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Authorship Trend and Collaborative Research in Lung Cancer: A Time Series Analysis Study

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Abstract:
This study highlights the authorship trend and collaborative research in the area of lung cancer literature based on 93512 scholarly communications appeared in the lung cancer literature during 1997 to 2016.The study elaborates on various bibliometric components such as year wise distribution of articles, relative growth rate, doubling time, authorship pattern and collaborative coefficients. High degree of collaborative research (0.92) was found in the field of lung cancer which shows there is trend towards collaborative research. The Lotka's distribution is well fitted and followed in the area of Lung cancer which is confirmed with K-S test. The highest number of publication has been contributed by two authors (13301-14.2%) followed by three authors(11869-12.69%).To examine the trend of research in the area of lung cancer with respect to authorship pattern. There is a high percentage of growth of publication was observed in case of single author (11.61%) for ten years (2021). The considerable percent of growth was observed (32%) for the period twenty years (2031) in the field of lung cancer. Finally, it can be concluded that, the major research activity is taking place in the area of Lung Cancer.

Keywords: *Lung cancer Literature, Authorship Trend, Time Series Analysis, Lotka's Law*

Introduction:

Scientometrics is the study of measuring and analyzing of science publication. Scientometric is often called as bibliometric. It has been originated from Russia. The scientific paper or text not only reveals the world building strategy of its authors, but also the nature and force of the building blocks derived from the domain of science from which it draws and to which it contributes (Gupta and Kumar, 2001).Bibliometrics offer a set of measures for studying the structure and process of scholarly communication (Gupta ,and Kumar, 2001). One of its main indicators is the number of published articles or science production in specific field of science. The cancer is one of the most emerging area in the field of medical sciences and there is dearth need of research. Hence, an attempt has been made to carry out the present research.

In the last few decades the field of Library and Information Science (LIS) has developed several quantitative methods for analysis. As Library and Information Science is a widely interdisciplinary field (Nisonger & Davis, 2005), academics from various disciplines (including LIS) have played a vital role development of its methods. Often scientists with different background from Library and Information Science, like Tibor Braun (Chemistry) or Vasily Nalimov (Philosophy), have contributed important concepts. The suffix 'metrics' is "derived either from the Latin or Greek word "metricus" or "metrikos" respectively, means measurement" (Sengupta, 1992). To date Several different metric fields that deal with the development and Application of measurement in the area of Information Science has emerged, such as Librametirics, Bibliometrics, Scientometrics, Informetrics, and more recently Webometrics and Altmetrics. However, all these fields are closely related, especially Bibliometrics, Informetrics and Scientometrics, and shows significant overlap.

Nowadays in all area of research we are observing collaborative research, "Collaborative research" , is any research in which two or more researchers work together toward a common target, and in which all of the

researchers make an important, equal contribution to the project. Not counted as researchers are people who provide assistance but do not make equal contribution; for example, someone who is hired to transcribe interviews but makes no other contribution to the research is not considered a part of the collaborative team. The focus is on aspects of collaborative research that are unregulated. Here in this paper an attempt is made to observe collaborative research in the area of Lung Cancer.

Lung Cancer:

The term lung cancer is used for tumors arising from the respiratory epithelium (bronchi, bronchioles, and alveoli).

A review of the history of lung cancer shows that about a century and a half ago, lung cancer was an extremely rare disease. Lung cancer has been known in industrial workers from the late 19th century. It came into prominence as a public health problem in the Western world in 1930s - at first in men, and later (in 1960s) among women. The causes of increase in lung cancer incidence were thought to have included increased air pollution, cigarette smoking, asphalting of roads, increase in automobile traffic, exposure to gas in World War I, the influenza pandemic of 1918 and working with benzene or gasoline. Duration of the disease, from diagnosis until death, was usually from half a year to 2 years and in practically all cases, there had been a long history of chronic bronchitis. According to WHO reports, between 1960 and 1980, the death rate due to lung cancer increased by 76% in men and by 135% in women.

The American Lung Association is committed to funding lung cancer research. As part of our Awards and Grants Program over 20% of funds go towards research on the prevention and treatment of lung cancer. The primary goal of this lung cancer research program is simple: To improve and save lives. Yet, the secondary goal is just as important: To fund top-notch lung cancer researchers at important crossroads of their careers to gain long-term

About PubMed database:

"PubMed is a free resource developed and maintained by the national Centre for Bio-technology Information(NCBI), a division of USA National Library of Medicine(NLM), at the National Centre Institutes of Health(NIH). PubMed comprises over 22 million citations and abstracts for biomedical literature indexed in NLM's MEDLINE database, as well as from other life science journals an online books. PubMed citations and abstracts include the fields of biomedicine and health, and cover portions of life sciences, behavioral sciences, chemical, and bioengineering. PubMed also provides access to additional relevant website and links to other NBI resources, includiong its various molecular biology databases."[www.ncbi.nlm.nih.gov, Retrieved on 12.30 PM 10/07/2017]. In the present study an attempt has been made to explores the research productivity in the field of Lung Cancer for the period of 20 years i.ee 1997 to 2016.

Statement of the problem

The present study is "Authorship Trend and Collaborative Research in Lung Cancer: A time series analysis study."

