

RESEARCH PRODUCTIVITY IN COLORECTAL CANCER - A SCIENTOMETRIC STUDY OF INDIA AND IRAN

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Abstract *The objective of the present study is to provide an overview of the global research productivity on colorectal cancer with an in-depth analysis of India and Iran. The study also identifies the authorship collaborations among the Indian and Iranian medical scientists. The research started with the selections of terms on "Colorectal cancer". The three (3) terms- Colorectal Neoplasm, Colorectal Cancer, and Colorectal Tumour were selected from the Medical Subject Headings (MeSH) to retrieve the data from the Web of Science (WOS) maintained by the Thomson Reuters using the Boolean Operator "OR". The data related to the Colorectal cancer research from 1989-2017 was retrieved and downloaded in the excel file. Later, the STRATA and EvIEWS software were used to analyse the data. The three important means- annual growth rate (AGR), relative growth rate (RGR), and Doubling Time (Dt) have been used to trace the development of literature from 1989 to 2017. Further, authorship patterns were analysed using the authorship collaboration and collaborative coefficient methods. The results reveal that the USA (64,031; 30.86%), Peoples Republic of China (20,209; 9.74%) and Japan (18,085; 8.71%) are the highly contributing nations in the field of Colorectal Cancer. India stands at 24th position and Iran at 32nd position with a contribution of 1,983 and 1057 publications respectively. The values of the annual growth rate (AGR) and relative growth rate (RGR) show fluctuations from 1989 to 2017 for both the nations. In India, AGR shows negative values in the years 1996, 2000, 2002, 2004, 2007 and 2009 and in Iran, AGR is negative in 2003, 2009, 2012 and 2013. However, the AGR of both the countries shows an increasing trend towards the end of 2017 which is a positive sign. The average growth rate of India is 43.96% whereas the average growth rate of Iran is 49.68%. The calculated values of Relative Growth Rate (RGR) and Doubling Time (Dt) clearly signify an inverse relationship between the two in both the nations. In India, the mean of the RGR is 0.27% and doubling time (Dt) is 3.68 years whereas in Iran, the mean of the RGR is 0.38% and doubling time (Dt) is 2.36 years. Authors in both the nations like to work in collaboration as the degree of collaboration (India= 0.97; Iran= 0.98) and the collaborative coefficient (India= 0.65; Iran= 0.66) of both the countries have very high values.*

Keywords: *Colorectal Neoplasm, Colorectal Cancer, Colorectal Tumour, Oncology, Scientometrics, Bibliometrics*

INTRODUCTION

Colorectal cancer is a formidable health problem worldwide. Colorectal cancer, also known as bowel cancer, colon cancer, or rectal cancer, is any cancer that affects the colon and the rectum (Nordqvist, 2018). Colorectal cancer is one of the dangerous cancers responsible for the high rate of mortality globally. It is the second most common in women (9.4%) and the third most common cancer in men (10.0%) of all cancer cases (Indian Council of Medical Research, 2014). The prominent factors responsible for the colorectal cancer are bad food habits, sedentary lifestyle, inherited syndromes, environmental factors, diabetes, obesity, stress, smoking, alcohol etc. colorectal cancer has the lowest incidence compared to the western world and other countries in South

East Asia. However, it has seen a steady increase in numbers with the increasing urbanization of India and presently it is the fifth most common cancer (Indian Council of Medical Research, 2014). In Iran, after cardiovascular diseases and accidents, cancer is the third most common cause of death. Colorectal cancer has a high incidence among Iranian men and women and is one of the five most prevalent cancers (Darabi et al., 2016). The medical scientists of reputed national and international institutions and organisations like World Health Organisation (WHO), American Cancer Society, Indian Council of Medical Research (ICMR), Iranian Medical Council Research (IMRC) etc. conduct research to curb this disease. In context of Library and Information Science, it becomes the need of hour to measure the research productivity in colorectal cancer.

Scientometrics is a very effective tool to analyse the research (Leydesdorff & Milojevic, 2012). The term “Scientometrics” was introduced by Nalimov & Mulchenko in 1969 and defined it as “the science of measurement and analysis of science.” Scientometrics is the study of measuring and analysing science and technology disciplines. It is concerned with the quantitative features and characteristics of science and scientific research with emphasis on investigations in which the development and mechanism of science are studied by statistical and mathematical methods. The methods of research include qualitative, quantitative and computational approaches. The main focus of studies have been on institutional productivity comparisons, institutional research rankings, journal rankings (Lowry, Denton, & Aaron, 2004), establishing faculty productivity and time series analysis, (Dean, Lowry, & Humpherys, 2011). Scientometrics is a very helpful in analysing the publication sketches of the most prolific subject experts and institutions as well (Karuga, Lowry, & Richardson, 2007). This is a very vital method in evaluating the impact of the most influential scholarly content. Therefore, it can be regarded as a very vital tool for the measurement of the research performance.

