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Original Article

Lung Cancer in India: A Scientometric Study of Publications during 2005–14

Ritu Gupta*, K. K. Mueen Ahmed, B. M. Gupta***, and Madhu Bansal******

ABSTRACT
This paper examines 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% and citation impact of 4.20. The world lung cancer output (169,352 publications) came from several countries, of which the top 15 most productive countries (United States, China, Germany, Japan, United Kingdom, Italy, France, Canada, and South Korea) accounted for 93.17% share of the global output during 2005–14. 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% during 2005–14, which decreased from 19.89 to 17.06% from 2005–09 to 2010–14. Breast cancer in the field of medicine accounted for the largest share (63.62%) of output, followed by biochemistry, genetics and molecular biology (28.77%); pharmacology, toxicology, and pharmaceutics (23.87%); chemistry (9.31%); agricultural and biological sciences (3.26%); and immunology and microbiology (2.23%) during 2005–14. Diagnosis, chemotherapy, surgery, and radiotherapy among treatments methods together accounted for a share of 61.20% publications in Indian lung cancer research during 2005–14. Among the different states, Maharashtra, Delhi, Karnataka, Chandigarh, and Telangana together account for 53.41% share during 2005–14. In India's cumulative lung cancer publications output during 2005–14, the most productive 14 Indian organizations, 15 authors, and 15 journals together contributed to 33.71, 11.27, and 20.23% share, respectively. The 31 high-cited papers in lung cancer research registered an average citation per paper of 294.74. Of the 31 high-cited papers (19 articles and 12 reviews), 7 were single institution, 3 national collaborative, and 21 international collaborative papers. The 31 high-cited papers have appeared in 23 journals. In light of this, the authors suggest the need to develop a National Cancer Prevention Policy, which should make specific recommendations for national action by governments and non-government organizations, including programs and strategies, to reduce the incidence of specific preventable cancer types.
Keywords: lung cancer, publications, India, scientometrics, bibliometrics

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INTRODUCTION

The lungs are a pair of sponge-like cone-shaped organs in the chest, which are a part of our respiratory system. The left lung is smaller because the heart occupies space on the left side. Furthermore, the lungs are slightly different on each side; the right lung has three lobes, whereas the left lung has two lobes. The lungs are covered by a thin membranous covering called "pleura," which protects and helps the lungs to move back and forth as they expand and contract during breathing. A thin, dome-shaped muscle below the lungs, called "diaphragm," separates the chest from the abdomen. The diaphragm moves up and down during breathing forcing air in and out of the lungs. Main function of the lungs is to exchange gases between the air we breathe and the blood. When we breathe in (inhale), oxygen enters into our body through the lungs and when we breathe out (exhale) carbon dioxide is sent out of our body. Air enters the lungs through the nose or mouth via windpipe (trachea), which divides into the right and left lungs. These airways are called "bronchi" (singular, bronchus). Inside each lung, the bronchus divides into smaller tubes, the "secondary bronchi," which further subdivide into smaller branches called bronchioles. At the end of the bronchioles are tiny air sacs known as "alveoli," which receives many tiny blood vessels. These tiny alveoli perform the function of exchange of gases.[1]

The vast majority (85%) of cases of lung cancer are due to long-term exposure to tobacco smoke. About 10–15% of the cases occur in people who have never smoked. These cases are often caused by a combination of genetic factors and exposure to radon gas, asbestos, or other forms of air pollutants, including second-hand smoke. Lung cancer may be seen on chest radiographs and computed tomography (CT) scans. Its diagnosis can be confirmed by biopsy, which is usually performed by bronchoscopy or CT-guidance.[2]

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Lung cancer appears to arise in the bronchi in response to repetitive carcinogenic stimuli, inflammation, and irritation. Disruption of cell development occurs in the mucosal lining and progresses to elevate or erode the basal membrane. The tumor then spreads throughout the lung and will eventually metastasize to the lymph nodes and other parts of the body. There are four main histologic classifications of lung cancer: squamous cell carcinomas, adenocarcinomas, small cell carcinomas, and large cell carcinoma. Because the behavior and management of squamous cell carcinoma, adenocarcinoma, and large cell carcinomas are very similar, they are often grouped together as non-small cell lung cancer (NSCLC) in contrast to small cell lung cancer (SCLC), which has a distinct natural history and management. Squamous cell carcinoma is most commonly found in men and shows the strongest relationship with smoking. It arises in the larger and more central bronchi and tends to spread locally, later metastasizing to other types but grows rapidly at its site of origin. Adenocarcinoma was previously known as the most common type of lung cancer in women and non-smokers; however, the incidence of adenocarcinoma has increased in the last two decades, and it is now the most common histological subtype in both males and females. The reason for the increasing incidence of adenocarcinoma is not well understood, but may be related to changing patterns of smoking. Cell carcinomas are likely to be undifferentiated squamous cell and adenocarcinoma. They usually consist of large polygonal cells with vesicular nucle.[3]