Objectives

1. To know the year wise distribution, growth rate, doubling time of publication in the field of Lung cancer (1997 to 2016).
2. To find out the trend in Author Productivity in the field of Lung Cancer.
3. To identify the Degree of Collaboration in the field of Lung Cancer.
4. To study the Collaborative co-efficient and moderate co-efficient and collaborative index in the field of Lung Cancer Literature
5. To study the implication of Lotka's law in the area of Lung Cancer.
6. To apply the time series analysis to predict the trend of research in the area of Lung Cancer with respective to authorship pattern.

REVIEW:

The trends of publication a type relating to Clinical Medicine based on the MEDLINE database has been analyzed through Correspondence Factor Analysis (CFA), which reveals that internal clock of the database was Broadly consistent. However there were periods of erratic activity. Ramakrishnan and Ramesh Babu (2007)[46] presented a bibliometric analysis of the literature output in the field of Hepatitis covered in three bibliographic databases namely MEDLINE, CINAHL and IPA. In the field of Hepatitis literature covered in three databases for the period 1984 - 2003 was considered. MEDLINE covered the maximum records followed by CINAHL and IPA databases.

Bibliometric analysis of global malaria vaccine research was carried out by Garg et al. (2009)[49] using PubMed database for the period 1972 - 2004. This study examined the pattern of growth of the output, it's geographical Distribution, profile of different countries in different subfields and pattern of citations using GOOGLE Scholar.

Hadagali and Anandhalli (2015) have revealed that the growth of neurology literature for the period 1961-2010. A total of 291702 records were collected from the Science Direct Database for fifty years. The Relative Growth Rate (RGR) and Doubling Time (Dt) of neurology literature have been calculated, supplementing with different growth patterns to check whether neurology literature fits exponential, linear and logistic model. The result of the study indicates that the growth of literature in neurology does not follow the linear or logistic model. However, it follows closely the exponential growth model. The study concludes that there has been a consistent trend towards increased growth of literature in the field of neurology.

Neelamma and Gavisiddappa Anandhalli(2016) have highlighted the research collaboration and authorship pattern in the area of Biology based on 1183 scholarly communication appeared in the Botany during 2005-2014. Study elaborates various significant aspects like trends of authorship, author productivity, collaborative index, degree of collaboration, Relative growth rate (RGT) and Doubling Time (Dt), geographical wise distribution. USA contributed high numbers of article in the field of Botany literature, collaborative research is more popular among botany literature, lastly verified through Kolmogorov Simonov test. It can be concluded

that botany literature does not follow the Lotka's law of author productivity and found that there is a negative Co-relation in botany literature.

Neelamma and Anandhalli (2016) have studied the research output performance of Crystallography literature, which is covered in Web of Science on-line version database for the period of 1989-2013. A total of 1387195 references cited in 45320 articles in 2043 journals. The study elaborates on various Bibliometric components such as distribution of citations by documents type, Country wise publication of citations, further the study also list out the most productivity journals in the field of crystallography. The analysis of the study reveals that out of 1387195 citations which 83.835% .Research articles contribute the highest number of citations and it is the most preferred sources of information used by researchers in the field of crystallography. Further journal of Molecular Biology is the most cited journal in the field of crystallography. The USA is most cited country in the world. Bradford's law well fitted in to the given data set for the present study. Finally it can be concluded that, the significant research activity is being taking place in the field of Crystallography. And it is one of the emerging research fields in the applied science.

Neelamma and Anandhalli (2016) have observed that research output performance of Botany Literature. Citation analysis of all the journal articles published in the Botany literature, which covered in Web of Science (on-line version database) for the period of 2005-2014. A total of 12051 references cited in 1183 articles in 572 journals. The study elaborates on various bibliometric components such as distribution of citations for Document type, Language wise distribution of citations, and Country wise publication of citations. Further the study also lists out the most productivity journals in the field of Botany Literature. The analysis of the results shows that out of 12051 citations, 61.96% Research articles contribute the highest number of citations and it is the most preferred sources of information used by researchers in the field of Botany. The USA is the most cited country in the world and the English language is the most preferred language in the world. Bradford's law well fitted into the given data set for the present study. Finally it can be concluded that, The Significant research activity is being taking place in the area of Botany and it is one of the emerging research field in the Biological Sciences.

Neelamma and Gavisiddappa (2016).The purpose of this paper is to determine the materials cited in zoology literature during the year 2005–2014. The data were extracted from Web of Science citation index database. The study reveals that distribution of citations for document type, language wise distribution of citations and country wise distribution of citations. Further the study also lists out the most productivity journals in the area of zoology literature. The analysis of the results shows that out of 5332 citations, 74.81% research articles contribute the highest number of citations and it is the most preferred sources of information used by researchers in the area of zoology. The USA (33.75%) is the most cited country in the world and the English language (98.59%) is the most preferred language in the world. Bradford's law well fitted into the given data set for the present study. Finally it can be concluded that, The significant research activity is being taking place in the field of zoology and it is one of the emerging research field in the biological sciences.

