is found that Collaboration index (CI) has increased from 3.26 in the block year 1985-1989 to 4.70 in the block year 2010-2014 with the mean value of 3.90. The CI which shows an increasing trend reports that the mean number of authors per paper goes on increasing. DC which has increased from 0.75 in 1985-1989 to 0.86 in 2010-2014 evidences a predominance of multi-authored papers. The overall DC for the study period is 0.80 which shows a strong multi-authors dominance over single authors. There is no difference between the collaboration coefficient (CC) and modified collaboration coefficient (MCC) in all the blocks under study (Table 4.16).

**Document Type Vs. Authorship Pattern of Cited Documents**: It is unearthed that Articles, letters and conference papers written in more than 3 author style received more citations than that written in single, double and triple author style. Two authored reviews were cited more than that of single, triple and more than 3 authored reviews. Single authored editorials, notes, book chapters and short surveys were cited more than that of two, three and >3 authored contributions (Table 4.17).

Single authored papers were cited more in 1985-89 (813) than multi-authored papers. In the remaining 5 blocks, mega authored papers were cited more than single,
two, three, four and five authored papers. Next to mega authored papers, single authored papers were cited more in all the blocks except the first and last ones. In the last block (2010-14), two authored papers were cited more (1762) next to mega authored papers (5011) (Table 4.18 and Figure 4.15).

**Co-Authorship Index for Cited Documents:** It is discovered that the CAI of single authored papers never saw a 100 but revealed the maximum of 96.64 in 1985-89. The CAI of two authored papers was > 100 during 1985-89, 1990-94 and 2005-2009. The three authored papers had the CAI of > 100 in the first three blocks and < 100 in the last three blocks. The CAI of > three authored papers was more than 100 in all the blocks except the first one (Table 4.19 and Figure 4.16).

**Collaborative Measures of Cited Documents:** It is found that the degree of collaboration is 0.84 among the authors of cited papers. Collaboration index of the cited documents is 4.14. The CC & MCC of the cited documents is 0.61. CI was high in 2010-2014 (5.09) and DC was high in 2010-14 (0.90) (Table 4.20).

**Comparison of Published and Cited Documents:** It is uncovered that while 19.07 % of published documents are single authored, 14.91 % of cited documents are single authored. 15.00 % of published documents are two authored but 15.64 % of cited documents are two-authored. 50.44 % of published documents and 54.88 % of cited documents are mega authored (>3). Thus, the researchers in infertility literature prefer to publish and cite mega authored papers (Table 4.21 and Figure 4.17).
Collaborative measures are high for the cited documents than for the published documents. It is proved that collaborative papers are most preferred documents for citations by the researchers in their research findings (Table 4.22 and Figure 4.18).

**Continent-wise Geographical Distribution of the Productivity:** It is found that Europe is the most productive continent with 35190 publications (46.86% by 47 countries) followed by North American continent with 20634 publications (27.48% by 16 countries) and Asia with 12015 publications (16.12% from 41 countries). “Australia/Oceania” continent contributed 2339 publications (3.11%, 2 countries) while Africa contributed 2072 publications (2.76% by 13 countries). South America is the least productive continent with 1754 publications (2.34% by 40 countries). Infertility research is more active in North America with 1290 publication per country followed by Australia (1170) and Europe (749) (Table 4.23 and Figure 4.19).

**Contributions by European Countries:** It is found that United Kingdom is the highly productive country in Europe with 6514 (18.51%) publications with the global share of 8.67%. France, Germany and Italy are the major contributors at the consecutive level on Infertility research with 4637 (13.18%), 4296 (12.21%) and 3930 (11.17%) share of European publications and with the global share of 6.17%, 5.72% and 5.23% respectively. Out of 47 countries contributing papers in this research area, only 10 countries published more than 1000 publications each; half of the countries contributed less than 100 records (Table 4.24).

**Contributions by North American Countries:** It is understood that United States of America (87.07%) has the highest productivity of 17965 papers occupying 1st rank
among 15 countries involved in contributing publications from this continent with a global share of 23.92%. Canada is in 2\(^{nd}\) position with 2228 publications (11.10%) and with a global share of 3.05% and Mexico is in the 3\(^{rd}\) place with 307 publications (1.46%) (Table 4.25).

**Contributions by Asian Countries:** It is inferred that Japan has produced 22.05% (2669) of Asian publications and 3.55% of world share holding 1\(^{st}\) rank followed by Peoples Republic of China which produced 1857 (15.34%) publications with 2.47% of world share occupying 2\(^{nd}\) rank. India contributed 1764 (14.57%) publications and with a global share 2.35%, it gets 3\(^{rd}\) rank among Asian countries in terms of Infertility output while Israel contributed 1684 papers (13.91%) with its global share 2.24% (Table 4.26).

**Contributions by Australian Countries:** It is found that Australia has published 2067 (88.37%) articles at continent level with 2.75% in global share and New Zealand has contributed 272 (11.63%) publications in continent level with 0.36 % percent in global share (Table 4.27).

**Contributions by South American Countries:** It is discovered that Brazil has the highest number of publications (1051, 60.26%) at continent level and with 1.40% of global share. Argentina and Chile have obtained 2\(^{nd}\) and 3\(^{rd}\) places with the publications of 314 (18%) and 179 (10.26%) respectively at continent level (Table 4.28).

**Contributions by African Countries:** It is found that Egypt has produced 815 (39.33 %) articles contributing 1.09 % of global share and tops the list followed by South
Africa, Nigeria and Tunisia which are placed in 2nd, 3rd and 4th positions with publications of 398 (19.21%), 287 (13.85%) and 181 (8.74%) respectively (Table 4.29).