LITERATURE REVIEW

Scientometrics is a century old field of research and many scientometric studies have been conducted on oncology from time to time. Gupta, Ahmed, Gupta, and Bansal (2016) examined 3,653 Indian publications on lung cancer research, as covered in Scopus database during 2005-14, experiencing an annual average growth rate of 18.81%. India's global publication share was 2.16% and holds 12th rank in the global output during 2005-14. India's share of international collaborative publications on lung cancer was 17.79%. In another study, Gupta, Gupta, and Ahmed (2016) examined 3042 Indian publications in colorectal cancer, as covered in Scopus database during 2005-2014, experiencing an annual average growth rate of 4.06%. Narzary and Murugan (2017) mapped the colorectal research output of India and concluded that only 261 publications are contributed by the top fifteen productive authors and the top fifteen institutions contribute only 461 papers with the highest by the Panjab University, Chandigarh. They also revealed that authors like to work in collaboration, not individually. Biglu, Somi, Ghojzadeh, Tabatabaei, and Alikhah (2015) studied the trend of gastrointestinal research output in Iran using Medline and Scopus databases and it was revealed that the research in this sphere has increased from year 2002 to 2012. The most prolific institutions were Tehran University of Medical Sciences (667), Shahid Beheshti University of Medical Sciences (306), and Shiraz University of Medical Sciences (139) respectively. The overall analysis of the already existing studies show that the scientometric analysis

of colorectal cancer research of India and Iran hasn't been studies till date and the present study is an attempt to measure the research output of these two great nations in the area of colorectal cancer.

RESEARCH DESIGN

Objectives

- To identify the prominent nations globally contributing to the research productivity of colorectal cancer;
- To identify the annual growth rate, relative growth rate and doubling time of the colorectal cancer literature in India and Iran; and
- To identify the collaborative authorship patterns of the Indian and Iranian authors in colorectal cancer using authorship collaboration and collaborative coefficient methods.

Hypothesis

In order to signify a sound relationship between publication count and GDP following hypothesis was formulated.

H_0 : There is no relation between the number of publications and the GDP of a nation.

H_1 : There is a significant relationship between the number of publications and the GDP of a nation.

Methodology

The research is a part of Ph.D. programme “Research Productivity of the Medical Scientists in the field of Oncology: A Scientometric Study of India and Iran”. Oncology deals with the study of cancers. Therefore, besides oncology and allied terms, top ten (10) cancers including “Colorectal Cancer” were selected for the study. However, three (3) terms- *Colorectal Neoplasm*, *Colorectal Cancer*, and *Colorectal Tumour* were selected from the Medical Subject Headings (MeSH) to retrieve the data on colorectal cancer from the Web of Science (WOS) maintained by the Thomson Reuters using the Boolean Operator “OR”. The data related to colorectal cancer research from 1989-2017 was retrieved and downloaded in the excel file. Later, the *STRATA* and *Eviews* software were used to analyse the data.

DATA ANALYSIS

Position of India and Iran

The top three nations with outstanding contribution in the field of colorectal cancer are the USA (64,031; 30.86%),

Peoples Republic of China (20,209; 9.74%) and Japan (18,085; 8.71%) respectively. India stands at 24th position and Iran at 32nd position with a contribution of 1,983 and 1057 publications respectively (Table 1).

Table 1: Position of India and Iran

Rank	Nation	Publication	Percentage	Gross Domestic Production (GDP) [US\$ at constant prices 2010]
1	USA	64,031	30.86	17304984279400.00
2	China	20,209	9.74	10161012758870.30
3	Japan	18,085	8.71	6156328720578.61
4	England	16,736	8.06	3865759081373.60
5	Germany	15,154	7.30	2111901941464.10
6	Italy	12,890	6.21	2857089402048.00
7	France	10,379	5.00	1883707911710.79
8	UK	8,266	3.98	1345945672416.94
9	Netherlands	7,653	3.68	2806903096896.07
10	Canada	7,593	3.66	2629542211700.51
24	India	2,143	1.03	563826247961.83
32	Iran	1,057	0.005	17304984279400.00

Source: GDP obtained from World Development Indicators (Recent Edition)