Data Collection Source:

In this paper necessary bibliographical data downloaded from PubMed database and PubMed is a bibliographic database containing abstracts and citations for academic journal articles and also covers medical Medline database , which is considered as main source of data for the present study, The study uses 20 years publications data from 1997 to 2016 on lung cancer collected from PubMed database. Thus a total of 93512 records were identified in the field of " lung cancer and downloaded required data, (required field identified or variables as basically year wise, title of the journal, authorship etc. were used as keyword to download the data) which is required for the study as per our objectives.

Data Analysis and Interpretation

The data so collected as been analyzed with help of MS-Excel for meaningful analysis and interpretation. In addition to, various statistical tools and scientometrics tools have been employed in the process of analysis and interpretation of data to draw the meaningful conclusion.

Analysis and Interpretation

Table -1 Lung Cancer Literature- Year wise Distribution

Year wise Distribution of publications

Year	No of Records	% age	Growth rate
1997	2013	2.15	0.987581
1998	1988	2.13	1.090543
1999	2168	2.32	1.129151
2000	2448	2.62	1.071078
2001	2622	2.80	1.076278
2002	2822	3.02	1.100283
2003	3105	3.32	1.087279
2004	3376	3.61	1.074941
2005	3629	3.88	1.052356
2006	3819	4.08	1.070961
2007	4090	4.37	1.028117
2008	4205	4.50	1.1044
2009	4644	4.97	1.099914
2010	5108	5.46	1.093579
2011	5586	5.97	1.190834

2012	6652	7.11	1.129886
2013	7516	8.04	1.10471
2014	8303	8.88	1.130555
2015	9387	10.04	1.068606
2016	10031	10.73	
total	93512	100	1.089003

Table-1 Reveals the research productivity of Lung Cancer from the year 1997 to 2016, out of total 93512 publications, maximum number of papers i.e. 10031(10.73%) have been published in the year 2016, followed by 2015 with 10.04% of total publication. On the other hand minimum no of articles have been published in the year 1998 which amounts to 2.3% (1988) of the total publication. The analysis of the results shows there is a consistency trend in the field of lung cancer.

Table 2 Authorship trend and Publication pattern

	Authorship Pattern		
No of Author	**No of Records**	**%age**	**CUM %**
One	5773	6.17	6.17
Two	13301	14.22	20.40
Three	11869	12.69	33.09
Four	11052	11.82	44.91
Five	9874	10.56	55.47
Six	9409	10.06	65.53
Seven	7108	7.60	73.13
Eight	6128	6.55	79.68
Nine	4732	5.06	84.74
Ten	4078	4.36	89.11
More than Ten	10188	10.89	100.0
Total	93512		

Table -2 presents a detailed overview of authorship pattern of papers published during 1997 to 2016. In this table all the publications were divided in to 11 categories.

It is observed that out of 93512 contributions, a total highest number of 13301(14.22%) publications have been contributed by two authors, followed by three authors (11869,12.69%) , more than ten authors (10188,10.89%), five authors (9874,10.56%), six authors 9409(10.06%), seven authors (7108,7.60%), eight authors

(6128,6.55%), nine authors (4732,5.06%) respectively. During the period of study only (4078),4.36% publication were authored by ten authors. Majority of publication are multi authored. It can be analyzed that there exist a collaborative research trend in the area of Lung Cancer.

Ta ble-3 Collaborative Research

						Pattern of authorship							
Year	one	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	> =10	Total no articles	DC
1997	198	442	562	264	152	122	101	85	63	15	9	2013	0.90
1998	157	336	612	325	158	145	96	95	42	12	10	1988	0.92
1999	227	337	458	498	243	112	89	89	52	48	15	2168	0.90
2000	316	516	412	419	241	256	88	95	78	16	11	2448	0.87
2001	278	526	612	359	245	215	98	70	100	80	39	2622	0.89
2002	333	915	539	323	215	215	101	96	52	19	14	2822	0.88
2003	312	998	698	463	249	128	93	63	45	32	24	3105	0.90
2004	274	792	786	498	412	301	49	89	63	89	23	3376	0.92
2005	189	1236	728	349	246	589	48	59	74	22	89	3629	0.95
2006	158	1456	258	478	369	107	211	189	214	189	190	3819	0.96
2007	349	878	736	874	496	196	196	123	80	70	92	4090	0.91
2008	320	405	403	479	480	440	369	349	210	200	550	4205	0.92
2009	293	409	468	486	495	550	406	364	291	275	607	4644	0.94
2010	283	450	473	520	610	588	517	384	297	287	699	5108	0.94
2011	263	448	520	564	603	668	541	431	362	335	851	5586	0.95
2012	340	574	597	634	693	795	632	597	404	337	1049	6652	0.95
2013	332	555	689	755	845	845	740	636	492	428	1199	7516	0.96
2014	392	661	683	848	941	936	820	702	524	426	1370	8303	0.91
2015	402	670	802	946	1074	1020	938	753	613	554	1615	9387	0.96
2016	357	697	833	970	1107	1181	975	859	676	644	1732	10031	0.96
Total	5773	13301	11869	11052	9874	9409	7108	6128	4732	4078	10188	93512	0.92

