Cloud Publications
International Journal of Advanced Library and Information Science
2014, Volume 2, Issue 1, pp. 72-81, Article ID Sci-143

Cloud Publications

Research Article | Open Access

Lung Cancer Research in G7 and BRIC Countries: A Comparative Analysis by Scientometric Method

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Publication Date: 29 January 2014

Article Link: http://scientific.cloud-journals.com/index.php/IJALIS/article/view/Sci-143

Abstract This paper examines the research output of lung cancer in the G7 and the BRIC countries by scientometric method. Data has been downloaded from Scopus database for the period of 10 years (2003–2012). This study compares the growth rate (CAGR), Collaboration Coefficient (CC) and Publication Activity (TAI) of the countries of both the groups. Two relative indicators– Absolute Citation Impact (ACI) and Relative Citation Impact (RCI) have been adopted to compare the quality and impact of the lung cancer research. We found that the BRIC countries had a significant growth in both in the number of articles and their share in the recent years when compared with the G7 countries.

Keywords *Lung Cancer; WHO; Scopus; G7 and BRIC Countries; Citation*

1. Introduction

The growth of abnormal cells in the lungs is termed as lung cancer. They spoil the development of healthy lung tissue. As they grow, the abnormal cells can form tumors and interfere with the functioning of the lung, which provides oxygen to the body via the blood [1]. There are two types of lung cancer namely primary lung cancer and secondary lung cancer. The origin of the primary lung cancer is developed within the lungs, whereas in the case of secondary lung cancer the growth is developed somewhere in the body and reaches the lungs. It is certainly no surprise that smoking is the leading cause for lung cancer; about 80% of individuals are current (20%) and former (60%) smokers. Smoking increases a person's lifetime risk of lung cancer by a factor of 20 times. Other causes are radon, second– hand smoke (passive smoker). Around 7.6 million deaths worldwide in each year are caused by cancer. About 13% of the deaths are caused by cancer in which lung cancer is regarded according to the report of World Health Organization (WHO).

It is estimated that 228, 190 men and women (118,080 men and 110,110 women) will be diagnosed with cancer and 159,480 men and women will die of cancer of the lung and bronchus in 2013 [3]. The financial ministers of the following seven countries namely USA, UK, France, Germany, Italy, Canada

and Japan are known as the group of G7. According to their global net wealth, they are regarded as the wealthiest nations on the world. About 50.4% of the global nominal GDP and 39.3% of the global GDP are comprised by the G7 countries. They discuss about economic policies in their meeting which is conducted every year.

The group acronym BRIC (refers to Brazil, Russia, India and China), coined by O'Neill [5] in 2001 in a report named "Building better global economic BRICs". He identified BRIC as four rapidly growing "developing countries" likely to challenge the G7 countries. His judgment has been vindicated over the past decade. Therefore, the G7 and BRIC countries can be used to study two kinds of countries in lung cancer research.

2. Review of Literature

The review regarding to the present study has been analyzed.

The research performance between BRIC and N-11 countries has been compared by Rons (2011). Who found that the economic profile of the country has been enhanced by the indicators which were related to research performance. .

(Yang et al., 2012) [7] compared the disciplinary structure of the G7 countries and BRICs countries and found that the disciplinary structure of the G7 countries was more balanced than that of the BRICs countries, but in recent years the disciplinary structure of the BRICs countries has become more and more similar to that of the G7 countries.

By using Scientometric indicators, (Yi et al., 2013) answered the question "Are CIVETS the next BRIC at the country group level and found out the significant difference between CIVETS and BRICs in knowledge– based economy performance, scientific research quality and scientific research structure.

The tribology research output in BRIC countries their document type, authorship and publication pattern were analyzed by (Elango et al., 2013). The majority of the world articles are published by G7 countries and their share was replaced by other countries in BRIC according to the study conducted by (Yang et al., 2013) on global trends of solid waste research.

3. Objectives of the Study

The main objective of the study is to identify/analyze the following.

- Research output of lung cancer research between the G7 and the BRIC countries during 2003 to 2012.
- Collaboration pattern of authors and activity profile of lung cancer research.
- Citation profile and Relative Citation Index of lung cancer research.

4. Methodology

The data in this study has been retrieved from Scopus (www.scopus.com). Scopus is the world's largest abstract and citation database of peer-reviewed literature. All document types from 2003 to 2012 which had the following keywords were downloaded: "lung cancer", "lung carcinoma", "lung metastasis", "lung malignancy" and "adenocarcinoma of lung". The following search strategy has been used for the G7 countries.