To identify the correlation between GDP and colorectal cancer publication, Karl Pearson's correlation coefficient was calculated for the publication count and GDP.

$$r = \frac{\sum (X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum (X_i - \bar{X})^2} \sqrt{\sum (Y_i - \bar{Y})^2}}$$

It is found the coefficient of correlation is, $r = 0.95$, i.e. GDP and Publications are highly correlated. However to test whether this coefficient is significant or not the T-test was applied which is given by:

$$t = \frac{r\sqrt{n-2}}{1-r^2}$$

After making use of *STATA* and cross-checked in *Eviews*, it is found that the above coefficient ($r = 0.95$) is significant at 1% level of significance. With $p = 0.01$, the null hypothesis is rejected and it is concluded that GDP and Publication are correlated at 1% level of significance. Therefore, it can be interpreted that the countries that have more GDP, spend more budget on health and research activities resulting in more number of research publications.

Annual Growth Rate

Annual Growth Rate can be calculated by using the formula:

$$[(\text{Last Value} - \text{Initial Value}) \div \text{Initial Value}] 100$$

The colorectal cancer research output in India and Iran from 1989 – 2017 with a total publication of 2143 from India and 1057 from Iran shows a fluctuating trend. The year 2017 marks the highest publication activity in both the countries as India (484) and Iran (224) records the highest publication count. India has opened a research account in colorectal cancer in 1989 whereas Iran started publishing activity in colorectal cancer in 1998 with one (1) publication each. In India, negative growth is witnessed in the years 1996, 2000, 2002, 2004, 2007 and 2009 and Iran has experienced the negative growth in 2003, 2009, 2012 and 2013 whereas for the rest of the years, annual growth rate for both the nations is positive with slight variations. The average growth rate of India is 43.96 whereas the average growth rate of Iran is 49.68 (Table 2). However, the number of publications has shown a positive growth till 2017 (Fig 1).

Table 2: Annual Growth Rate in India and Iran

Period	India			Iran		
Year	Publications	Cumulative	Annual Growth Rate	Publications	Cumulative	Annual Growth Rate
1989	1	-	-	0	-	
1990	3	4	200	0	0	-
1991	4	8	33	0	0	-
1992	4	12	0	0	0	-

Period	India			Iran		
Year	Publications	Cumulative	Annual Growth Rate	Publications	Cumulative	Annual Growth Rate
1993	5	17	25	0	0	-
1994	5	22	0	0	0	-
1995	7	29	40	0	0	-
1996	3	32	-57	0	0	-
1997	4	36	33	0	0	-
1998	5	41	25	1	1	-
1999	12	53	140	0	1	0
2000	3	56	-75	2	3	0
2001	13	69	333	2	5	0
2002	8	77	-38	2	7	0
2003	18	95	125	1	8	-50
2004	17	112	-6	6	14	500
2005	19	131	12	12	26	100
2006	32	163	68	14	40	17
2007	30	193	-6	29	69	107
2008	72	265	140	47	116	62
2009	55	320	-24	39	155	-17
2010	99	419	80	52	207	33
2011	114	533	15	92	299	77
2012	141	674	24	68	367	-26
2013	176	850	25	67	434	-1
2014	225	1075	28	100	534	49
2015	242	1317	8	132	666	32
2016	342	1659	41	167	833	27
2017	484	2143	42	224	1057	34
1989-2017	73.90	Average	43.96	52.58	Average	49.68