Authorship Pattern in the Field of Lung Cancer
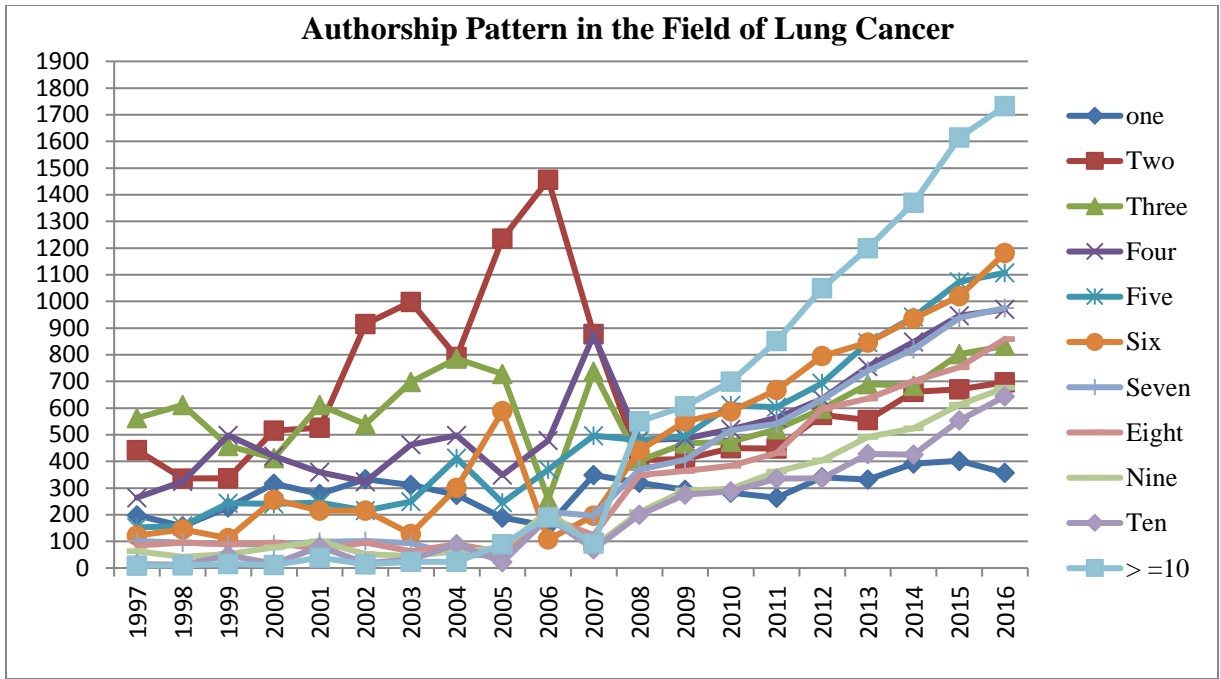
Degree of collaboration of authors by year-wise is shown in table table-3. The year- wise degree of collaboration falls between 0.87 to 0.96 with an average of 0.92 during the study period. From 1997 onwards, it has been increased gradually. This clearly indicates that there exists collaborative research in Lung Cancer literature.It also shows that the scientists working in this research field preferred to do research and publish in joint collaboration instead of single authorship. The degree of collaboration in research can be measured with the help of the formula given by K Subramnyam(1982)

$$C= \frac{Nm}{Nm+Ns}$$

Where C= Degree of Collaboration

N_m= Number of multiple authors

N_s= Number of single authors

Table: 4 **collaborative co-efficient, modified co-efficient and collaborative index**

Year	One	Multi authored	TA	CC	MC	CI
1997	198	1815	2013	0.62	0.62	3.74
1998	157	1831	1988	0.65	0.65	3.86
1999	227	1941	2168	0.64	0.64	3.97