TITLE-ABS-KEY ("lung cancer" OR "lung malignancy" OR "lung metastasis" OR "lung carcinoma" OR "adenocarcinoma of lung") AND PUBYEAR > 2002 AND PUBYEAR < 2013 AND (LIMIT-TO (AFFILCOUNTRY, "United States") OR LIMIT-TO(AFFILCOUNTRY, "Japan") OR LIMIT-TO (AFFILCOUNTRY, "United Kingdom") OR LIMIT-TO(AFFILCOUNTRY, "Germany") OR LIMIT-TO (AFFILCOUNTRY, "Italy") OR LIMIT-TO (AFFILCOUNTRY, "France") OR LIMIT-TO (AFFILCOUNTRY, "Canada"))

The following search strategy has been used for the BRIC countries.

TITLE-ABS-KEY ("lung cancer" OR "lung malignancy" OR "lung metastasis" OR "lung carcinoma" OR "adenocarcinoma of lung") AND PUBYEAR > 2002 AND PUBYEAR < 2013 AND (LIMIT-TO (AFFILCOUNTRY, "China") OR LIMIT-TO (AFFILCOUNTRY, "India") OR LIMIT-TO (AFFILCOUNTRY, "Brazil") OR LIMIT-TO (AFFILCOUNTRY, "Russian Federation"))

Bibliographic details like author, title, affiliations, document type, language, year, and number of citations were exported to Microsoft Excel.

5. Analysis and Discussion

All types of documents related to the research of lung cancer from 2003 to 2012 for the G7 and the BRIC countries have been processed. There were 73,788 papers for the countries of both the groups.

5.1. Year Wise Output and Growth Rate of the G7 and the BRIC Countries

The research output and growth rate of the G7 and the BRIC countries were shown in Table 1 and Table 2 respectively. It was also revealed from the table that 61407 articles were published by the G7 countries from 2003 to 2012. Among the G7 countries, US topped with 27375 (44.58%) papers, followed by Japan with 10666 (17.37%).

Table 1: *Year Wise Output and Growth Rate of the G7 Countries*

Country / Year	US	UK	France	Germany	Italy	Canada	Japan	Total
2003	1893	381	295	357	359	154	838	4277
2004	2125	432	381	485	413	216	844	4896
2005	2327	442	347	467	392	244	929	5148
2006	2459	496	398	514	478	246	1000	5591
2007	2613	520	410	523	480	291	969	5806
2008	2785	546	407	525	500	329	903	5995
2009	2908	599	469	596	549	354	1184	6659
2010	3144	624	485	641	565	377	1261	7097
2011	3380	686	552	601	634	415	1295	7563
2012	3741	733	588	704	716	450	1443	8375
Total	27375	5459	4332	5413	5086	3076	10666	61407
%	44.58	8.89	7.05	8.81	8.28	5.01	17.37	100.00
CAGR	**7.86**	**7.54**	**7.97**	**7.84**	**7.97**	**12.65**	**6.22**	

Table 2: *Year Wise Output and Growth Rate of the BRIC Countries*

Country / Year	Brazil	Russia	India	China	Total
2003	43	48	54	261	406
2004	43	54	70	295	462
2005	36	40	77	481	634
2006	55	39	86	563	743
2007	60	42	97	733	932
2008	65	36	120	988	1209
2009	70	30	153	1300	1553
2010	70	45	211	1391	1717
2011	86	56	298	1634	2074
2012	111	74	353	2113	2651
Total	639	464	1519	9759	12381
%	5.16	3.75	12.27	78.82	100.00
CAGR	11.11	4.93	23.20	26.16	

The growth rate was measured with Compound Annual Growth Rate (CAGR) [11]. The mathematical formula of CAGR is

$$\text{CAGR} = \left(\frac{\textit{Ending Value}}{\textit{Begining Value}} \right)^{\frac{1}{n-1}} - 1$$

China had the highest growth rate of 12.65. Except Japan, other countries (US, UK, France, Germany and Italy) have shown similar growth rate.

Among the BRIC countries, China topped with 9759 (78.82%) papers, followed by India with 1519 (12.27%) papers. China had the highest growth rate of 26.16 followed by India (23.20), Brazil (11.11) and finally Russia (4.93). When the G7 countries were compared with the BRIC countries, one of the BRIC country i.e. China had the highest growth rate (26.16).