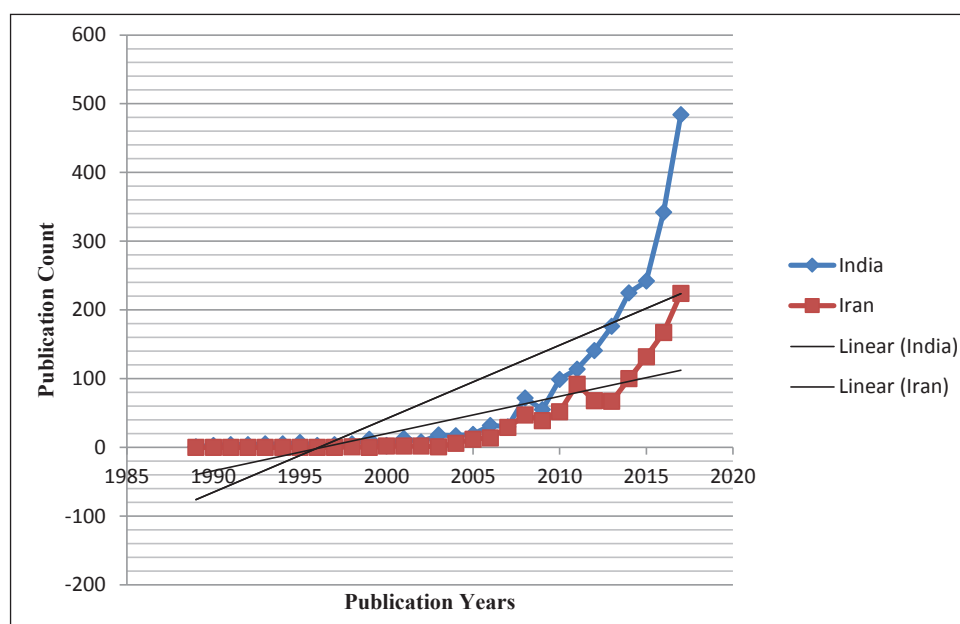


Fig. 1: Annual Growth Rate

Relative Growth Rate (RGR) and Doubling Time (Dt)

Relative Growth Rate (RGR) can simply be defined as the increase in the number of articles or pages per unit time. The mean relative growth rate over a specific time interval can be calculated as follows:

Relative Growth Rate (RGR)

$$RGR = \frac{\log_e W_2 - \log_e W_1}{T_2 - T_1}$$

Whereas

RGR is actually mean relative growth rate over the specific period of time.

$\log_e W_1$ - log of initial number of articles.

$\log_e W_2$ - log of final number of articles after a specific period of time.

$T_2 - T_1$ - the unit difference between the initial time and the final time.

Here a year is taken as the unit of time.

Doubling time is calculated by $0.693/R$.

Table 3 traces the year relative growth rate of the colorectal research output in India and Iran. It is quite clear that India experiences the highest relative growth rate in the year 1990 about 1.38 and lowest of 0.05 in the year 2000 while Iran has witnessed the highest growth rate of 1.09 in the year 2000 and lowest of 0.13 in the year 2003. The relative growth rate of the literature pertinent to colorectal cancer undergoes considerable variation in both the countries under study.

The year-wise calculated values of the doubling time imply that there is a considerable variation in the respective values for both the nations. For the research output of India, the doubling time is 0.50 in the year 1990 and has increased to 13.86 in the year 2000 it has further decreased to 2.77 by the year 2017 for Iran the doubling time for the year 2000 is 0.63 and has increased to 5.33 by the year 2003 doubling time shows fluctuation as the value is 2.88 for the year 2017. In India, the mean of the RGR is 0.27 and doubling time (Dt) is 3.68 years whereas in Iran, the mean of the RGR is 0.38 and doubling time (Dt) is 2.36 years (Table 3).

Table 3: Relative Growth Rate (RGR) and Doubling Time (Dt)

Year	India						Iran					
	Output	Cumulative	W_1	W_2	RGR	DT	Output	Cumulative	W_1	W_2	RGR	DT
1989	1	-	-	0	-	-	0	-	-	0	-	-
1990	3	4	0	1.38	1.38	0.50	0	0	0	-	-	-
1991	4	8	1.38	2.07	0.69	1.00	0	0	-	-	-	-
1992	4	12	2.07	2.48	0.41	1.69	0	0	-	-	-	-
1993	5	17	2.48	2.83	0.35	1.98	0	0	-	-	-	-
1994	5	22	2.83	3.09	0.26	2.66	0	0	-	-	-	-
1995	7	29	3.09	3.36	0.27	2.56	0	0	-	-	-	-
1996	3	32	3.36	3.46	0.1	6.93	0	0	-	-	-	-
1997	4	36	3.46	3.58	0.12	5.77	0	0	-	-	-	-
1998	5	41	3.58	3.71	0.13	5.33	1	1	-	0	-	-
1999	12	53	3.71	3.97	0.26	2.66	0	1	0	0	-	-
2000	3	56	3.97	4.02	0.05	13.86	2	3	0	1.09	1.09	0.63
2001	13	69	4.02	4.23	0.21	3.3	2	5	1.09	1.60	0.51	1.35
2002	8	77	4.23	4.34	0.11	6.3	2	7	1.60	1.94	0.34	2.03
2003	18	95	4.34	4.55	0.21	3.3	1	8	1.94	2.07	0.13	5.33
2004	17	112	4.55	4.71	0.16	4.33	6	14	2.07	2.63	0.56	1.23
2005	19	131	4.71	4.87	0.16	4.33	12	26	2.63	3.25	0.62	1.11
2006	32	163	4.87	5.09	0.22	3.15	14	40	3.25	3.68	0.43	1.61
2007	30	193	5.09	5.26	0.17	4.07	29	69	3.68	4.23	0.55	1.26
2008	72	265	5.26	5.57	0.31	2.23	47	116	4.23	4.75	0.52	1.33
2009	55	320	5.57	5.76	0.19	3.64	39	155	4.75	5.04	0.29	2.38
2010	99	419	5.76	6.03	0.27	2.56	52	207	5.04	5.33	0.29	2.38
2011	114	533	6.03	6.27	0.24	2.88	92	299	5.33	5.70	0.37	1.87
2012	141	674	6.27	6.51	0.24	2.88	68	367	5.70	5.90	0.20	3.46