|						
2000	316	2132	2448	0.61	0.62	3.82
2001	278	2344	2622	0.63	0.63	4.00
2002	333	2489	2822	0.59	0.59	3.45
2003	312	2793	3105	0.59	0.59	3.35
2004	274	3102	3376	0.64	0.64	3.80
2005	189	3440	3629	0.64	0.64	3.77
2006	158	3661	3819	0.66	0.66	4.49
2007	349	3741	4090	0.65	0.65	3.97
2008	320	3885	4205	0.73	0.73	5.85
2009	293	4351	4644	0.75	0.75	6.04
2010	283	4825	5108	0.75	0.75	6.10
2011	263	5323	5586	0.76	0.76	6.30
2012	340	6312	6652	0.76	0.76	6.28
2013	332	7184	7516	0.77	0.77	6.38
2014	392	7911	8303	0.77	0.77	6.37
2015	402	8985	9387	0.77	0.77	6.48
2016	357	9674	10031	0.78	0.78	6.58
Total	5773	87739	93512	0.62	0.62	4.93
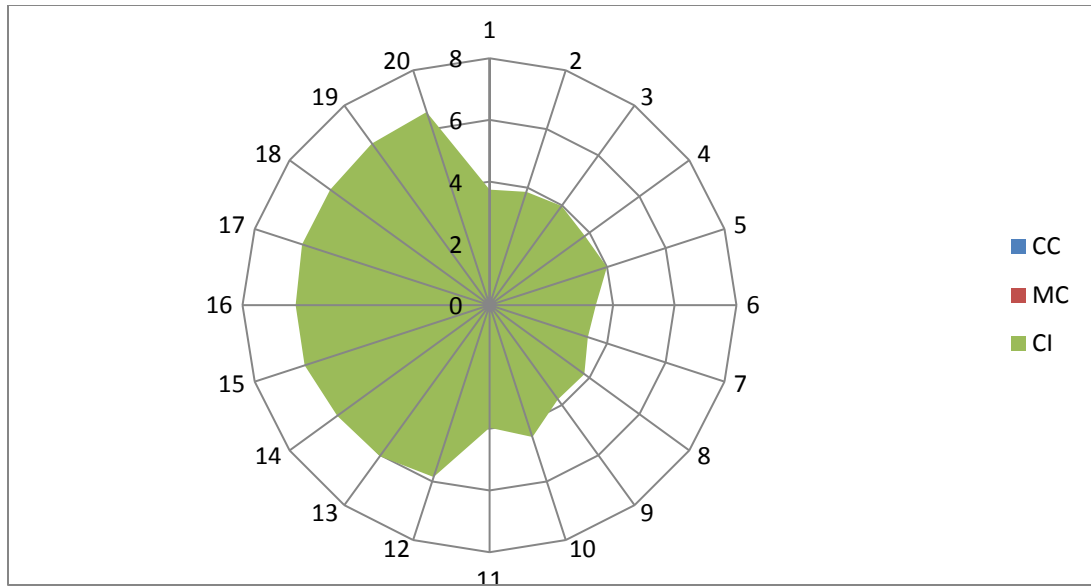
Table-4 shows the Collaborative coefficient research in Lung Cancer Literature from 1997-2016. The analysis of the data shows that out of 93512 articles published, single author share is 5773 and multiple paper author shares is 87739. This indicates that multiple paper contribution is more than single author papers. Collaborative coefficient is observed 0.62, Modified coefficient is 0.62, Moderate and Collaborative index is observed is 4.93 in the Lung Cancer literature. It can be summarized from the above discussion that very high collaborative research activities are being observed in Lung Cancer literature.

Table: 5 Relative Growth Rate and Doubling time

Relative Growth Rate and Doubling Time								
Year	Record	C.R	W1	W2	Rt	Mean	dt	mean dt
1997	2013	2013	0	7.61	0		0	
1998	1988	4001	7.59	8.29	0.69		1.01	
1999	2168	6169	7.68	8.73	0.43		1.60	
2000	2448	8617	7.80	9.06	0.33		2.07	
2001	2622	11239	7.87	9.33	0.27	0.263222116	2.61	2.670221
2002	2822	14061	7.95	9.55	0.22		3.09	
2003	3105	17166	8.04	9.75	0.20		3.47	

2004	3376	20542	8.12	9.93	0.18		3.86	
2005	3629	24171	8.20	10.09	0.16		4.26	
2006	3819	27990	8.25	10.24	0.15		4.72	
2007	4090	32080	8.32	10.38	0.14		5.08	
2008	4205	36285	8.34	10.50	0.12		5.63	
2009	4644	40929	8.44	10.62	0.12		5.75	
2010	5108	46037	8.54	10.74	0.12		5.89	
2011	5586	51623	8.63	10.85	0.11		6.05	5.758336
2012	6652	58275	8.80	10.97	0.12		5.72	
2013	7516	65791	8.92	11.09	0.12		5.71	
2014	8303	74094	9.02	11.21	0.12	0.120624247	5.83	
2015	9387	83481	9.15	11.33	0.12		5.81	
2016	10031	93512	9.21	11.45	0.11		6.11	
total	93512							

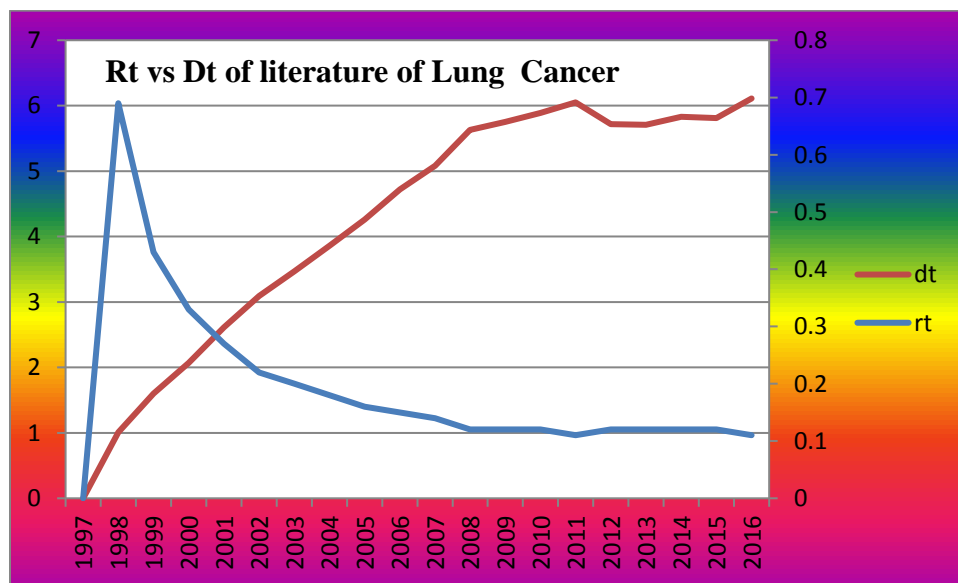Rt vs Dt of literature of Lung Cancer

Table indicates the Lung Cancer scientists contributions i.e. 93512 publications. The mean relative growth rate of publications come down from 0.686 (1997) to 0.11 (2016) for the period of twenty years. The mean relative growth for the first ten years (1997 to 2007) exhibits a growth of 0.136. Similarly for the next block of ten years (2007 to 2016) the growth is 0.1206.