The pattern of output and rank during the period 2003 to 2012 in two blocks for 5 years is depicted in Table 3. US, one of the G7 countries holds the first rank during the period 2003-2007 and 2008-2012. One of the G7 countries, Japan holds the second rank during the year 2003–2007, but during the year 2008–2012, one the BRIC countries, China holds the second rank.

Table 3: *Rank of the G7 and the BRIC Countries*

	Country	2003-2007	Rank	2008-2012	Rank	2003-2012
BRICS	Brazil	237	10	402	10	639
	Russia	223	11	241	11	464
	India	384	9	1135	9	1519
	China	2333	4	7426	2	9759
G7	US	11417	1	15958	1	27375
	UK	2271	5	3188	4	5459
	France	1831	7	2501	7	4332
	Germany	2346	3	3067	5	5413
	Italy	2122	6	2964	6	5086
	Canada	1151	8	1925	8	3076
	Japan	4580	2	6086	3	10666

Comparison between the G7 and the BRIC countries is demonstrated in Figure 1. Although the G7 countries played a predominant role in lung cancer research and the articles from these countries kept increasing in quantity, their article share was decreasing in the last 5 years. On contrary, BRIC countries had a significant growth in both in the number of articles and their share.

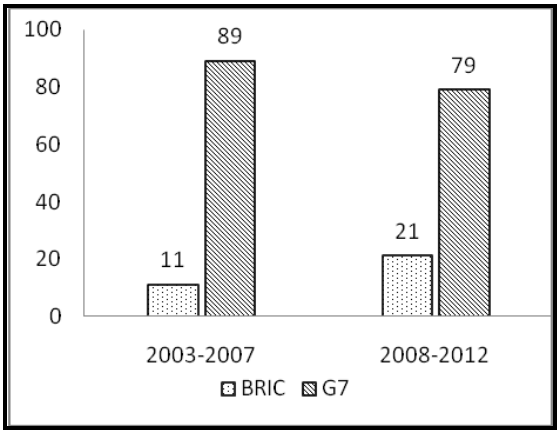

Figure 1: *Comparison between G7 and BRIC on the Percentage of the Articles*

5.2. Measure of Collaboration

Collaboration Coefficient (CC) can be defined as (Ajiferuke, 1988) [12],

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

CC always lies between 0 and 1. As the number of single authors dominate CC 0. CC distinguishes between single authors and multiple authors. However, CC fails to yield 1 for maximal collaboration, except when number of authors is infinite. From Table 4, it can be observed that Japan (one of the G7 country) and Russia (one of the BRIC country) have highest collaboration rate of 0.80 followed by China (0.79) and Italy (0.78). Except US and UK, all the countries have collaboration rate ≥ 70.

Table 4: *Collaboration Rate of the G7 and the BRIC Countries*

	Country	Number of Authors					Total	CC
		1	2	3	4	> 4		
BRIC	Brazil	21	55	62	85	416	639	0.77
	Russia	10	34	39	52	329	464	0.80
	India	65	260	266	309	619	1519	0.70
	China	123	599	1144	1264	6629	9759	0.79
G7	US	3083	4181	3288	2865	13958	27375	0.68
	UK	644	823	764	664	2564	5459	0.67
	France	446	400	376	387	2723	4332	0.72
	Germany	559	639	536	572	3107	5413	0.70
	Italy	236	337	423	455	3635	5086	0.78
	Canada	219	356	342	381	1778	3076	0.73
	Japan	487	430	579	810	8360	10666	0.80

5.3. Co–Authorship Pattern

Based on the suggestions made by Garg and Padhi, the Co-Authorship pattern and Co-Authorship Index (CAI) has been calculated by using the following formula.

$$CAI = \frac{N_{ij}/N_{io}}{N_{oj}/N_{oo}} X\ 100$$

Where, N_{ij} = Number of publications for the particular authorship pattern for a particular country

N_{io} = Total output for the particular authorship pattern
N_{oj} = Total output of the particular country
N_{oo} = Total output of all the countries

Table 5: *Co–Authorship Pattern of the G7 and the BRIC Countries*

	Country	Single Author	CAI	Two Author	CAI	Three Authors	CAI	> Three Authors	CAI	Total
BRICS	Brazil	21	41	55	78	62	92	501	111	639
	Russia	10	27	34	67	39	79	381	117	464
	India	65	54	260	156	266	165	928	87	1519
	China	123	16	599	56	1144	111	7893	115	9759
G7	US	3083	141	4181	139	3288	113	16823	87	27375
	UK	644	148	823	137	764	132	3228	84	5459
	France	446	129	400	84	376	82	3110	102	4332
	Germany	559	129	639	107	536	93	3679	97	5413
	Italy	236	58	337	60	423	78	4090	114	5086
	Canada	219	89	356	105	342	105	2159	100	3076
	Japan	487	57	430	37	579	51	9170	122	10666
	Total	5893		8114		7819		51962		73788

