ONE HUNDRED YEARS OF RESEARCH ON SMOKING IN THE AMERICAN JOURNAL OF RESPIRATORY AND CRITICAL CARE MEDICINE

AJUNTAMENT DE VALENCIA
REGIDORIA DE SANITAT, SALUT I ESPORTS
PLAN MUNICIPAL DE DROGODEPENDENCIAS
UPCCA VALENCIA
VNIVERSITAT DE VALÈNCIA
CSIC
UISYS Unidad de Información e Investigación Social y Sanitaria
ingenio CSIC-UPV Instituto de gestión de la innovación y del conocimiento
IdiPAZ Instituto de Investigación Hospital Universitario La Paz
UAM UNIVERSIDAD AUTONOMA DE MADRID
UNIVERSIDAD COMPLUTENSE MADRID
Hospital Universitario 12 de Octubre
i+12 Instituto de Investigación Hospital 12 de Octubre

ONE HUNDRED YEARS OF RESEARCH ON SMOKING IN THE AMERICAN JOURNAL OF RESPIRATORY AND CRITICAL CARE MEDICINE

AUTHORS:

José Ignacio de Granda-Orive

Adolfo Alonso-Arroyo

Rafael Aleixandre-Benavent

Francisco García-Río

Francisco-Jesús Bueno Cañigral

AUTHORS:

José Ignacio de Granda-Orive
Pneumology Service, Hospital Universitario 12 de Octubre, Madrid, Spain.
Universidad Complutense de Madrid, Madrid, Spain.

Adolfo Alonso-Arroyo
Department of History of Science and Documentation, Faculty of Medicine and Dentistry, University of Valencia, Valencia, Spain.
UISYS (University of Valencia), Valencia, Spain.

Rafael Aleixandre-Benavent
IInstituto de Gestión de la Innovación y del Conocimiento-Ingenio (Spanish National Research Council-CSIC and Polytechnic University of Valencia).
UISYS (University of Valencia), Valencia, Spain.

Francisco García-Río
Pneumology Service, Hospital Universitario La Paz, IdiPAZ, Madrid, Spain.
Department of Medicine, Autonomous University of Madrid, Madrid, Spain.
CIBER of Respiratory Diseases (CIBERES), Madrid, Spain.

Francisco-Jesús Bueno Cañigral
Municipal Plan of Drug Addiction. (PMD/UPCCA-València.
Department of Public Healthcare and Health.
Valencia City Council. Spain.

Edita:
Plan Municipal de Drogodependencias (PMD)
Unitat de Prevenció Comunitaria en Conductes Adictives (UPCCA-València)
Concejalía de Sanidad, Salud y Deportes
Ayuntamiento de Valencia
ISBN: 978-84-9089-085-1
Imprime: Martín Gràfic
Depósito Legal: V-2082-2017

PRESENTATION

The characteristics and dimensions of the tobacco epidemic, with a prevalence in the 15-year-old Spanish current major population of 23% and demonstrated sufficiently in the scientific literature as the single most important cause of morbidity and preventable premature mortality in our country, force to the priorization of the activities for its prevention and control.

The harmful effects of smoking on the smoker's health are beyond doubt, resulting in enormous costs mainly due to health costs, productivity losses due to the increase in premature morbidity and mortality, and costs due to fires and damages on the property without forgetting those directly related to the interventions in smoking.

In our country, the number of deaths attributable to tobacco use in 2012 was 60,456, which accounted for 15% of all deaths occurring in the population aged 35 or over. By sex, 45,669 men and 14,787 women died because of tobacco, accounting for 22.6% of all deaths in men and 7.6% in women, respectively. Among the diseases that cause higher mortality attributable to smoking, lung cancer accounts for 30.5% of all attributable deaths, followed by Chronic Obstructive Pulmonary Disease (COPD) and cardiovascular diseases. By sex, lung cancer stands out, which is the highest attributable mortality in males (with 34.46%), while in women they are other heart diseases, with 29.41%.