**Most Productive Countries in Infertility Research: Science Production Index:** It is understood that United States topped the list with global publication share (SPI) of 23.92%; United Kingdom ranked 2nd with global share of 8.69%, followed by France, Germany, Italy, Japan, Canada, Australia, Netherlands, Spain, China, Belgium, India and Israel (global share ranging from 2.24% to 6.17%) (Table 4.30).

**Most Productive Journals:** It is found that the largest number of papers (7485 papers, 9.97%, 249.5 papers per year) are published by “Fertility and Sterility” followed by 4999 papers in “Human Reproduction” (6.66%, 166.6 papers/year), 1471 papers in “Reproductive Biomedicine Online” (1.96%, 49 papers/year) and 1269 papers in “Journal of Assisted Reproduction and Genetics” (1.69%, 42.3 papers/year). 99.40% of articles published in ‘International Journal of Andrology’ are cited followed by ‘Journal of Clinical Endocrinology and Metabolism’ 97.96% of its articles being cited. The journal whose papers were least cited are ‘Middle East Fertility Society Journal’ (43.23%) and “Contraception Fertile Sexualité” (48.72%) (Table 4.31).

**Most Productive Institutions (Top 25):** It is uncovered that the top twenty five institutions together contributed 8651 papers (11.51%) in cumulative infertility literature during 1985-2014. Most number of productive institutions (9) belong to USA followed by Netherlands (4), Italy (2) and Canada (2). Cleveland Clinic Foundation of USA tops with 473 publications followed by Inserm with 460 and University of
California, San Francisco with 452 papers. Academic institutions are more active in infertility research than the hospital, clinical and research foundations (Table 4.32).

**Activity Index of the Selected Countries:** It is understood that Japan has the highest Activity Index in 1985 (126.21), 1990-1997 and 1999 among all the countries contributing to infertility research. UK has the highest AI in 1998, 2002 and 2003 while France in 1986, 1987, 2001 and 2007 and Germany in 1989, 2000 and 2005. India has the highest AI among all other countries from 2009 to 2014. After 1995, research on infertility research increased in USA with slight fluctuation. From the year 2008, the research activity on infertility literature steadily increased in Italy, Netherlands, India and Australia and decreased in UK, France, Germany and Japan (Table 4.33).

**Transformative Activity Index of the most productive Countries:** It is found that infertility research activities in USA, UK, France, Germany and Japan have decreased whereas the countries like Italy, Canada, Australia and India showed an increase in infertility research activities therein. The intensity of decrease in research activity of Japan is comparatively higher than that of other countries. TAI of India is increased from 0.70 during 1995-2004 to 1.38 during 2005-2014. It indicates the enhanced research thrust and technological breakthroughs among India researchers in infertility research during 1995-2014 (Table 4.35 and Figure 4.21).

**Authorship Pattern and Co-Authorship Index:** It is brought to the light that Mega authored (> 4 authors) papers are more in numbers than the papers by other authorship pattern in all the selected countries, especially in United States of America, Italy, United kingdom and France, Japan, Germany. Single authored papers are high in United States of America, United Kingdom and France and low in Italy and China. There is no much
difference in the number of contributions of other authorship pattern than that of mega authored papers in all the selected countries except United States of America and United Kingdom and France. In multi-authored contributions, USA is in the top followed by UK, Germany. In India, mega authored papers are high followed by three authored papers, four authored and two authored papers in the order(Table 4.36 and Figure 4.22).

Degree of Collaboration (DC) of the Productive Countries: It is discovered that in the years 1987, 1988, 1990 and 1997, DC of India is 1. (DC = 1 indicates that the number of single author papers is zero). In other selected countries, degree of collaboration varies slightly from year to year and it is very close to their overall degree of collaboration. During the study period, Italy has the highest degree of collaboration (0.95) followed by Japan (0.91) and Netherlands (0.89) (Figure 4.24).

Countries’ Relative share of Non-Collaborative and Collaborative papers: It is found that the trend of collaboration varies among the countries in producing research publications during the study period (1985-2014). According to number of authors involved in research publications in infertility, collaborative papers are greater than 75% of country’s publications and the single authored / non-collaborative papers are below 25% among the selected countries. Only 5% of the papers are non-collaborative in Italy while it is below 10% in Japan, 10% in Netherlands and 12% in India. (Table 4.37 and Figure 4.25).

Trend of Collaboration in the Most Productive Countries: It is discovered that collaborative papers are more than single papers in all the most productive countries. France has highest number of single papers (22.31%) followed by United Kingdom
(21.73%), United States (21.68%) and Australia (20.68%). The least number of single papers are from Italy (5.32%) followed by Japan (8.66) and Netherlands (9.32%). Domestic collaborative papers are higher than internationally collaborative papers in all the most productive countries. Japan has produced the maximum number of domestic collaborative papers (80.38%) followed by India (79.02%) and Italy (75.91%). Canada has least number of domestic collaborative papers (51.88%) followed by United Kingdom (53.32%) and Australia (56.87%) (Table 4.38 and Figure 4.26).