Lung cancer has been the most common cancer in the world for several decades. There are estimated to be 1.8 million new cases in 2012 (12.9% of the total), of which 58% occur in developing countries. Lung cancer remains as the most common cancer in men worldwide (1.2 million, 16.7% of the total), with the highest estimated age-standardized incidence rates in Central and Eastern Europe (53.5 per 100,000) and Eastern Asia (50.4 per 100,000). The low rates are observed in Middle and Western Africa (2.0 and 1.7 per 100,000, respectively). In women, the incidence rates are generally lower, and the geographical pattern is a little different primarily reflecting different historical exposure to tobacco smoking. Thus, the highest estimated rates are in Northern America (33.8%) and Northern Europe (23.7%) with a relatively high rate in Eastern Asia (19.2%) and the lowest rates again in Western and Middle Africa (1.1 and 0.8%, respectively). Lung cancer is the most common cause of death from cancer worldwide, estimated to be responsible for nearly one in five (1.59 million deaths, 19.4% of the total). Furthermore, the overall ratio of mortality to incidence is 0.87.[4]

According to GLOBOCAN 2012, there were estimated 70,000 new cases (54,000 in men and 17,000 in women) and estimated mortality of 64,000 in 2012 (49,000 in men and 15,000 in women) in India. In India, lung cancer constitutes 6.9% of all new cancer cases and 9.3% of all cancer related deaths in both sexes; it is the commonest cancer and cause of cancer-related mortality in men, with the highest reported incidences from Mizoram in both males and females (age-adjusted rate: 28.3 and 28.7 per 100,000 population in males and females, respectively). The time trends of lung cancer show a significant rise in Delhi, Chennai, and Bengaluru in both sexes. The incidence and pattern of lung cancer differ as per geographic region and ethnicity and largely reflect the prevalence and pattern of smoking. The overall 5-year survival rate of lung cancer is dismal with approximately 15% in developed countries and 5% in developing countries 3. Screening by low-dose computed tomography (CT) in high-risk population demonstrated a relative risk reduction of 20% in lung cancer mortality but with a false positive rate of 96%. In India, where tuberculosis is prevalent, the applicability of such screening tool is questionable. Development of newer non-invasive methods/biomarkers for early diagnosis and screening of high-risk population is warranted.[5]

Literature Review

Ho, Satoh, and Lin[6] explored a bibliometric approach to quantitatively assess research trends in lung cancer in Japan using the Science Citation Index (SCI) database of lung cancer from 1991 to 2008. They analyzed the articles by the scientific output and research performances of individuals, institutions, and collaborative countries with Japan. They applied distribution of words in the article title, author keywords, and Keywords Plus in different periods to evaluate research trends by the frequency of keywords used. Their analysis indicated a strategy to connect molecular biology with clinical practice. Ho, Nakazawa, Sato, Tamura, Kurishma, and Satoh[7] explored a bibliometric approach to quantitatively assess research trends in cisplatincontaining chemotherapy for SCLC using related literature in the SCI expanded database from 1992 to 2011. They analyzed the articles by the scientific output and research performances of countries and institutions. Chitra, Jeyshankar, and Abu[8] examined the research output of lung cancer in the G7 and in Brazil, Russia, India, and China (BRIC countries) using scientometric data by obtaining from Scopus database on lung cancer during 2003–12. They compared the compound annual growth rate (CAGR), collaboration coefficient (CC), and publication activity using transformative activity index (TAI) of both G7 and BRIC countries. They adopted two relative indicators—absolute citation impact (ACI) and relative citation impact (RCI) to compare the quality and impact of the lung cancer research.

Objectives

In this study, our main objectives were to study the performance of Indian research in lung cancer during 2005–14, based on publications covered in Scopus database. In particular, following were the study objectives: (i) to study the growth of world and Indian research output and the citation pattern of the Indian research output; (ii) to study the global publication share of top 15 most productive countries and the place of India in global output; (iii) to study the international collaboration share of Indian publications and the contribution of leading foreign countries in India's collaborative output; (iv) to study the distribution of Indian research output by broad subject areas and study their growth and decline; (v) to study the Indian lung cancer output by treatment methods and their distribution by geographical areas; (vi) to study the publication productivity and citation impact of 15 most productive organizations and authors; (vii) to study the medium of communication; and (vii) to study the characteristics of high-cited papers.

Methodology

We retrieved and downloaded the publication data of the world and of 15 most productive countries in lung cancer from the Scopus database (http://www.scopus.com) for 10 years during 2005–14. We used a number of keywords, such as "lung" and "cancer or neoplasm or carcinoma" were used in "title, abstract, and keyword" tag and restricting it to the period 2005–14 in "date range tag" to search the global publication data, which we term as the main search string. When the main search string was used restricted to 15 most productive countries in "country tag," as shown below, the publication data on 15 productive countries were obtained. When the main search string was further restricted to "subject area tag," "country tag," "source title tag," "journal title name," and "affiliation tag," we obtained information on distribution of publications by subject, collaborating countries, and organization. For citation data, the 3-year, 2-year, and 1-year citation window was used for publications during 2005–12, 2013, and 2014. In addition, citations to publications were also collected from date of publication till the end of April 2015. The data for the study was collected in April 2015.