Here, the mean Doubling time of the first block period is 0.263 (1997-2007). Whereas, it increased to 5.758 (2007-2016) in the second block period.

Lotka's Law:

Lotka's law explains the frequency of publication by authors in a given fields. It states that "The number of authors making ' n' contribution is about 1/n 2 of those making one and the proportion of all contributors that make a single contribution is in the region of 60 per cent" (Lotka,1926, cited in Potter (1988)). This means that out of all the authors in a given field, 60 per cent will have just one publication; 15 per cent will have two publications (1/22 times 0.60); 7 per cent will have three publications (1/32 times 0.60), and so on. More generally, the law takes the form.

The general formula says:

$$Y = \frac{C}{X^n}$$

Where,

X = The number of publications,
Y = The relative frequency of authors
With X publications,
n and **C** are constants depending on the specific field (n=2).

Lotka's law also could be written as per the Bookstien's findings, after taking the logarithms:

$$Log(Y) = Log(K) - a\ Log(X)$$
'K' and 'a' are constant which have to be determined

To test the applicability of Lotka's Law, Kolmogorov-Smirnov test, following the Bookstien's findings applied on the concerned data. The Value of a is determined as 1.008which is also mean value of Log(x)
The K is determined by taking the reciprocal of the sum of the reciprocal of x for x^n where value of x takes 1,2,3,4,5,,,,25the difference of theoretical in the observed figure are worked out it is found that the maximum difference (D_{max}= 0.015843) found – at 5% level of significance of KS sample test of goodness of fit. In the present study the critical value found to be $1.63/(\sqrt{426149} + 1) = 0.002496$. It is found that the maximum difference obtained is 0.015843 which is greater than critical value of 0.002497. Hence the applicability of Lotka's law is not followed and fitted in the area of Lung cancer.

Author vs No of Publication in the field of lung cancer
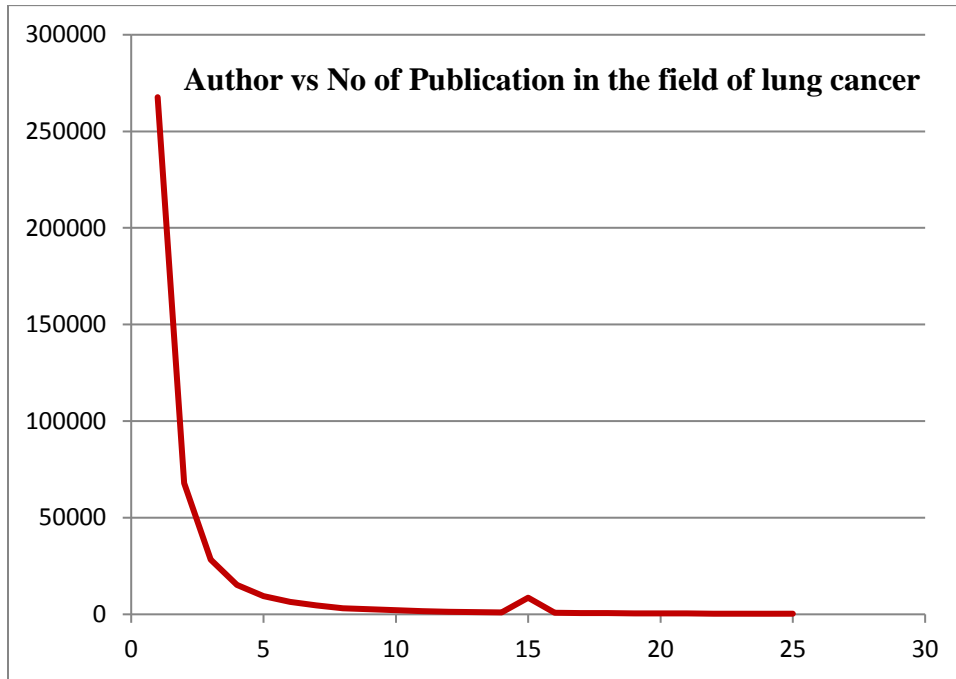
The values of c and n have been calculated with data available in Table-6. The calculated value of the constant c for Lung Cancer Literature is 0.644; the value of n is calculated to -1.78.