**Lateral Relations among Countries in Infertility Literature:** It is uncovered that unilateral (one country collaborative) contributions are relatively higher in all the countries than that of any other lateral relationship. Bilateral contributions are high (>100 papers) in United States (331) followed by United Kingdom (195), Germany (138), France (187) and Italy (128). While United Kingdom tops the list in multilateral contributions (148 papers), France and Netherlands secured 2\textsuperscript{nd} place with 99 papers each. Japan has produced only 10 papers in trilateral relationship. India has produced 15 papers in multilateral relationship. USA tops in unilateral and bilateral relationship followed by United Kingdom. United Kingdom (89) and USA (81) are strong in trilateral relationship. While 29.49% of Canada’s papers are internationally collaborated, 28.47% of Netherland, 24.95% of United Kingdom and 23.32% of Australia’s papers are produced in international cooperation with other countries. India is in the last rank with its 9.98% of publications produced out of international collaboration. While India is the weakest country in unilateral, bilateral and multilateral relationships, Japan is the weakest in trilateral relationship for producing internationally collaborated papers. (Table 4.39).
Domestic and International Collaboration Share of the Collaborative Papers: It is found that out of total number of collaborative papers published in India, 88.79% papers are out of domestic collaboration and just 11.21% are out of international collaboration. Among the countries which have produced papers out of domestic collaborative research, India tops the list followed by Japan (88%), United States (80.22%) and Italy (80.18%). Canada has produced least number of papers out of domestic collaboration (64.41%) followed by United Kingdom (68.12%) and Netherlands (69.44%). Canada has produced 35.59% of its total collaborative research output out of international collaboration followed by United Kingdom (31.88%) and Netherlands (30.56%). The least number of international collaborative papers out of total collaborative publications are produced by India (11.21%) followed by Japan (12%) and United States (19.78%) (Table 4.40 and Figure 4.27).

Country Collaboration Linkages: It is unearthed that the largest number (363) of collaborative links exists between United States and United Kingdom, followed by 287 links between United States and Canada, 246 links between United States and Germany & 203 links between United States and France. All the countries have the largest number of collaboration links with United States and least number of collaboration links with India except Netherlands which has largest number of (163) collaboration linkages with United Kingdom. India has the largest number (72) of collaboration linkages with United States and least number of links with Italy (2) (Table 4.41).

Growth in International Publications (1985-2014): It is made known that USA has the highest number of international publications among the most productive countries in all the years (1985-2014). United Kingdom and Germany follow United States with
1629 and 929 international publications respectively. Japan and India have relatively less number of international publications. Increasing growth rate is seen in the international publications of France, United Kingdom, Italy, Germany and Australia. till 1995 there was no significant increase in the international collaborative papers among the countries. During 1996-2002, it gradually increased in all the countries (Table 4.42 and Figures 4.28, 4.28a and 4.28b).

**Domestic Collaboration Index (DCI):** It is found that less collaborative effort (DCI<100) is found in Italy and India than national average during the year 1985-2004 and these countries have high DCI > 100 during 2005-2014. India has the highest collaborative effort in 2010-2014 with DCI of 168.48 while Netherlands has the highest DCI of 115.01 during 2005-2009. DCI is >100 from 1985-1989 to 2000-2004 in United Kingdom, Germany and Japan indicating that their collaborative effort are more than the national average. The DCI of these countries decreased in the later blocks. Germany and Japan have the least DCI from 2005-2014. In general half of the most productive countries show an increasing trend in DCI over the years while it is the reverse in the remaining half (Table 4.43).

**International Collaboration Index (ICI):** It is brought to the light that The ICI of United States, United Kingdom, France, Germany, Italy, Netherlands and Canada from 1985-1999 is <100 while it is more than 100 since 2000. In case of Australia and India, ICI is < 100 till 2004 and it went past 100 since 2005. Japan is the only country where ICI is >100 since 1995. India has the highest ICI in the last 2 blocks 2005-09 and 2010-2014 among all other countries. During the first half of the study period domestic
collaborative effort was relatively higher in many countries than international collaborative effort and vice versa in the second half of the study period (Table 4.44).

**International Cooperation Index, (ICoI):** It is discovered that the highest international cooperation index of 0.045 is found between the countries USA and Canada, UK and Netherlands; 0.034 between USA and UK, 0.033 between UK and Australia, 0.032 between UK and Italy, 0.031 between the countries UK and France, and France and Italy etc. (Table 4.46).

**Affinity Index (AFI):** It is found that the affinity index USA for UK is 0.13; USA for Canada is 0.10. UK’s affinity for USA is 0.22; Japan has the highest affinity for USA (0.59). Canada has the affinity index of 0.44 for USA; India has AFI of 0.41 for USA. Netherlands has the highest affinity index for UK (0.28). The affinity index of Australia for USA is 0.28; Australia for UK is 0.26. It is clear that all the selected productive countries have good scientific relations with the United States (Table 4.47).

**Internationalization Index (INI):** It is uncovered that Netherlands is ranked 1st with the highest internationalization index of 45.58 followed by Canada, United Kingdom, Italy and France with INI value of 43.14, 36.62, 35.97 and 31.98 respectively. India’s very low internationalization index value (26.08) emphasizes the need for collaboration with the developed countries to improve the research activities in infertility (Table 4.48).

**Research Profile of India in Infertility Research:** It is made known that India has published 1764 papers in the area of Infertility and ranked 13th among the most productive countries with its global publication share of 2.35% during the period 1985-
2014 with an average publication per block (APPB) of 294. It can be observed that there is a steady growth in publications over the study period. Except during the block 1990 - 1994, the publications were almost doubled in each block showing a healthy publishing trend. 96.03% of the publications are joint-authored whereas single authored publications are found to be very low. The average collaboration index during the study period is 3.6 and the average degree of collaboration is 0.89. Relative Growth Rate varies from 0.809 to 0.156 indicating a decreasing trend. Doubling time is showing the increasing trend with the values from 0.86 to 4.43.

**Collaboration Trend in Infertility Research in India:** It is found that the domestic collaborative papers were gradually increasing over the period; but there was no international collaborative paper till 1990. Even in domestic collaboration, high collaboration exists among the various departments of the single institution. India’s international collaborative papers were below 5 in numbers till 2002. After the year 2008, ICP of India was gradually increasing but it has not reached 25 papers in any year. The highest number of 20 single papers was published in 2013. The highest number of 161 collaborative papers was published in 2013 and 2013. A maximum of 145 papers were produced out of domestic collaboration in 2013 followed by 138 in 2012. With international collaboration, a maximum of 24 articles were produced in 2011 followed by 23 in 2012 (Table 4.49 and Figure 4.30).