(((TITLE-ABS-KEY (lung) AND TITLE-ABS-KEY(cancer or neoplasm or carcinoma)) AND PUBYEAR > 2004 AND PUBYEAR < 2015) AND

TITLE-ABS-KEY(cancer or neoplasm or carcinoma)) AND PUBYEAR > 2004 AND PUBYEAR < 2015))

(((TITLE-ABS-KEY (lung) AND TITLE-ABS-KEY(cancer or neoplasm or carcinoma)) AND PUBYEAR > 2004 AND PUBYEAR < 2015) AND TITLE-ABS-KEY(cancer or neoplasm or carcinoma)) AND PUBYEAR > 2004 AND PUBYEAR < 2015)) AND (LIMIT-TO (AFFILCOUNTRY,"India"))

Analysis

The world and India published 169,352 and 3,653 publications on lung cancer during 2005–14, which increased respectively from 12,476 and 143 in 2005 to 18,947 and 630 in 2014, registering an annual average growth rate of 5.00 and 18.81%, respectively. The cumulative growth of world and Indian publications in lung cancer has increased respectively from 71,127 and 945 during 2005–09 to 98,225 and 2,708 during 2010–14, witnessing a growth rate of 38.10 and 186.57%, respectively. Of the India's total publications in lung cancer, 71.83% (2,624) appeared as articles, 15.3% (559) as reviews, 5.36% (196) as letters, 3.61% (132) as conference papers, 1.29% (47) as notes, 0.98% (36) as editorials, 0.66% (24) as articles in press, 0.55% (20) as short surveys, 0.27% (10) as book chapters, 0.05% (2) as erratum, and 0.027% (1) as book during 2005–14. India's share of global publications in lung cancer was 2.16% during 2005–14, which increased from 1.33% during 2005–09 to 2.76% during 2010–14. The average citation per publication registered by Indian publications in lung cancer was 4.20 during 2005–14, which decreased from 4.29 during 2005–09 to 4.17 during 2010–14 (Table 1).

Global Publication Share and Citation Impact of Top 15 Most Productive Countries

The global research output in lung cancer originated in more than 100 countries during 2005–14. Table 2 lists the output of top 15 most productive countries in lung cancer that produced 93.17% of the global output during 2005–14, which increased from 89.50% during 2005–09 to 95.84% during 2010–14. The publication share of 15 most productive countries in lung cancer varied from 1.69 to 30.29% during 2005–14, with highest publication share (30.29%) coming from United States, followed by China (11.19%); Japan (10.03%); United Kingdom (5.92%); Germany (5.63%); Italy (5.50%); Canada, France, and Japan (from 4.04 to 4.48%); Spain, Australia, Netherlands, India, and South Korea (from 2.49 to 2.80%); and Sweden and Switzerland (from 1.51 to 1.71%, respectively) during 2005–14. The global publication share has increased by 6.61% in China, followed by India (1.43%), South Korea (0.89%), Australia (0.44%), Taiwan (0.38%), Canada (0.16%), Netherlands (0.04%), and Turkey (0.01%), as against decrease by 1.91% in the United States, followed by Germany (0.56%), United Kingdom (0.48%), France (0.24%), Spain (0.21%), Italy (0.20%), Canada (0.16%), and Japan (0.01%) from 2005–08 to 2009–14 (Table 2).

International Collaboration

India's share of international collaborative publications in lung cancer research output was 17.79% during 2005–14, which decreased from 19.89% during 2005–09 to 17.06% during 2010–14. India has collaborated with several countries in lung cancer research during 2005–14. Among the collaborating countries, the largest share (51.69%) was contributed by the United States, followed by United Kingdom (10.77%), France (10.46%), Germany (10.31%), Italy and Australia (7.23% each), Japan (6.92%), China and Canada (5.85% each), and South Korea (5.69%) during 2005–14. The international collaborative publication share of foreign countries in India's publication output increased by 4.99% in France, followed by United States (3.88%), Germany (1.78%), Australia (1.19%), China (0.74%), and Italy (0.44), as against decrease by 2.20% in Japan, followed by South Korea (1.72%), United Kingdom (1.30%), and Canada (0.01%) from 2005–09 to 2010–14 (Table 3).

Subject-wise Distribution of Research Output

India's lung cancer research output during 2005–14 has been published in the context of six subfields (as reflected in Scopus database classification), with highest publication share (63.62%) coming from medicine; followed by biochemistry, genetics, and molecular biology (28.77%); pharmacology, toxicology, and pharmaceutics (23.87%); chemistry (9.31%); agricultural and biological sciences (3.26% share); and immunology and microbiology (2.23%). The research activity, as reflected in activity index, has witnessed increase in pharmacology, toxicology, and pharmaceutics (from 68.27 to 111.27); chemistry (from 57.98 to 114.66); and agricultural and biological sciences (from 87.71 to 104.29) in contrast to decrease in medicine (from 111.44 to 96.01); biochemistry, genetics, and molecular biology (from 104.0 to 95.30); and immunology and microbiology (from 104.46% to 98.44) from 2005–09 to 2010–14. Among these six subjects, the largest citation impact per publication (5.15 and 5.09) was registered by chemistry and biochemistry, genetics and molecular biology, followed by pharmacology, toxicology, and pharmaceutics (4.99); agricultural and biological; sciences (4.88); immunology and microbiology (4.87); and medicine (2.77) during 2005–14 (Table 4).

Type of Lung Cancer

Lung cancer may be classified into four main groups: NSCLC (85%), SCLC (15%), mesothelioma, and carcinoid cancers. NSCLC is further divided into three major subgroups: adenocarcinoma, squamous cell carcinoma, and a less well-characterized group "large cell carcinoma" (40, 30, and 15% of all lung cancer cases, respectively). As expected, the largest publication share (28.90%) was contributed by as NSCLC, followed by SCLC (20.0%), mesothelioma (5.39%), and carcinoid tumors (0.99%) during 2005–14. The publication share increased in NSCLC (from 26.14%to 29.80%) and SCLC (from 17.35 to 20.9%), but decreased in mesothelioma (from 4.13 to 2.58%), and carcinoid tumors (from 1.38 to 0.85%) from 2005–09 to 2010–14 (Table 5).