It is observed from Table 5 that except India, for the rest of the BRIC countries the value of CAI was more than 100 which shows that they preferred to work in small and big teams. The value of CAI for India for two and three authored publications were higher than the average, it seems that they were more preferred to work in small teams. For single authored publications in some of the G7 countries like US, UK, France and Germany, the CAI value stands higher than the average value which indicates that these countries preferring to work independently. In the case of multi authored paper the CAI value for Japan and Italy are higher than the average value which represents that these two countries prefer working as a team.

5.4. Publication Activity

In order to study the change in output of lung cancer articles among the countries, use of Transformative Activity Index (TAI) suggested by Guan and Ma [14] has been made. Mathematically,

$$TAI = \frac{C_i/C_o}{W_i/W_o} X\ 100$$

C_i – Number of publications of the specific country in the i^{th} block;
C_0 - Total number of publication of the specific country during the period of study;

W_i – Number of publications all the countries in the i^{th} block;
W_0 - Total number of publication of all the counties during the period of study.

Table 6: *TAI of the G7 and the BRIC Countries*

	Country	2003-2007	TAI	2008-2012	TAI	2003-2012	Change in TAI
BRICS	Brazil	237	95	402	103	639	+9
	Russia	223	123	241	85	464	-37
	India	384	65	1135	123	1519	+58
	China	2333	61	7426	125	9759	+64
G7	US	11417	107	15958	96	27375	-11
	UK	2271	106	3188	96	5459	-10
	France	1831	108	2501	95	4332	-13
	Germany	2346	111	3067	93	5413	-18
	Italy	2122	107	2964	96	5086	-11
	Canada	1151	96	1925	103	3076	+7
	Japan	4580	110	6086	94	10666	-16
		28895		44893		73788	

Table 6 shows the publication output of lung cancer research of the G7 and the BRIC countries during the two blocks i.e. 2003–2007 and 2008–2012. The TAI has been calculated for the two blocks.

It is clear from the Figure 2 that the publication activities in Russia, US, UK, France, Italy, Germany and Japan have been decreasing considerably. The remaining countries show an increasing trend in their publication activity as shown by the values of TAI. When the G7 countries were compared with the BRIC countries, the publication activity has increased considerably for the BRIC countries such as China, India and Brazil.

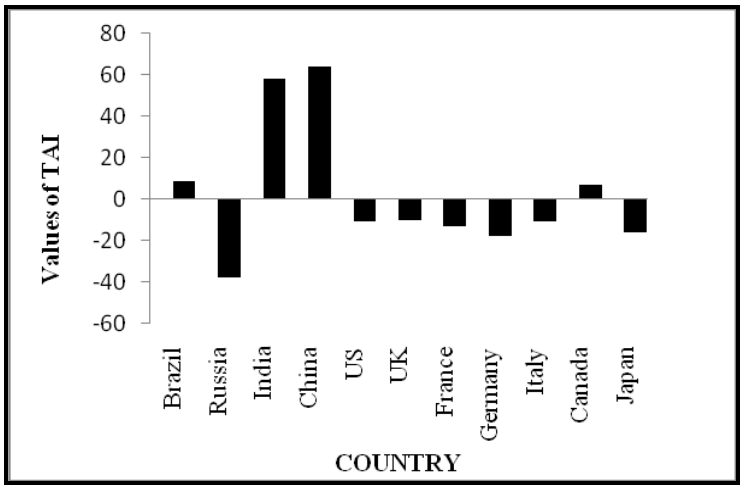

Figure 2: *Change in the Values of the TAI for the G7 and the BRIC Countries*

5.5. Citation Profile of Lung Cancer Research for the G7 and the BRIC Countries

The impact of publication is assessed in terms of number of citations that it has received. Out of 61407 publications in lung cancer research in the G7 countries, 11024 (18%) articles did not receive any citations. Remaining 50383 papers received 1404375 citations during 2003 to 2012. Average citation rate is 22.9 for all publications and US, UK and Canada received citations more than average

which was showed in Table 7. It was interesting to note that one of the article published by France during 2005 received 9936 citations.