Table 7 Kolmogorov-Smirnov test, n= -1.78

No of Publication(X)	Authors(Y)	X=log(x)	Y=log(y)	value of a log(x)	theoratical value of y(x)	logk	observed value	diffrence
1	267689	0.00	5.43	0.000	0.556	5.428	5.43	0.000
2	67922	0.30	4.83	0.303	0.160	5.135	4.83	0.303
3	28369	0.48	4.45	0.481	0.077	4.934	4.45	0.481

4	15260	0.60	4.18	0.607	0.046	4.790	4.18	0.607
5	9449	0.70	3.98	0.704	0.031	4.680	3.98	0.704
6	6451	0.78	3.81	0.784	0.022	4.594	3.81	0.784
7	4647	0.85	3.67	0.852	0.017	4.519	3.67	0.852
8	3083	0.90	3.49	0.910	0.013	4.399	3.49	0.910
9	2607	0.95	3.42	0.962	0.011	4.378	3.42	0.962
10	2071	1.00	3.32	1.008	0.009	4.324	3.32	1.008
11	1687	1.04	3.23	1.049	0.007	4.276	3.23	1.049
12	1379	1.08	3.14	1.087	0.006	4.227	3.14	1.087
13	1166	1.11	3.07	1.122	0.005	4.189	3.07	1.122
14	1006	1.15	3.00	1.155	0.005	4.157	3.00	1.155
15	8543	1.18	3.93	1.185	0.004	5.117	3.93	1.185
16	754	1.20	2.88	1.213	0.004	4.091	2.88	1.213
17	649	1.23	2.81	1.240	0.003	4.052	2.81	1.240
18	617	1.26	2.79	1.265	0.003	4.055	2.79	1.265
19	521	1.28	2.72	1.289	0.003	4.005	2.72	1.289
20	479	1.30	2.68	1.311	0.003	3.991	2.68	1.311
21	437	1.32	2.64	1.332	0.002	3.973	2.64	1.332
22	396	1.34	2.60	1.353	0.002	3.950	2.60	1.353
23	351	1.36	2.55	1.372	0.002	3.917	2.55	1.372
24	308	1.38	2.49	1.391	0.002	3.879	2.49	1.391
25	309	1.40	2.49	1.409	0.002	3.899	2.49	1.409

C=0.644   **C.V**=0.002497   **n= -1.78**   **D-Max=** 1.408601

$$n = (N\sum XY - (\sum X)(\sum Y)) / (N\sum X^2 - (\sum X)^2) \text{ ------ eqn 1}$$

$$n = (25*78-(25*84))/ (25*29-(25)^2)$$

$$n = 1950-2100/725-625$$

$$n = -1.78$$

The calculated critical value found to be 0.002497and the value of maximum difference (D) between the real and estimated accumulated frequencies is -0.00573. Therefore it is observed that the difference value 1.48601 is greater than critical value 0.002497 indicating that Lotka's law is not fitted good in case of author productivity in the field of Lung Cancer Publications.

Time series analysis

Time series analysis is analyzing data to know the underlying structure and function that produce the observations. It is a mechanism which allows a mathematical model to be developed that explains data in such a way that forecasting, monitoring or control can occur which is widely used in economics and business. The main purpose of using this technique is to predict the number of publications for the near future. The year has considered as the independent variable and number of publications measured as the dependent variable. In this study The researcher has collected data for 20 years (1997–2016) and with simple linear regression method to projections can be made. In the present study the Time Series Analysis (Regression analysis) has applied to the concepts of authorship pattern, and quantum of publication output to predict authorship trend in the field of lung cancer. The trend of the authorship can be calculated with the help of following equation.

$$Y_c = a+bx$$

$$a = \sum\frac{Y}{n} \qquad b = \sum\frac{XY}{\sum X^2}$$

Where,

Y= is the dependent variable (number of publications),

X =is independent variable (The reference Year),

a and b are the constants.

Here growth of literature is calculated using this formula

$$\text{Increasing \%age} = \frac{\text{Estimated} - \text{original}}{\text{original}} * 100$$

Table-8.1 Single Authored Publications- Time Series Analysis

SINGLE AUTHOR				
YEAR	Y	X	X2	XY
1997	198	-10	100	-1980
1998	157	-9	81	-1413
1999	227	-8	64	-1816
2000	316	-7	49	-2212
2001	278	-6	36	-1668
2002	333	-5	25	-1665
2003	312	-4	16	-1248
2004	274	-3	9	-822
2005	189	-2	4	-378
2006	158	-1	1	-158
2007	349	1	1	349
2008	320	2	4	640
2009	293	3	9	879
2010	283	4	16	1132
2011	263	5	25	1315
2012	340	6	36	2040
2013	332	7	49	2324
2014	392	8	64	3136
2015	402	9	81	3618
2016	357	10	100	3570
Total	**5773**	**0**	**770**	**5643**

Straight Line equation is $Y_c = a+bx$

$$a = \Sigma \frac{y}{n} \qquad b = \Sigma \frac{xy}{\Sigma x^2}$$

$$a = \frac{5773}{20} = \mathbf{288.65} \quad b = \frac{5643}{770} = \mathbf{7.32}$$

Estimated literature in 2021 is when X = 2021-2006

=288.65+7.32*15
= 288.65+109.8
=398.45
Estimated literature in 2031 is when X = 2031-2006
= 288.65+ 7.32*25
=288.65+183
=471.65

$$\text{Increasing \%age} = \frac{\text{Estimated} - \text{original}}{\text{original}} * 100$$

$$\text{Increasing \%age} = \frac{471.65 - 398.45}{398.45} * 100$$

This shows that there will be 11.61%increased in single authored publications in the year 2021 and 32.11% increase in the year 2031.