Distribution of Publications by Treatment Methods

In terms of treatment methods used in lung cancer research in India during 2005–14, the largest publication share (20.5%) was registered by diagnosis, followed by chemotherapy (18.20%), surgery (11.20%), radiotherapy (10.90%), screening (8.73%), prognosis (8.08%), pathology (7.80%), genetics (2.27%), quality of life (2.27%), epidemiology (1.64%), and palliative care (1.23%) during 2004–13. The top five treatment methods together account for 56.26% share of the total publication output on lung cancer during 2005–14. The publication share has increased by 3.79% in screening, as against decrease by 4.04% in pathology, 2.52% in prognosis, 1.65% in surgery, 1.6% in diagnosis, 1.4% in radiotherapy, 0.91% in palliative care, 0.60% in chemotherapy, 0.36% in genetics, 0.08% in quality of life, and 0.07% in epidemiology from 2005–09 to 2010–14 (Table 6).

Distribution of Research Output by Geographical Areas

Among Indian states and union territories contributing to lung cancer research during 2005–14, the largest publication share (16.07%) came from Maharashtra, followed by Delhi (15.93%), Karnataka (8.65%), Chandigarh (6.65%), Telangana (6.10%), Tamil Nadu (4.38%), Kerala (4.35%), West Bengal (2.87%), Uttar Pradesh (2.52%), Punjab (2.35%), Haryana (2.24%), Rajasthan (2.08%), Orissa (0.49%), Madhya Pradesh (0.46%), and Bihar (0.22%) during 2005–14. Together the first five states account for 53.41% share of the Indian output in lung cancer during 2005–14. The share of lung cancer publications have increased in

Table 1: World and Indian Literature in Lung Cancer: Growth, Citation Impact, and International Collaboration, 2005–14

Publication Year	World	India					
	TP	TP	TC	ACPP	ICP	%ICP	Global Share
2005	12,476	143	649	4.54	35	24.48	1.15
2006	13,216	141	551	3.91	25	17.73	1.07
2007	13,939	186	661	3.55	29	15.59	1.33
2008	14,894	211	970	4.6	41	19.43	1.42
2009	16,602	264	1,221	4.63	58	21.97	1.59
2010	17,654	352	1,854	5.27	53	15.06	1.99
2011	18,906	497	2,618	5.27	85	17.1	2.63
2012	20,812	582	4,558	7.83	92	15.81	2.8
2013	21,906	647	1,825	2.82	102	15.77	2.95
2014	18,947	630	430	0.68	130	20.63	3.33
2005–09	71,127	945	4,052	4.29	188	19.89	1.33
2010–14	98,225	2708	11,285	4.17	462	17.06	2.76
2005–14	169,352	3,653	15,337	4.20	650	17.79	2.16

TP = Total Papers, TC = Total Citations; ACPP = Average Citations Per Paper; ICP = International Collaborative Papers

Table 2: Publication Output and Global Publication Share of Top 15 Most Productive Countries in Lung Cancer, 2005–14

Country Name	Number of Publications			Global Share of Publications		
	2005–09	2010–14	2005–14	2005–09	2010–14	2005–14
United States	22,336	28,963	51,299	31.4	29.49	30.29
China	5,236	13,720	18,956	7.361	13.97	11.19
Japan	7,131	9,847	16,978	10.03	10.02	10.03
United Kingdom	4,412	5,619	10,031	6.203	5.721	5.92
Germany	4,236	5,299	9,535	5.956	5.395	5.63
Italy	3,993	5,316	9,309	5.614	5.412	5.50
France	3,290	4,303	7,593	4.626	4.381	4.48
Canada	2,381	3,451	5,832	3.348	3.513	3.44
South Korea	1,921	3,528	5,449	2.701	3.592	3.22
Spain	2,277	2,934	5,211	3.201	2.987	3.08
Netherlands	1,704	2,396	4,100	2.396	2.439	2.42
India	945	2,708	3,653	1.329	2.757	2.16
Taiwan	1,318	2,194	3,512	1.853	2.234	2.07
Australia	1,270	2,188	3,458	1.786	2.228	2.04
Turkey	1,200	1,670	2,870	1.687	1.7	1.69
World	71,127	98,225	16,9352	100	100	100

Telangana (2.67%), West Bengal (1.88%), Uttar Pradesh (1.68%), Karnataka (1.39%), Haryana (1.17%), Punjab (0.75%), Madhya Pradesh (0.49%), Tamil Nadu (0.48%), Orissa (0.38%), and Bihar (0.15%), as against decrease in Delhi (5.06%), Maharashtra (3.59%), Chandigarh (2.73%), Kerala (0.98%), and Rajasthan (0.76%) from 2005–09 to 2010–14 (Table 7).