In BRIC countries, out of 12381 papers, 5049 (41%) papers did not receive any citations; remaining 7332 papers received 94292 citations during 2003 to 2012. Average citation rate is 7.6 for all publications and Brazil, Russia and India received citations more than average which was showed in Table 8. Among the BRIC countries, one of the article published by Brazil during 2005 received 2881 citations.

Table 7: *Citation Profile of the G7 Countries*

Citations Range	US	UK	France	Germany	Italy	Japan	Canada	Total
0	3676	927	953	1099	908	3040	421	11024
1	2109	498	456	467	455	1025	226	5236
2	1620	357	299	396	354	704	197	3927
3	1369	293	252	277	276	546	168	3181
4	1226	245	163	263	195	442	120	2654
5	1058	173	163	189	211	384	122	2300
6 – 10	3800	727	528	707	758	1382	444	8346
11 -100	11256	1997	1396	1845	1785	2968	1244	22491
101 - 1000	1223	236	113	167	136	167	131	2173
> 1000	38	6	9	3	8	8	3	75
Total	**27375**	**5459**	**4332**	**5413**	**5086**	**10666**	**3076**	**61407**
Total Citation	**740180**	**128982**	**98564**	**105467**	**101770**	**151063**	**78349**	**1404375**
Average citations	**27.0**	**23.6**	**22.8**	**19.5**	**20.0**	**14.2**	**25.5**	**22.9**

Table 8: *Citation Profile of the BRIC Countries*

Citations Range	Brazil	Russia	India	China	Total
0	127	156	541	4225	5049
1	102	60	198	1350	1710
2	49	32	129	681	891
3	48	19	111	505	683
4	38	17	77	396	528
5	30	20	48	279	377
6 - 10	95	33	153	864	1145
11 -100	140	111	252	1419	1922
101 - 1000	8	15	9	38	70
> 1000	2	1	1	2	6
Total	639	464	1519	9759	12381
Total Citation	**11387**	**9005**	**11714**	**62186**	**94292**
Average citation	**17.8**	**19.4**	**7.7**	**6.4**	**7.6**

The impact of scientific publications was compared by two relative indicators namely Absolute Citation Impact and RCI. The Absolute Citation Impact is also called as CPP which is calculated by the average number of citations per publication. This is the most common and frequently used indicator which normalizes the large disparity in volumes of literature published among prolific publishing G7 countries and BRIC countries to compare the quality of the research. On the other hand, Thomson reuters developed RCI to calculate science and Engineering Indicators.Lalitha Kumari studied the field of synthetic organic research to analyze the impact of different countries.

$$RCI = \frac{A\ country's\ share\ of\ total\ citations}{A\ country's\ share\ of\ total\ publicatoins}$$

RCI = 1 indicates denotes a country's citation rate equal to world citation rate.
RCI < 1 indicates a country's citation rate less than world citation rate and also implies that the research efforts are higher than its impact.
RCI > 1 indicates a country's citation rate higher than world citation rate and also imply high impact research in that country.

Table 9: *RCI of the G7 and the BRIC Countries*

	Country	TP	TC	ACI	RCI
BRIC	Brazil	639	11387	17.8	0.88
	Russia	464	9005	19.4	0.96
	India	1519	11714	7.7	0.38
	China	9759	62186	6.4	0.31
G7	US	27375	740180	27.0	1.33
	UK	5459	128982	23.6	1.16
	France	4332	98564	22.8	1.12
	Germany	5413	105467	19.5	0.96
	Italy	5086	101770	20.0	0.99
	Canada	3076	78349	25.5	1.25
	Japan	10666	151063	14.2	0.70
		73788	1498667		

Table 9 presents the value of ACI and RCI for the G7 and the BRIC countries. For US, UK, France and Canada, RCI is more than 1, indicating higher citation impact that the world rate. Italy, Germany and Russia with RCI = 0.96 to 0.99 have almost equal to world citation rate. Brazil, India, China and Japan have RCI value less than 1 indicates that the research efforts are higher than visibility and impact.

6. Conclusion

Based on the above study, comparing the G7 and the BRIC countries in the lung cancer research, we conclude that although the G7 countries played a predominant role in lung cancer research and the articles from these countries kept increasing in quantity, their article share was decreasing in the last 5 years. On contrary, BRIC countries had a significant growth in both in the number of articles and their share. Detailed research work in the topic has revealed that further more scientomentric studies have been done and the results were similar– stating that the "Output from the BRICs shifted steadily to more closely resemble that of the G7" [17]. The publication activity has increased considerably for the BRIC countries such as China, India and Brazil than the G7 countries.

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