Even for those who smoke 10 or less cigarettes per day, life expectancy is, on average, 5 years shorter and the risk of lung cancer is up to 20 times higher in smokers than in non-smokers. Those who smoke less than 4 cigarettes per day have up to 5 times increased risk of lung cancer.

Therefore, there is no safe level of tobacco consumption and the best way to prevent tobacco-related deaths is to avoid their consumption.

Helping the smoker who wants to stop smoking is a priority of national health systems. These have strategies that have proven to be cost-effective, not only in the area of prevention, but also in clinical treatment, which has already been evaluated in our environment.

The City Council of Valencia, from the Department of Health and Health, through the Drug Addiction Service - Unidad de Prevención de Conductas Adictivas (UPCCA-València), has maintained a constant fight against smoking promoted numerous activities, campaigns and studies aimed at prevention and treatment of tobacco use. In this monograph, we conducted a general bibliometric and smoking study in the American Journal of Respiratory Critical Care Medicine, the journal with the greatest impact in the Respiratory System of the Web of Science and the Journal Citation Reports, which this year 2017 is 100 years old. The study analyzes the production, repercussion and collaboration of the different thematic areas of the journal, but we focus mainly on the indicators obtained on smoking. Since the American Journal of Respiratory Critical Care Medicine is considered one of the most important journals in the area, it is interesting to know what aspects it has published and published about smoking, as well as the patterns of scientific collaboration and its repercussion according to several variables. On the other hand, since smoking is a multidisciplinary topic, it analyzes the contribution of research on tobacco consumption and its consequences in other thematic areas.

MAITE GIRAU MELIÀ
Department of Public Healthcare and Health.
Valencia City Council. Spain.

ABSTRACT

Rationale: Although the Blue Journal is the most prestigious forum for respiratory and critical care medicine, information about the evolution of its bibliometric patterns is scarce.

Objectives: Analyze the evolution of the collaboration networks, thematic areas and impact of the manuscripts published in the AJRCCM.

Methods: All documents published in the journal that are indexed in the Web of Science database were examined, and original manuscripts were selected. The year of publication, number of authors, affiliations, thematic area, and number of received citations were recorded for each. International collaboration was assessed using bibliometric transaction matrices.

Measurements and Main Results: United States was the largest producer (47.0% of documents), followed by United Kingdom and Canada. Among countries with a medium-high output, the highest average of citations per article were achieved by Denmark, Spain and Italy. The international collaboration increased from 9.9% in 1994 to 46.9% in 2016, with two main nodes centered in North America and Europe. Manuscripts produced through international collaboration received more citations, and several patterns in the evolution of collaboration networks have been identified. Asthma (20.2%), COPD (9.4%), critical care (9.1%) and sleep (7.5%) were the areas with the most output, although a progressive decrease in output related to asthma is evident. There are notable differences in the international collaboration, the evolution of the collaboration networks and the received citations among the different thematic areas. Productivity, repercussion and collaboration of smoking research are very active being an important topic in Blue Journal.

Conclusions: The international collaboration among authors of the AJRCCM is increasing, accompanied by notable changes in their collaboration networks and thematic areas. Research in smoking through the Blue Journal is active while maintaining a cohesive collaboration and significant impact.

Key words: Smoking research; Bibliometrics; international collaboration; thematic areas; citations; impact; American Journal of Respiratory and Critical Care Medicine.

INDEX

INDEX OF TABLES

INDEX OF FIGURES

1.INTRODUCTION

Since the publication of the first issue of the journal in March 1917 as the American Review of Tuberculosis and up through the establishment of its most recent title of the American Journal of Respiratory and Critical Care Medicine (AJRCCM) in 1994 (1), the Blue Journal has become the most prestigious international forum for state-of-the-art respiratory and critical care medicine of this century. Despite the evident interest in developing new scientific indicators that are capable of facilitating the analysis of the results of scientific activities together with research planning and management (2) as well as the existence of previous information regarding the outputs and repercussions of scientific activities concerning the respiratory system (3,4) and related research trends (5), specific information about the activities reported in the Blue Journal is very scarce.