**India’s Leading Collaborative Countries / Institutes in Infertility Research:** It is uncovered that India had collaboration with 53 countries during the study period in producing infertility literature. Only 33 countries have published two or more collaborative papers with India during 1985-2014. USA is the leading collaborating
partner for India with 72 publications, UK in the next place with 25 publications, Australia with 15 publications & Canada and Saudi Arabia with 7 publications. During 1985-1994, India had collaboration only with USA and UK. It had collaboration with only five countries till 1999. After 2000, India started to collaborate with many other countries. During 2010-2014, India’s collaboration was significant that it had collaboration with almost 45 countries (Figure 4.31).

Highly Productive Institutions in Infertility Research in India: It is made known that “All India Institute of Medical Sciences, New Delhi” has produced 223 papers with 12.64% of national share. It is followed by “National Institute of Research in Reproductive Health, Mumbai (48 papers)”, with 2.72% of national share and “Postgraduate Institute of Medical Education and Research, Chandigarh (45 papers)”, with 2.55% of national share. Among the institutes involved in contributing infertility publications, “All India Institute of Medical Sciences” has internationally collaborated for producing 15 papers and “Indian Council of Medical Research” for 8 papers (Table 4.50).

5.2.2 QUALITATIVE ANALYSIS

Citation Impact of Research Publications on Infertility: It is found that the overall average citation per papers was 16.79. It is found that more than 50% of papers published during the year 2003-2012 were cited. More than 50% citations were received by the papers published during 1997-2008. In the remaining percentage of citedness and citations, the recently published papers were received high citedness and citations compared to that of the publications of earlier study period (Table 4.51).
73.98% (55561) of papers were cited by others. While a maximum of 81.57% (10665) of papers were cited during 2000-2004, the minimum of 61.54% (4151) of papers were cited during 1985-1989. The last two blocks (2005-2014) could see a declining trend in the number of papers cited. While 38.46% of papers were not cited during 1985-1989, 34.58% of papers were not cited during 2010-2014 (Table 4.52 and Figure 4.32).

**Authorship pattern Vs Citations Score:** It is brought to the light that the block 2000-2004 received more citations in all authorship patterns. It means that the citation age was 10-15 years in the infertility research field. Mega authored papers are cited more than solo/co-authored papers in all the blocks of study period. Three authored papers were cited more, next to mega authored, in the first 3 blocks (1985-1999) where two authored papers were cited more, next to mega authored, in the last 3 blocks (2000-2014). Single authored papers were least cited during 1990-2004 & 2010-14. Five authored papers were the least cited during 1985-89 and 2005-2009 (Table 4.54).

**Relative Quality Index (RQI):** It is discovered that more than 60% of the contributions published from 1986-1991 were cited. More than 70% of contributions published from 1992-1997 and from 2010-2012 were cited. More than 80% of the papers published from 1998-2009 were cited with a small fluctuation. Out of overall citations, more than 5% of citations were received in all the years from 2000 to 2006, 4.5 % of citations in all the years from 1997 to 1999 and from 2007 to 2008 and the during the remaining years, publications received less than 4% of total citations. From 1985 to 1991 and from 2007 to 2014, the RQI value was greater than 1 but CPP was less. For the remaining
years (i.e. 1992-2006), the CPP ranged from 18.35 to 29.92 but RQI value was less than 1 (Table 4.55).

The highest RQI was seen in the blocks 2010-2014 (2.78) and 1985-1989 (1.61). In other blocks (1990-2009), RQI was less than 1 but the average citation rate was higher (Table 4.56).

**Research Impact of the Most Productive Countries:** It is found that USA and Canada have the highest PEI of 1.60 followed by Australia (1.50), UK (1.44), Italy (1.23), Germany (1.04), France (0.98), Japan (0.80) and India (0.38). The impact of the publications of the countries like USA, Canada, Australia, UK and Germany is higher than their research efforts to publish papers in this research area. The RCI of USA, UK, Canada, Australia and India are higher than world citation rate and it shows the high research impact. RCI value of France, Germany, Italy and Japan were also nearly 1 indicating the closeness of their research impact to world citation rate. Thus, though some countries publish more papers, impact of their research is not equivalent to overall research impact.

Canada has high CPP value of 26.93 followed by USA with 26.84, Australia with 25.17 and United Kingdom with 24.24. India’s very less CPP value (6.30) represents the lack of visibility for Indian infertility research publications. Australia has the highest attractive index (1.06) followed by India (1.04), United Kingdom (1.03) and USA (1.02) which indicates that citation rate of these countries was greater than national citation rate. Attractive index of Japan was equal to national citation rate during the study period (Table 4.57 and Figure 4.34).
Highly Cited Publications of Infertility Literature: It is made known that of the 15 highly cited papers, 9 are articles, 2 are conference proceedings and 4 are reviews. Publication period of highly cited papers (first six) is between the years 1995-2000. Out of 15 highly cited papers, USA has (8), Denmark (2), Belgium (1), France (1), UK and Denmark (1), Japan (1) and Sweden and Finland (1). With respect to highly cited papers, no single authored papers received more than 1000 citations. Most of the highly cited papers were published by large research teams. Out of 15 papers, papers by less than five authors (8) were higher than the other co-authored papers (7). Collaboration between the authors was found mostly within the departments or institutions at the national level than the international level. Only 2 papers are published in joint collaboration with other countries, while rest of 13 papers had no collaboration with other countries (Table 4.58).