Profile of Top 14 Most Productive Organizations

The productivity of 14 most productive Indian organizations in lung cancer varied from 35 to 267 publications, which together contributed 33.71% (1201 publications) share in the cumulative publications output of India in lung cancer research during 2005–14. Table 8 presents the scientometric profile of these 14 Indian organizations. Seven organizations have registered higher publications output than the group average of 85.79%: Tata Memorial Hospital, Mumbai (267 publications); All India Institute of Medical Sciences, New Delhi (210 publications); Postgraduate Institute of Medical Education and Research, Chandigarh (159 publications); Indian Institute of Chemical Technology, Hyderabad (88 publications); University of Madras (112 publications); Indian Institute of Chemical Technology (IICT), Hyderabad (110 publications); and

Table 3: Share of Leading Countries in India's International Collaborative Output in Lung Cancer during 2005–14

Country Name	Number of Papers			Share of Papers		
	2005–09	2010–14	2005–14	2005–09	2010–14	2005–14
United States	92	244	336	48.94	52.81	51.69
United Kingdom	22	48	70	11.7	10.39	10.77
France	13	55	68	6.91	11.9	10.46
Germany	17	50	67	9.04	10.82	10.31
Italy	13	34	47	6.91	7.36	7.231
Australia	12	35	47	6.38	7.58	7.231
Japan	16	29	45	8.51	6.28	6.923
China	10	28	38	5.32	6.06	5.846
Canada	11	27	38	5.85	5.84	5.846
South Korea	13	24	37	6.91	5.19	5.692
Total of the Country	188	462	650	100		

Table 4: Subject-wise Break-up of India's Publications in Lung Cancer, 2005–14

Broad Subject*	Number of Papers			2005–14						
	2005–09	2010–14	2005–14	TC	ACPP	HI	ICP	%ICP	HCP	%HCP
Medicine	670	1654	2324	6439	2.77	48	401	17.3	24	1.03
Biochemistry, Genetics, & Molecular Biology	284	767	1051	5350	5.09	46	261	24.8	5	0.48
Pharmacology, Toxicology, & Pharmaceutics	154	718	872	4347	4.99	41	147	16.9	9	1.03
Chemistry	51	289	340	1752	5.15	29	85	25	0	0
Agricultural & Biological Sciences	27	92	119	581	4.88	16	28	23.5	2	1.68
Immunology & Microbiology	22	63	85	414	4.87	13	14	16.5	0	0
Total of the Country	945	2708	3653							

TP = Total Papers, TC = Total Citations; ACPP = Average Citations Per Paper; ICP = International Collaborative Papers; HI = h-index; HCP = High Cited Papers
*There is a duplication of papers under the various subjects, because of overlapping of journals covered

Table 5: Distribution of Publications by Type of Lung Cancer during 2005–14

Type of Lung Cancer	Number of Papers			Share of Papers		
	2005–09	2010–14	2005–14	2005–09	2010–14	2005–14
Non-Small Cell Lung Cancer	247	808	1,055	26.14	29.8	28.9
Small Cell Lung Cancer	164	565	729	17.35	20.9	20.0
Squamous Cell Carcinoma	72	242	314	7.62	8.94	8.6
Adenocarcinoma	86	334	420	9.10	12.3	11.5
Large Cell Carcinoma	31	63	94	3.28	2.33	2.57
Mesothelioma	39	70	197	4.13	2.58	5.39
Carcinoid Tumors	13	23	36	1.38	0.85	0.99
Total of the Country	945	2,708	3,653			

Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh during 2005–14. Three organizations have registered more than the average citation per publication (6.29) among the 15 organizations during 2004–15: Sanjay Gandhi Postgraduate Institute of Medical Sciences (SGPIMS), Lucknow (44.50); All India Institute of Medical Sciences (AIIMS), Delhi (9.054); and National Institute of Pharmaceutical Education and Research (NIPER), Mohali (6.33) during 2005–14. Seven organizations have registered more than the average h-index (12.07) of all 14 organizations: Tata Memorial Centre (TMC), Mumbai (23); All India Institute of Medical Sciences (AIIMS), Delhi (19); Indian Institute of Chemical Technology (IICT), Hyderabad (16); University of Madras and Postgraduate Institute of Medical Sciences (PGIMER), Chandigarh (15 each); and Indian Institute of Integrated Medicine (IIIM), Srinagar (13) during 2005–14. Seven organizations have achieved more than the average share of international collaborative publications (14.90%) of all organizations: Christian Medical College (CMC), Vellore (29.17%);

Table 6: Distribution of India's Lung Cancer Publications by Treatment Methods, 2005–14

Treatment Methods	Number of Publications			Share of Publications		
	2005–09	2010–14	2005–09	2010–14	2005–09	2010–14
Diagnosis	205	544	749	21.7	20.1	20.5
Chemotherapy	176	488	664	18.6	18.0	18.2
Surgery	121	302	423	12.8	11.2	11.6
Radiotherapy	113	286	399	12.0	10.6	10.9
Screening	56	263	319	5.93	9.71	8.73
Prognosis	94	201	295	9.95	7.42	8.08
Pathology	102	183	285	10.8	6.76	7.80
Genetics	24	59	83	2.54	2.18	2.27
Quality of Life	22	61	83	2.33	2.25	2.27
Epidemiology	16	44	60	1.69	1.62	1.64
Palliative Care	18	27	45	1.9	1	1.23
	945	2,708	3,653			

Table 7: Geographical Distribution of Lung Cancer Research Publications in India, 2005–14