For years, the generation of knowledge has been increasingly conducted within large and diverse networks of researchers working cooperatively and organized into research groups. The progressive increase in collaboration is one of the defining features of the evolution of science in recent decades, and scientific collaboration is an essential aspect of the professional activity of any researcher (6). In fact, cooperation generates synergies that extend beyond the sum of the potential contributions of the individual participants (6-8). The importance of scientific collaboration as a form of organization for scientists for the generation of new knowledge makes it necessary to understand the scope and significance of such collaboration, and because scientific journals are the main vehicle through which this knowledge is made public and diffused, their analysis becomes essential. In particular, for a journal with a vocation of worldwide representation such as the Blue Journal, which is focused on compiling the studies that make the most relevant contributions to the understanding of the pathophysiology and treatment of diseases that affect the respiratory system and critically ill patients, it is important to know whether the collaboration networks formed by its authors reflect this situation and to understand the evolution of its thematic areas.

Smoking is the main health problem of Western societies. The importance of tobacco related issues, which have great interest, which in turn has increased production of scientific works produced by the different lines research activities. Numerous bibliometrics studies have been published in recent

years on smoking. The conclusion of all of them could be summarized in the significant growth science, both globally and if we analyze different and specific thematic areas (7,8).

Through the use of various indicators, bibliometrics enables the quantification of certain aspects of importance, such as the output, circulation, obsolescence, consumption and repercussions of scientific activities (9). Despite its known limitations and frequent abuse (10), bibliometric analysis offers great utility in evaluating the health sciences. Among the available bibliometric indicators, the number of citations received has most commonly been used as the main instrument for gauging the impact or visibility of the scientific output of an author, journal or scientific community (11). It is clear that the practice of citation is an essential element of scientific work, and its analysis allows us to observe how scientific ideas are transmitted, define research topics and frontiers, and measure the impacts and prestige of scientists.

The objective of this study was to analyze productivity, repercussion and collaboration of smoking research among Blue Journal. The evolution of the international collaboration networks of the authors of the Blue Journal as well as to describe the development of the main thematic areas of the journal and compare the numbers of citations received according to the thematic and geographical areas and the levels of collaboration associated with the articles.

2. METHODS

2.1. Search

On November 18, 2016, all documents published in the AJRCCM from January 1994 to October 2016 that are indexed in the Web of Science Database Core Collection database were retrieved. Only original documents were included in the analysis; all other documents (editorials, reviews, clinical notes and letters to the director as well as special issues, monographs and conference abstracts) were excluded. In order to compile articles about smoking from the total number of papers retrieved from Blue Journal, the term "Smoke*" in the fields, title, abstract and keywords was used as a search strategy.

2.2. Collection of data and variables analyzed

For each article retrieved, the following variables were recorded: year of publication, title, author(s), institutional affiliation, country, thematic area(s), collaboration and number of citations received. The classification by thematic area was performed independently by two researchers, using the following categories defined by the journal itself: airway biology, asthma and allergy, chronic obstructive pulmonary disease, critical care, cystic fibrosis, environmental and occupational lung disease, interstitial lung disease, lung cancer and oncology disorders, lung transplantation and surgery, lung physiology, pediatrics and lung development, pulmonary infections, pulmonary vascular disease, sleep and control of ventilation, tuberculosis and mycobacterial disease, and miscellaneous.

2.3. Bibliometric indicators

As bibliometrics indicators of productivity, the number of authors and the number of documents were determined by year, thematic area and country. Impact was assessed by means of citation analysis, including the total number of received citations and the number of citations per article index. In addition, bibliometric transaction matrices were analyzed to graphically represent the cooperation among countries (12).