Citation Range of the Cited Documents: It is found that a total of 55,561 cited papers had received a total of 1,261,162 citations during the study period with an average of 22 citations per paper. Of the 55561 papers cited, 54.10% of papers received 1-10 citations; 16.54% papers received 11-20 citations; 8.94% papers received 21-30 citations; 7.34 % papers received 51-100 citations and only 0.03% of papers received more than 1000 citations. While 67 papers received >500 citations, a majority of 30058 papers received only 1-10 citations (Table 4.59).

Most Cited Journals in Infertility: It is discovered that The journal “International Journal of Andrology” is ranked first with 99.40% of its articles cited followed by the “Journal of Clinical Endocrinology & Metabolism” with 97.96% of its articles cited. Eleven journals have received citations for 90 % and above of their articles. Twelve
Journals have received citations for 80-89% of their articles. Four journals have received citations for 60-79% of their articles (Table 4.60).

**Citation Impact of Journals:** It is uncovered that The journals ‘Human Reproduction’ (h-index of 152) and “Fertility and Sterility” (h-index of 143) are very productive and have high impact than other journals. H-index of “Human Reproduction Update” is 95. Though the h-index of “Reproductive Biomedicine Online” is 61, more articles from it were cited than that of Human Reproduction Update. There are two journals with a h-index of more than 100, one journal with a h-index of 90-99, two journals with a h-index of 80-89 and six journals with a h-index of 60-69 (Table 4.61).

**Highly Productive Authors in Indian Infertility Research:** It is found that the top 10 authors contributed 319 papers or 18% of the national output and received 4533 citations which accounted for 33.56% of national citations. Only five authors have CPP value of > 15 and only 6 authors have RCI>1 indicating that their citation rate is higher than the national citation rate. All prolific authors are not always highly cited. Dada, R has the highest h-index of 16 with total citations of 715 for 49 documents followed by Kumar, R & Gupta, N.P. having the h-index of 15 for their 38 & 31 documents respectively. Seven researchers have h-index of > 10 (Table 4.62).

**Authorship Pattern Vs Productivity, Cited Papers and Citations:** It is brought to the light that mega authored documents were cited (83.24%) more than the documents of other authorship patterns. While 79.82% of five authored papers were cited, 77.97% of four-authored papers were cited, only 54.06% of single authored papers were cited. Out of total citations received for 55561 cited documents, 35.31% was for mega
authored papers followed by 15.21% for two authored papers & 14.16% for 3 authored papers. Mega-authored papers (>5 authors) were cited more than the other co-authored papers and single authored papers. Not much difference is found in the citations received by three, four and five authored papers (50% together). Publications made by more number of contributors (>20 authors) are less likely to be cited compared to publications by a small team (4, 5 and >5 authors) (Table 4.63).

5.2.3 RESEARCH NETWORK ANALYSIS

Co-Author Mapping of Infertility Literature: It is found that among 11122 unique authors identified in the study period, a large group of 10834 authors collaboratively worked to produce the publications and 288 authors individually contributed their publications. 1115 papers are published by unknown authors. The biggest cluster consists of 814 authors whose contributions vary from 5 - 118 papers; second biggest cluster consists of 802 authors, and so on. Among the most productive authors who had more than 150 publications, Devroey, P. (377 papers) emerged as the topmost author in the global infertility literature during the study period. He belongs to cluster 14 which consists of 241 authors. The 2nd highest contributor Diedrich, K (304 papers) belongs to the cluster 7 (Figure 4.45).

Co-Author Mapping of Cited Infertility Literature: It is found that among the 55561 cited documents, 8797 unique authors were found and only 8591 authors were connected in 212 clusters. Cluster 1 consists of 582 authors whose cited papers range from 5 – 93. Second cluster consists of 575 authors whose cited papers range from 5-59. The most cited author is Devroey, P. (341 papers cited) who belongs to cluster 14;
the 2nd most cited author is Agarwal, A (276 papers) belonging to cluster 27 (Figure 4.46).

**Author Network of Indian Publications in Infertility:** It is made known that there are 16 clusters in this network. Contributions range from 5 – 63 papers. The biggest cluster consists of 20 authors and the smallest cluster consists of 4 authors. Authors (15) who had contributed more than 20 papers were identified and their research network was observed. Kumar, S (63 papers), Malhotra, N (39 papers), Singh, N (37 papers) and Mittal, S (35 papers) belong to cluster 1. Kumar, R (51 papers), Dada R (49 papers), Gupta, N.P (32 papers), Shamsi, M.B and Venkatesh, S (each 24 papers) belong to cluster 4 (Figure 4.47).

**Institutional Network of Indian Publications in Infertility:** It is found that All India Institute of Medical Sciences (AIIMS), New Delhi has published 351 papers in collaboration; PGIMER, Chandigarh 73 papers; National Institute of Research in Reproductive Health, Mumbai 61 papers. AIIMS, New Delhi has strong link with National Institute of Immunology, Delhi and its strength value is 9.50; the strength value of AIIMS with Indian Institute of Toxicology Research, Lucknow is 5.00; 4.00 with Indian Council of Medical Research, Delhi (Figure 4.48).

**Country Mapping of Indian Publications in Infertility:** It is found that India has jointly worked with many countries (53) during the study period 1985 - 2014 and published papers in infertility literature (176 papers). It has 146 links with United States and its strength value is 129.09; 47 links with United Kingdom and its strength value is 37.96; with Australia, the strength value is 23.94 and 10 links each with Singapore and France. the clusters are limited by the collaborative papers of at least five resulting into
8 clusters. The biggest cluster consists of 6 countries - Australia, China, India, Japan, Malaysia and Singapore (Figure 4.49).