Name of Geographical Area	Number of Publications			Share of Publications		
	2005–09	2010–14	2005–09	2010–14	2005–09	2010–14
Maharashtra	177	410	587	18.7	15.1	16.07
Delhi	186	396	582	19.7	14.6	15.93
Karnataka	72	244	316	7.62	9.01	8.65
Chandigarh	82	161	243	8.68	5.95	6.65
Telangana	39	184	223	4.13	6.79	6.10
Tamil Nadu	38	122	160	4.02	4.51	4.38
Kerala	48	111	159	5.08	4.1	4.35
West Bengal	14	91	105	1.48	3.36	2.87
Uttar Pradesh	12	80	92	1.27	2.95	2.52
Punjab	17	69	86	1.8	2.55	2.35
Haryana	13	69	82	1.38	2.55	2.24
Rajasthan	25	51	76	2.65	1.88	2.08
Orissa	2	16	18	0.21	0.59	0.49
Madhya Pradesh	1	16	17	0.11	0.59	0.46
Bihar	1	7	8	0.11	0.26	0.22
Total of the Country	945	2,708	3,653			

Bhabha Atomic Research Centre (BARC), Mumbai (28.57%); National Institute of Pharmaceutical Education and Research (NIPER), Mohali (22.5%); Tata Memorial Centre (TMC), Mumbai (22.47%); Punjab University, Chandigarh (17.86%); Sanjay Gandhi Postgraduate Institute of Medical Sciences (SGPIMS), Lucknow (17.14%); and Indian Institute of Chemical Technology (IICT), Hyderabad (15.91%) during 2005–14.

Profile of Top 15 Most Productive Authors

The productivity of 15 most productive Indian authors in lung cancer varied from 21 to 37 publications and together contributed 11.27% (400 publications) share in the cumulative publications output of India in lung cancer research during 2005–14. Table 9 presents the scientometric profile of these 15 Indian authors. Five authors have registered higher publications output than the group average of 26.67: N. Singh and A. K. Saxena (37 publications each), C. S. Pramash (33 publications), K. Sakthise (30 publications), and K. Prabhash (27 publications) during 2005–14. Six authors have registered more than the average citation per publication (3.05) among all 15 authors. Seven authors have registered more than the average h-index (7.27) of all 15 organizations during 2004–13: A. Kamal, A. K. Saxena, R. Guleria, A. Mohan, and K. Sakthise (10 each) and D. Behera and T. Devaki (8 each) during 2005–14. Five authors have achieved more than the average share of national collaborative publications (13.00%) of all authors: S. Basu (50.00%), C. S. Pramash (27.30%), A. Kamal (20.80%), A. Mohan (15.40%), and K. Prabhash (14.80%) during 2005–14.

Medium of Communication

Of the total publications in lung cancer, 97.18% (3,550) appeared in journals, 1.75% (64) in conference proceedings, 0.30 % (11) in books, and 0.11% (4) in trade publications. The 15 most productive journals

Table 8: Scientometric Profile of Top 14 Most Productive Indian Organizations in Lung Cancer, 2005–14

S.No	Name of the Organization	TP	TC	ACPP	H1	ICP	%ICP	HCP	%HCP
1	Tata Memorial Centre (TMC), Mumbai	267	1414	5.3	23	60	22.47	4	1.5
2	All India Institute of Medical Sciences (AIIMS), Delhi	210	1901	9.05	19	24	11.43	3	1.43
3	Post Graduate Institute of Medical Sciences (PGIMER), Chandigarh	159	368	2.31	15	12	7.547	0	0
4	Indian Institute of Chemical Technology (IICT), Hyderabad	88	433	4.92	16	14	15.91	0	0
5	University of Madras	77	261	3.39	15	10	12.99	0	0
6	Indian Institute of Integrated Medicine (IIIM), Srinagar	61	285	4.67	13	3	4.918	0	0
7	Punjab University, Chandigarh	56	222	3.96	10	10	17.86	0	0
8	Christian Medical College (CMC), Vellore	48	247	5.15	8	14	29.17	1	2.08
9	Institute of Rotary Cancer Hospital (IRCH), Delhi	48	269	5.6	8	4	8.333	1	2.08
10	CSM Medical University, Lucknow	42	137	3.26	5	1	2.381	1	2.38
11	National Institute of Pharmaceutical Education & Research (NIPER), Mohali	40	253	6.33	12	9	22.5	1	2.5
12	Sher-I-Kashmir Institute of Medical Sciences (SKIMS), Srinagar	35	79	2.26	7	2	5.714	0	0
13	Sanjay Gandhi Postgraduate Institute of Medical Sciences (SGPIMS), Lucknow	35	1,556	44.5	8	6	17.14	2	5.71
14	Bhabha Atomic Research Centre (BARC), Mumbai	35	130	3.71	10	10	28.57	0	0
	Total of 14 Organizations	1,201	7,555	6.29	12.07	179		13	1.08
	Total of the world	3563							
	Share of 14 Organizations in World Total	33.71							

TP = Total Papers, TC = Total Citations; ACPP = Average Citations Per Paper; ICP = International Collaborative Papers; HI = h-index; HCP = High Cited Papers

Table 9: Scientometric Profile of Top 15 Most Productive Indian Authors in Lung Cancer, 2005–14