2013	176	850	6.51	6.74	0.23	3.01	67	434	5.90	6.07	0.17	4.07
2014	225	1075	6.74	6.98	0.24	2.88	100	534	6.07	6.28	0.21	3.3
2015	242	1317	6.98	7.18	0.2	3.46	132	666	6.28	6.50	0.22	3.15
2016	342	1659	7.18	7.41	0.23	3.01	167	833	6.50	6.72	0.22	3.15
2017	484	2143	7.41	7.66	0.25	2.77	224	1057	6.72	6.96	0.24	2.88
1989-2017	India		Mean		0.27	3.68	Iran		Mean		0.38	2.36

Author Collaboration

The extent and pattern of authorship helps to understand the nature of authorship. Two measures “Degree of collaboration” and “Collaborative Coefficient” have been used to give a brief idea of authorship collaboration in India and Iran. Degree of collaboration helps to understand the

level/depth of the collaboration it is calculated by using the formula suggested by Subramanyam (1983).

Where

C = Degree of collaboration

NM = Number of multi-authored papers

NS = Number of single-authored papers

Table 4: Degree of Author Collaboration

Authorship	India		Iran	
	Number of Publications	Percentage	Number of Publications	Percentage
Single	60	2.80	20	1.89
Two	252	11.76	78	7.38
Three	315	14.70	84	7.95
More than Three	1516	70.74	875	82.78

Degree of collaboration (India)

$$C = NM/(NM + NS)$$

$$C (\text{India}) = 2083 / 2143$$

$$C (\text{India}) = 0.97$$

$$C (\text{Iran}) = 1037 / 1057$$

$$C (\text{Iran}) = 0.98$$

(b) Collaborative Coefficient

To understand the nature of authorship in two nations collaborative coefficient has been calculated as recommended by Ajiferuke, Burell, and Tague (1988) for both the nations. The value of collaboration coefficient of both the countries (India= 0.65; Iran= 0.66) is above 0.50 which shows that both the nations prefer the multiple authorship pattern.

$$CC = 1 - \left[\sum_{j=1}^k \frac{(1/j) F_j}{N} \right]$$

F_j = the number of authored papers

N = total number of research published; and

k = the greatest number of authors per paper

$$CC (\text{India}) = 1 - [(60/2143) + (252/2143)/2 + (1831/2143)/3]$$

$$CC (\text{India}) = 0.65$$

$$CC (\text{Iran}) = 1 - [(20/1057) + (78/1057)/2 + (959/1057)/3]$$

$$CC (\text{Iran}) = 0.66$$

FINDINGS

The study unfolds different scientometric facets of the colorectal cancer research in India and Iran. It is quite evident that there exists a strong relationship between Gross Domestic Production (GDP) of a nation and its Publication activity as both are directly related to one another. The more the GDP of a nation more is the research output / productivity. A close examination at the calculated values of the annual growth rate (AGR) shows a positive sign as there is an increase at the end of 2017 for both the nations. The average growth rate of India (1989-2017) is 43.96 whereas the average growth rate of Iran (1998-2017) is 49.68. It is also obvious from the calculated values of the relative growth rate (RGR) and doubling time (Dt) as both are inversely related to each other. In India, the mean of the RGR is 0.27% and doubling time (Dt) is 3.68 years whereas in Iran, the mean of the RGR is 0.38% and doubling time (Dt) is 2.36 years. The fluctuation in the values of the AGR, RGR and Dt are credited to the non-uniform publication activity of the two countries. The evaluation of the nature of collaboration of the authorship strongly conveys that the medical scientists of India and Iran

work as a team with other researchers inside and outside countries to find the final treatment of the colorectal cancer.

CONCLUSION

Colorectal Cancer is the third most prevalent cancer all over the world. India ranks 24th and Iran 32nd in the colorectal cancer research output which is area of concern. Both the nations need to excel their respective potential in colorectal cancer research.

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