Predicted Trend of Research in the area of Lung Cancer with Respective to Authorship Pattern. (Future Growth of the Publication)

Authorship Pattern	Predicted percent of growth in the year 2021 (%age)	Predicted percent of growth in the year 2031 (%age)
Single	11.61	32.11
Double	-2.63	-1
Three	-14.88	-5.52
Four	0.15	29
Five	5.37	5.29
Six	1.36	42.38
Seven	7.43	54.75
Eight	3.27	48.35
Nine	1.70	46.16
Ten	-1.77	42.60
More than ten	4.03	53.79

This table shows predicted trend in research in the area of Lung Cancer with respect to authorship pattern. It is noticed that in case of single author 11.61% percent growth was observed in 2021, it is also increased by 32% in the year 2031. However, in case of double author, growth is declined by -2.63% and again gradually increases by -1% in 2031. There is considerable decline in the percent of growth   in case of three author (-14.88%) in the year of 2021 but steadily increases to   -5.52% in the year 2031. Small positive growth rate was observed in case of four authors (0.15 %) for the year 2021 however it has considerably increased by 5.37% in the year 2031. The significant   percent of growth was registered at 29%   in case of five authors in the year 2021and the same amount of growth rate was also (5.29%) observed for the period of ten years (2031). There is a moderate Growth rate(7.43%) was observed in case of seven authors for the year 2021, there is a significant increase of percent of growth at the rate of 54.75% recorded in the year 2031. There is steady growth rate observed in case of eight, nine, ten and more than ten authors.   It can be inferred that except double

and three authors there is steady percent of growth of literature for the period of twenty years in the area of Lung Cancer.

Major Findings of the study:

- Research productivity of Lung Cancer from the year 1997 to 2016, out of 93512 publications, maximum number 10031(10.73%) papers published in 2016, followed by 2015(10.04%), and 2014-1997(less than 10%) respectively. There is considerable growth in the research publications.
- It is observed that out of 93512 contributions, a total of 13301(14.22%) publications have been contributed by two authors, followed by three authors 11869(12.69%). Majority of publication are multi authored, shows that the collaborative research more useful in Lung Cancer literature.
- Collaborative coefficient research in Lung Cancer Literature from 1997-2016. The analysis of the table shows out of 93512 articles published, single author share is 5773 and multiple paper author shares is 87739. This indicates multiple paper contribution is more than single author papers. Collaborative coefficient is observed 0.62, Modified coefficient is 0.62, Moderate and Collaborative index is observed 4.93. It can be summarized as very high collaborative research activities are observed in Lung Cancer literature.
- The average relative growth rate of articles come down from 0.686 (1997) to 0.113 (2016) for a period of twenty years. The mean relative growth for the first ten years (1997 to 2007) elaborates a growth of 0.136. Similarly for the next block of ten years (2007 to 2016) the growth is 0.113. Here, the mean Doubling time of the first block period is 2.670 (1997-2007). Whereas, it is increased to 5.758 (2007-2016) in the second block period.
- The Lotka's law is not well fitted and not followed in the field of Lung Cancer Literature.
- To predict the trend of research in the area of lung cancer with respect to authorship pattern. There is a high percentage of growth of publication was observed in case of single author (11.61%) for ten years(2021). The considerable percent of growth was observed (32%) for the period twenty years (2031) in the field of lung cancer. It can be inferred that except double and three authors it can be forecasted there is steady percent of growth of publication for the period of twenty years in the area of Lung Cancer.

Conclusion:

The bibliometrics techniques are taken in to consideration as the most powerful technique for conducting quantitative studies in the present study. An attempt was made to measure the authorship pattern trend and research productivity in various aspects of published publications in the field of lung cancer

The study is based on 93512 research papers published between 1996 to 2016 as reflected in PubMed online database which is one of the most comprehensive databases in the medical sciences. The data was collected, tabulated and analyzed based on the objectives of the study. The study reveals the various aspects of Bibliometric components like year wise distribution, relative growth rate, doubling time, authorship pattern and collaborative coefficients. The empirical data was verified with Lotka's distribution. The result of the present study shows that there is stable growth of publication in the field of Lung cancer. High degree of collaborative research (0.92) was found in the field of lung cancer which shows there is trend towards collaborative research.

The Lotka's distribution is not well fitted and not followed in the area of Lung cancer which is confirmed with K-S test. The highest number of publication has been contributed by two authors(13301-14.2%) followed by three authors(11869-12.69%).To predict the trend of research in the area of lung cancer with respect to authorship pattern, there is a high percentage of growth of publication was observed in case of single author(11.61%) for ten years(2021). The considerable percent of growth was observed (32%) for the period twenty years (2031) in the field of lung cancer. The study concludes that there has been consistence trend towards increased percent of growth of publication in the field of lung cancer.

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