S.No	Name of the Author	Affiliation of the Author	TP	TC	ACPP	HI	ICP	%ICP
1	N. Singh	PGIMER-Chandigarh	37	58	1.57	6	0	0
2	A. K. Saxena	IIIM-Srinagar	37	168	4.54	10	0	0
3	C S Pramash	TMC-Mumbai	33	60	1.82	5	9	27.3
4	K. Sakthise	Dr ALM Postgraduate Institute, University of Madras	30	78	2.6	10	4	13.3
5	K. Prabhash	TMC-Mumbai	27	72	2.67	5	4	14.8
6	A. Mohan	AIIMS-Delhi	26	77	2.96	10	4	15.4
7	R. Kumar	AIIMS-Delhi	26	75	2.88	7	3	11.5
8	S. Basu	TMC-Mumbai	26	83	3.19	6	13	50
9	A. N. Aggarwal	PGIMER-Chandigarh	24	63	2.63	6	0	0
10	A. Kamal	IICT-Hyderabad	24	167	6.96	10	5	20.8
11	V. Rangarajan	TMC-Mumbai	23	25	1.09	4	0	0
12	R. Guleria	AIIMS-Delhi	23	73	3.17	10	3	13
13	S. Thulkar	AIIMS-Delhi	22	34	1.55	4	3	13.6
14	D. Behera	PGIMER-Chandigarh	21	94	4.48	8	2	9.52
15	T. Devaki	University of Madras	21	91	4.33	8	2	9.52
		Total of 15 Authors	400	1218	3.05	7.27	52	13.00
		Total of the Country	3563					
		Share of 15 Authors in Country Output	11.27					

TP = Total Papers, TC = Total Citations; ACPP = Average Citations Per Paper; ICP = International Collaborative Papers; HI = h-index; HCP = High Cited Papers

Table 10: List of Most Productive Journals in Indian in Lung Cancer during 2005-14

S.No	Name of the Journal	Number of Papers		
		2005–09	2010–14	2005–14
1	Journal of Cancer Research and Therapeutics	16	66	82
2	Asia Pacific Journal of Cancer Prevention	21	60	81
3	Indian Journal of Cancer	14	53	67
4	Lung India	8	56	64
5	European Journal of Medicinal Chemistry	3	56	59
6	Indian Journal of Pathology & Microbiology	32	25	57
7	Medicinal Chemistry Research	0	47	47
8	BMJ Case Reports	1	40	41
9	Bioorganic & Medicinal Chemistry Letters	6	35	41
10	Indian Journal of Pharmacy & Pharmaceutical Science	0	35	35
11	Indian Journal of Medical & Pediatric Oncology	2	32	34
12	Journal of Clinical & Diagnostic Research	0	34	34
13	PLOS One	0	33	33
14	Indian Journal of Nuclear Medicine	0	32	32
15	Journal of Indian Medical Association	8	24	32
	Total of 15 journals	111	628	739
	Total of the country	945	2,708	3,653
	Share of 15 journals in country output	11.75	23.19	20.23

contributed from 32 to 82 papers and together contributed 20.23% share (739 papers) to the total journal publication output in lung cancer during 2005–14. The publication share of these top 15 most productive journals increased from 11.75 to 23.19% from 2005–09 to 2010–14. The most productive journals (82 papers) were *Journal of Cancer Research and Therapeutics*, followed by *Asia Pacific Journal of Cancer Prevention* (81 papers), *Indian Journal of Cancer* (67 papers), and *Lung India* (64 papers) during 2005–14 (Table 10).

High-Cited Papers

There were 31 high-cited papers (18 papers in citation range of 100–199; 7 papers in 200–299; 1 paper in 400–499; 2 papers in 500–599; 1 paper each in 600–699, 1000–1099, and 1400–1499) which together received 9,137 citations, accounting for average citation per paper of 294.74. Of the 31 high-cited papers (19 articles and 12 reviews), 7 were single institutional, 3 national collaborative, and 21 international collaborative papers. The 31 high-cited papers have appeared in 23 journals, of which the largest number (7) was published in *The Lancet,* followed by 2 papers in *Nanomedicine*, *The Lancet Oncology*, and *New England Journal of Medicine*, and 1 paper each in *AAPS Journal, Advanced Drug Delivery Reviews, American Journal of Transplantation, Biochemical Pharmacology, Chinese Medicine, Current Drug Delivery, Current Problems in Cancer, Histopathology, International Journal of Epidemiology, Journal of Clinical Biochemistry and Nutrition, Journal of Clinical Oncology, Journal of Controlled Release, Journal of the American College of Surgeons, Journal of Thoracic Oncology, Pharmacological Reports, PLoS One, Science Translational Medicine, Vascular Pharmacology,* and *World Psychiatry.* The 31 high-cited papers involve 37 Indian organizations, of which the highest number of papers (four) are published by Tata Memorial Hospital, Mumbai, followed by three papers by All Indian Institute of Medical Science, New Delhi (3 papers), two papers each by Betty Cowan Research and Innovation Center, Ludhiana; Center for Chronic Disease Control, New Delhi; Institute of Life Sciences, Bhubaneswar; Regional Cancer Centre, Trivandrum; and Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow. One paper each by Amala Cancer Research Center, Amala Nagar, Thrissur; Annamalai University, Annamalainagar; Associates in Clinical Endocrinology, Education and Research, Chennai; Bharathidasan University, Tiruchirappalli; Birla Institute of Technology and Science, Pilani; C. U. Shah College of Pharmacy and Research, Wadhwan City; Calcutta University, Kolkata; Cancer Institute (WIA), Chennai; CARE Foundation, Banjara Hills, Hyderabad; Christian Medical College, Vellore; Dr. Ambedkar College, Nagpur; MS, Dr. B.C. Roy College of Pharmacy and Allied Health Sciences, Durgapur; GEM Digestive Disease Foundation, GEM Hospital, Coimbatore; Institute of Hematology and Transfusion Medicine, Medical College, Kolkata; Institute Rotary Cancer Hospital, All-India Institute of Medical Sciences, New Delhi; Jadavpur University, Kolkata; Jamia Hamdard, New Delhi; Japanese Society of Transcultural Psychiatry, Medical College, Jaipur; Jawaharlal Nehru Cancer Hospital and Research Center, Bhopal; Medical College, Jaipur; NIPER-Mohali; SAL Hospital and Medical Institute, Ahmedabad; Sekhsaria Institute for Public Health, Mumbai; Sitaram Bhartia Institute of Science and Research, New Delhi; Sterling Hospital, Ahmedabad, University of Delhi; Vector Control Research Centre, Pondicherry; and Voluntary Health Services, Sneha, Chennai.