5.2.4. TENABILITY OF HYPOTHESES

Hypothesis 1: There exists an exponential growth trend in infertility publications during the study period

The documents studied were closer to linear adjustment ($r=0.974$) (Figure 4.2a) than to exponential adjustment ($r=0.901$) (Figure 4.2b). It indicates that the linear model of growth pattern exists in infertility publications during the study period. Hence the hypothesis H1 i.e. there exists an exponential growth pattern in infertility literature during study period is not accepted.

Hypothesis 2: There is a significant change in collaboration pattern among infertility researchers

There is a significant change in the collaboration pattern among researchers on infertility literatures in recent times. Hence the hypothesis H2 is accepted (Table 4.14 and Figure 4.13).

Hypothesis 3: Collaborative papers are most cited

The degree of collaboration is 0.84 among the authors of cited papers. It is proved that collaborative papers are most preferred documents for citations by the researchers in their research findings. Therefore, the hypothesis H3 is accepted (Table 4.22).

Hypothesis 4: Research and clinical foundations are actively participating in the infertility research activity
Academic institutions are more active in infertility research than the hospital, clinical and research foundations. Hence the hypothesis H4 is rejected (Table 4.32).

**Hypothesis 5 : Scientists in developed countries are working as a large team**

Mega authored (> 4 authors) papers are more in numbers than the papers by other authorship pattern in all the selected countries, especially in United States of America, Italy, United Kingdom and France, Japan, Germany. Hence, the hypothesis H5 is substantially proved (Table 4.36).

**Hypothesis 6 : National / Domestic collaboration is dominating in infertility research publications of all the countries**

Domestic collaborative papers are higher than internationally collaborative papers in all the most productive countries. Since, domestic collaboration trend is dominant in infertility research output. Hence, the hypothesis H6 is accepted (Table 4.38).

**Hypothesis 7 : There is a steady increase in International Collaboration publications among all the countries**

During the first half of the study period domestic collaborative effort was relatively higher in many countries than international collaborative effort and vice versa in the second half of the study period. There is a steady increase in international collaboration in the infertility research area during the study period. Hence, the hypothesis H7 is accepted (Table 4.44).

**Hypothesis 8: Countries which have produced high number of publications**
received high citation impact

The citation indicators such as, PEI, RCI, CPP and AAI reveal that though some countries are publishing more papers, impact of their research was not equivalent to overall national impact. All highly productive countries do not acquire high citation impact. Hence, the hypothesis H8 is rejected (Table 4.5).

Hypothesis 9: The scientific productivity of authors in the discipline of Infertility research conforms to Lotka’s law

Of the 11122 unique authors, 2395 produced 5 articles, 1641 produced 6 articles, 1217 produced 7 articles, 883 produced 8 articles and so forth. From the observed frequency, the expected frequencies have been calculated by applying Lotka’s law. The Kolmogorov-Smirnov test was applied to verify whether the observed data fit into the theoretical distribution according to Lotka’s law. The highest value in Dmax was taken as reference for comparison with the critical value (c.v). The maximum difference (Dmax) obtained is 0.615. Since it is greater than the critical value (0.015), the author productivity in this hypothetical research does not fit into Lotka’s law. Thus, the hypothesis H9 is rejected.

Hypothesis 10: There will be an increasing trend in infertility literature in future

Time series forecasting is the use of a model to predict future values based on previously observed values. A straight-line equation is adopted as statistical measure to forecast the trend pattern as suggested by Daya Sridhar. The future of infertility research output will have an increasing trend in the year 2020 (4604.089) and 2050
(7605.264). There will be an increasing trend in infertility literature in future. Thus, the hypothesis H10 is accepted (Table 4.64).

5.2.5 RELATION BETWEEN VARIOUS SCIENTOMETRIC INDICATORS

The findings of the study on the relationship or association existing among various scientometric indicators are given below:

Correlation between number of authors and number of Contributions: The p value is 0.001. Since it is less than 0.05, null hypothesis is rejected and the alternate hypothesis is accepted. Thus, there exists a strong correlation between the authorship pattern and number of publications. But there is a strong negative correlation as the r.value is -0.427. When the number of authors increases, the number of publications decreases (Table 4.65a and Figure 4.35).

Correlation between Citedness and Publications: The p-value calculated is 0.245. Since it is more than 0.05, null hypothesis is accepted and the alternate hypothesis is rejected. Thus, there is no correlation between the number of papers published by different authors and the average number of citations (CPP) of their papers. (r=0.219). Hence, the hypothesis H11b is not accepted (Table 4.66 and Figure 4.36).

Correlation between Publications and Cited papers: The p-value calculated is 0.000. The ‘r’ value is 0.910 for the variables - the number of publications and cited papers. Since p-value is less than 0.05, null hypothesis is rejected and the alternate hypothesis is accepted. It is concluded that the number of publications has a strong positive relation with the number of papers cited. Hence, the hypothesis H11c is accepted (Table 4.67 and Figure 4.37).
Relationship between No. of Publications and Citations: The r value is 0.205 and the p-value is 0.183. Since p-value is more than 0.05, null hypothesis is accepted. The data reveals that the correlation between number of publications and citations is relatively low (r=0.250). It means that it is not true that publishing more number of papers will attract more citations; even less number of papers will obtain more citations due to research relativity, visibility and publication period. Therefore, the hypothesis H11d is rejected. (Figure 4.38).

Correlation between Number of Cited Papers and Citations Received: The p-value is 0.002. The ‘r’ value is (0.540) low but significant. Since p-value is less than 0.05, null hypothesis is rejected and the alternate hypothesis is accepted. It indicates that there is a correlation between these 2 variables. Hence, the hypothesis H11e is proved (Figure 4.39).