Summary and Conclusion

India has contributed 3,653 publications on lung cancer during 2005–14, which has increased from 143 to 630 from 2005 to 2014, registering a growth rate of 18.81%. India's global publication share on lung cancer was 2.16%, which increased from 1.33 to 2.76% from 2005–09 to 2010–14. India registered a citation impact per paper of 4.20 on lung cancer during 2005–14, which decreased from 2.29 to 4.17 from 2005–09 to 2010–14. The global contribution (169,352 papers) contribution on lung cancer during 2005–14 came from more than 100 countries, with largest contribution coming from United States (20.29%), China (11.19%), Japan (10.03%), United Kingdom (9.23%), Germany (5.63%), Italy (5.50%),

France (4.48%), Canada (3.44%), and South Korea (3.22%). The contribution of top 15 most productive countries on lung cancer together contributed 93.17% to global share, which has increased from 89.50 to 95.84% from 2005–09 to 2010–14. The global publication share among the top 15 countries increased in China, India, South Korea, Australia, Taiwan, Canada, Netherlands, and Turkey, as against decrease in United States, Germany, United Kingdom, France, Spain, Italy, Canada, and Japan from 2005–09 to 2010–14. India's share of international collaborative papers on lung cancer was 17.79% during 2005–14, which decreased from 19.89 to 17.06% from 2005–09 to 2010–14. Among the major contribution to India's international collaborative output, the largest share (51.69%) came from United States, followed by United Kingdom (10.77%), France (10.46%), Germany (10.31%), Italy and Australia (7.23% each), Japan (6.92%), China and Canada (5.85% each), and South Korea (5.69%) during 2005–14. Medicine, among subjects, contributed the largest publication share (63.62%), followed by biochemistry, genetics, and molecular biology (28.77%); pharmacology, toxicology, and pharmaceutics (23.87%); chemistry (9.31%); agricultural and biological sciences (3.26%); and immunology and microbiology (2.23%). The research activity witnessed increase in pharmacology, toxicology, and pharmaceutics; chemistry; and agricultural and biological sciences in contrast to decrease in medicine, biochemistry, genetics, and molecular biology and immunology and microbiology from 2005–09 to 2010–14. Chemistry and biochemistry registered the largest citation impact per paper (5.15 and 5.09), genetics and molecular biology, followed by pharmacology, toxicology, and pharmaceutics (4.99); agricultural and biological sciences (4.88); immunology and microbiology (4.87); and medicine (2.77) during 2005–14. Among the various types of lung cancers, the largest publication share (28.90%) came from NSCLC, followed by SCLC (20.0%), mesothelioma (5.39%), and carcinoid tumors (0.99%) during 2005–14. Diagnosis, Chemotherapy and Surgery together account for 50.3% share of the total publication output on lung cancer during 2005–14. Maharashtra among Indian states and union territories contributed the largest publication share (16.07%), followed by Delhi (15.93%), Karnataka (8.65%). Chandigarh (6.65%), Telangana (6.10%), Tamil Nadu (4.38%), Kerala (4.35%), West Bengal (2.87%), Uttar Pradesh (2.52%), Punjab (2.35%), Haryana (2.24%), and Rajasthan (2.08%) during 2005–14. The 14 most productive Indian organizations and 15 authors in lung cancer together respectively contributed 33.71 and 11.27% to the cumulative India's lung cancer publications output during 2005–14. The 15 most productive journals together contributed 20.23% to the total journal publication output in lung cancer during 2005–14. In all, there were 31 high-cited papers (18 papers in citation range of 100–199, 7 papers in 200–299, 1 paper in 400–499, 2 papers in 500–599, 1 paper each in 600–699, 1000–1099 and 1400–1499), which together received 9137 citations, accounting for average citation per paper of 294.74. Of the 31 high-cited papers (19 articles and 12 reviews), 7 were single institution papers, 3 national collaborative and 21 international collaborative. The 31 high-cited papers have appeared in 23 journals, of which the largest number (7) was published in *The Lancet*, followed by 2 papers in *Nanomedicine*, *The Lancet Oncology*, and *New England Journal of Medicine* and 1 paper each in other journals.

The authors suggest the need for developing a National Cancer Prevention Policy, which should make specific recommendations for national action by governments and non-government organizations, including programs and strategies to reduce the incidence of specific preventable cancer types. The authors also suggest the need for increased federal research funding for lung cancer research and ensuring a comprehensive plan of action to increase survival. There is also the need for educating the public about their lung cancer risk and to ensure equitable access to the service; providing guidance to lung cancer screening programs about how to set up and implement responsible, high quality screening programs (meeting these criteria) and encouraging collaborative research for improving early detection in lung cancer and to identify other high-risk populations.

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