Association between Author pattern and Cited papers: The Pearson correlation value is -.437. Since the “p” value (.001) is less than 0.05, null hypothesis is rejected and the alternate hypothesis is accepted. Thus, there exists a negative correlation between authorship pattern & cited papers (Table 4.68a and Figure 4.40).

Correlation between Authorship pattern and Citations: The value of coefficient of correlation(r) is -.452. Since the “p” value (.000) is less than 0.05, null hypothesis is rejected and the alternate hypothesis is accepted. Thus, there is a correlation between authorship pattern & the number of citations received. But there exists a negative correlation between these two variables. When the number of authors increases, the number of citations received decreases (Table 4.69a).
Association between Most Productive Journal and Most Cited Papers: Pearson correlation coefficient ($r=0.998$) between the most productive journals (journals with more articles) and the number of cited articles is found to be high and significant. The p-value calculated is .000. Since p-value is less than 0.05, null hypothesis is rejected and the alternative hypothesis is accepted. There exists a correlation between these two variables. It indicates that the most cited articles are the most productive journals. Hence, the hypothesis H11h is approved (Table 4.70 and Figure 4.42).

Association between Journal Productivity and Citations Obtained: The correlation coefficient between journal productivity and citation count is $r=0.9687$. The p-value is (0.000) less than 0.05 and hence null hypothesis is rejected and the alternate hypothesis is accepted. Thus, there exists a correlation between the variables. It clearly supports the existence of correlation between the number of articles published by a journal and the number of citations received by it. Obviously, more number of publications attracts higher number of citations (Table 4.71 and Figure 4.43).

Association between Papers by Productive Authors of India and their Citations: The correlation coefficient between the number of papers published by the productive Indian authors and the number of citations received is $r = 0.469$. Since p-value (0.171) is more than 0.05, null hypothesis ($H11j$) is accepted and the alternate hypothesis is rejected. No correlation is found between the variables - the productive Indian authors (more number of publications) and their citations received by them (Table 4.72 and Figure 4.44).

5.3. SUGGESTIONS
5.3.1 Specific Suggestions from Findings

a) Favoured document type

Since articles are the most favoured document types both for publication and citations, the researchers may be instructed to publish their infertility research findings in journal articles so as to reach a wider variety of audience.

b) Problem of anonymity in publications

It is surprising to note that 372 documents (0.67%) of total published documents are anonymous. The publishers may be directed to include author(s)’ names in the documents being published by them without fail.

c) Promotion of Collaborative Research (CI, DC and CC values keep on increasing)

- Authors may be encouraged to publish documents co-authoring with other researchers in infertility literature since co-authored papers are more published and cited.
- Necessary Research Circles may be created in infertility research institutions enabling the researchers work in teams to produce collaborative papers.
- Collaborative Research Funding may be instantiated. More funds will be allocated to the infertility researches being undertaken by the research teams of moderate size rather than that by the individuals.
- Both domestic collaboration and international collaboration should be encouraged.

d) Research Visibility
• The researchers on Infertility studies may be directed to publish their findings on the most productive journals – the journals with high citations / h-index/ impact factor to increase their visibility.

• A good number of open access online journals and databases may be initiated in infertility research studies.

• The researchers may be suggested to publish their research findings in English language since the documents which are published and cited most are in English.

e) Collaboration with Other Countries

• The countries should undertake research activities in infertility studies in collaboration with other countries to enable sharing and caring culture.

• Special funds may be provided to undertake collaborative research with other countries.

f) Domestic Collaboration

A national level network of institutions carrying out research in infertility studies may be formed to promote domestic collaborative research efforts.

g) How to increase the Infertility Research output of India?
• For 30 years period, only 1764 papers were produced (59 papers/yr) by India. Government should establish a separate research institute for infertility and related studies to improve the focused research activities on infertility.

• The very few Indian institutions which are internationally collaborating with other countries in infertility research should be further equipped with advanced infrastructure facilities.

• The majority of Indian institutions which are not taking up collaborative research work with other countries may be encouraged with specific grants-in-aid and technical expertise.

• The investments, infrastructures and facilities to access international databases should be provided to the institutions which are lagging behind, to accelerate their research activities and to collaborate with other active institutions at national and international level.

• Only 15 authors produced more than 20 papers in 30 years of period in India. Scientists must be encouraged to have collaboration with various departments / institutions at both national and international level.

• Indian institutions should be encouraged to undertake international level R & D projects to improve the international collaboration and to increase the visibility of their research findings.

• PEI of India (0.38) is very low. The researchers must be encouraged to participate in international conferences / seminars and also to publish their research findings in international journals to improve their research impact.
India has very low INI and AFI values. So, the collaboration with the developed and developing countries should be encouraged and supported in India to improve the research activities and visibility.

5.3.2. GENERAL SUGGESTIONS – INDIAN CONTEXT

- National Information Centre for Infertility Literature (NICIR) may be created to maintain a national level database on the subject with a decentralized input and centralized output mode.

- A network of nationally acclaimed infertility research centers may be proposed.

- Patent literature on infertility research may be identified and added in the Indian Patent database.

- The directory of infertility institutions and the most productive researchers in the infertility research may be created state-wise and made available in public domains.

- A national level survey may be initiated on infertility rate statistics. This survey will help us decide the extent and direction of infertility research we require in our country.

- The mushrooming infertility cure clinics should be checked for their genuineness and authentic certificates.

- Infertility literacy campaigns may be carried out by NGOs and the government agencies.

- Like any other specialization in medicine (like child, women, ortho, eye, ENT etc), specialized courses / degrees / diplomas may be introduced in infertility studies.
• Both the central and state governments should allocate sufficient funds for undertaking R & D activities in infertility research.

• Mini, Micro and Major level projects may be granted to the teaching and practicing medical professionals.

• Both short term and long term proposals may be invited from the interested researchers for carrying out research in infertility and related areas.

• The infertility cure clinics may be advised to submit to the national level formed for the purpose the details of infertility problems they encountered and how they treated them without disclosing the identity of the patients.

• More journals may be published in infertility and related areas of research in open access mode.

• People having infertility issues may be encouraged through counsellors, advertisements and other media to spell out their unsolved issues freely and secretly. Local counselling centres may be established in village or district level government hospitals.

• Recognitions in terms of awards, rewards, extra grants, concessions may be provided to the institutions / individual researchers who make a great breakthrough in infertility research studies.

• National and international level conferences and seminars may be organized in India to kindle the interest of young researchers to publish their research papers in infertility studies.

• Libraries and information centres should provide alert services, SDI services and new arrivals services to the scientists working on infertility research to keep them updated in the field.
Industry-academic collaboration is to be emphasized both in teaching and research arenas.

5.4 DIRECTIONS FOR FURTHER RESEARCH

- Country-specific qualitative and quantitative studies on infertility research output may be studied using the scientometric tools.
- Infertility research output of a group of countries like SAARC countries, G-7 countries, ASEAN countries, BRIC countries may be undertaken.
- Research on the publications covered by other databases like web of science, Pubmed etc may be carried out.
- A comparative study of research output as disclosed by various databases like Scopus, WoS and Pubmed may be undertaken.
- A survey research may be undertaken to evaluate the infertility literacy among the male and female population of 20-40 years category.
- State wise analysis on both Indian and international databases and indexed journals can also be carried to have detailed analysis of Indian productivity by the future researchers.
- Scientometric portraits of the most productive authors in infertility research may be carried out.
- Advanced scientometric tools and techniques like Research Priority Index, Strike Rate Index and the like which are not used in this study may be used in future studies.
Transparent national / state level funding policies should be formulated and activated.

5.5 DISCUSSION AND CONCLUSION

Infertility remains one of the leading global problems. For decades, family planning in India has meant not having more than two children; now, the government wants to help infertile couples have babies. There is a growing realization that infertility is a problem not only in urban areas, where treatment is available at expensive rates in the private sector, but even in rural areas. NIRRH survey found that 5%–6% of the couples visiting government hospitals suffered from infertility but the staff was not trained to treat it.

Total Fertility Rate (TFR) is the average number of children expected to be born per woman during her entire span of reproductive period. In India total fertility rate is 2.4. Among the biggest states, Tamil Nadu and West Bengal have the lowest TFR of 1.7 as per the last survey (2013). It is necessary to carry out a lot of R & D activities in infertility related areas. This in turn demands knowledge of the present status of research at global and country level. The present study is perhaps the first attempt that has analyzed the status of infertility research globally and nationally.

An analysis of worldwide scientific efforts in terms of publications published during last 30 years (1985-2014) on infertility research witnessed that globally 75098 papers were published with an annual growth rate 1.04% and registering an impact of 16.79 citations per paper. Among the countries, USA leads and contributes 23.92% share of global publications in infertility research. The publication activity of the most
developed countries (USA, France, Germany and Japan) is gradually declining over time in global context. The countries that have shown rise in their global publications share over time are relatively few including UK, Italy, Canada, Netherlands and India. Indian infertility research publications were 1764 with the global share of 2.35%; its global share increased from 0.94 from 1985 to 4.60 in 2014; with an annual average global share of 2.01. International collaboration has increased considerably in India; but very few institutions were collaborated internationally.

There are many regional and country level variations in the infertility research literature published/indexed in SCOPUS. These significant variations among the rich countries, especially in Europe, in infertility research output are due to legal restrictions affecting the practice of ARTs in some countries. These restrictions have not only influenced the type of research performed but the amount of research literature published. Other empirical studies have also suggested the availability of funding as a key factor of infertility research in the world. For most developing countries, infertility services are not widely accessible or affordable. Although optimal utilization of IVF has been estimated to be around 1500 cycles per one million people per year, the provision of such services has declined significantly in developing countries. Indeed, the contribution of developing countries to global infertility research has remained limited due to lack of infrastructures and financial resources. In addition, infertility prevention, treatment and care have been neglected, ranking low on the research priorities, particularly in developing countries.

The present study has identified the major institutions and their research thrust. Collaboration pattern identified the major collaborating countries, institutions and
authors. Keeping in view the rise of infertility rate in the country, there is a need to increase the R & D efforts through investments, deployment of more qualified professionals and technological infrastructures. Health care system should be strengthened for infertile couples by identifying cost-effective treatments, upgrading standards, accessibility of infertility care at different levels. Government should have a strategy to licensing the infertility clinics, insurance policies, legal and ethical guidelines, adoption policies, counselling services and to educate the people to decrease the burden of infertility problem.

In order to increase the research output, improve the quality and undertake more focused research, there is a need to formulate a national health plan. High quality of research in India is grossly inadequate and requires strategic planning, investment and resource facilities. Though the study has provided some valuable insights on the status and trend of infertility research in global and national level, there is a necessity to prepare a comprehensive profile of research capacity and capability in infertility. This will be really useful to take good decisions about future R & D activities. Since the input and quality of infertility research in India is in poor condition, heavy investment is needed in terms of R & D activities from the government to upgrade this field and increase the research impact. For the high research effort & impact, R & D team should be encouraged to have national collaboration with basic and clinical research institutes and social science research institutes, international collaboration with developed and developing countries and wider participation of international conferences and seminars.