2.4. Bibliometric transaction matrices

Using the collected data, one-mode symmetric co-occurrence matrices were constructed in relation to the corresponding attribute matrices and used to represent relationships between countries, defined as "collaboration or

co-authorship in the same scientific article". Through the analysis of social networks, bibliometric maps were constructed to visualize the collaboration relationships among countries; these maps were used to restrict the analysis to only well-established relationships by establishing a threshold or minimum number of collaborations. "In these networks, the intensity of collaboration between two countries was represented by the weight of the link between the corresponding nodes (7,8). For all graphic representations, we used the Pajek network visualization and analysis program (http://pajek.imfm.si/doku.php) and the image editor Inkscape.

2.5. Statistical analysis

The data for continuous variables are summarized in the form mean ± SD, whereas frequencies (percentages) are used for categorical variables. The normality of the variable distributions was tested using the Kolmogorov-Smirnov test. Comparisons between groups were performed via analysis of variance followed by the Bonferroni post hoc test for continuous variables or the chi-square test with a Yates continuity correction (or the Fisher exact test if the expected frequencies were less than 5) for categorical variables. In addition to an overall analysis of the entire evaluated period, comparisons between individual five-year periods (1995-1999, 2000-2004, 2005-2009, and 2010-2014) were conducted. A p-value of <0.05 was deemed statistically significant throughout. The statistical analysis was performed using the Statistical Package for Social Sciences for Windows 15.0 (SPSS, Chicago, USA)..

3. RESULTS

We retrieved 9178 manuscripts published between 1994 and 2016. The evolution of paper publication by year is presented in Figure 1. A slight progressive decrease in the number of articles published per year is observed, along with an increase in the collaboration index, or the mean number of authors per article, from 5.2 in 1994 to 10.5 in 2015.

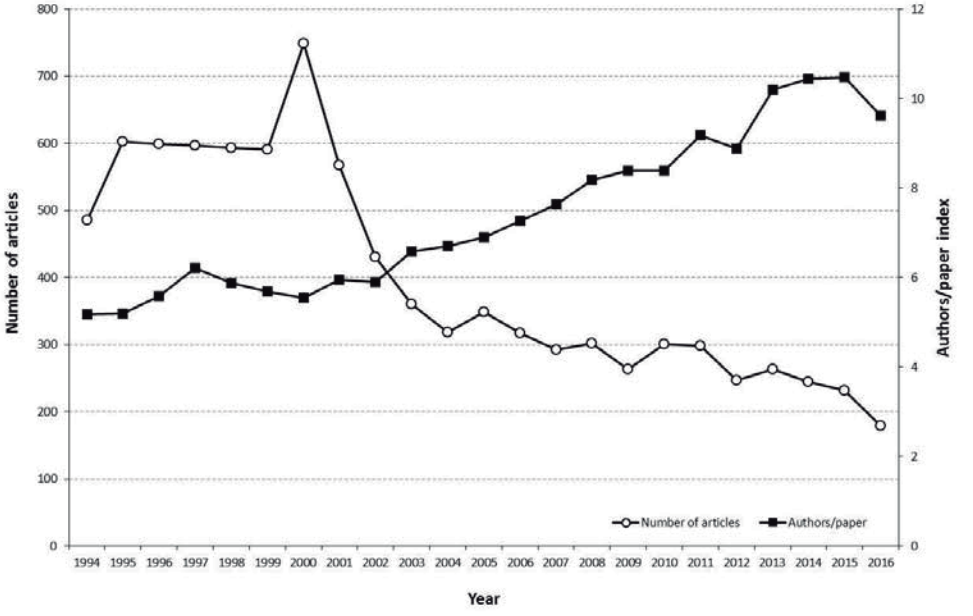


***Figure 1**. Evolution of the number of manuscripts and the collaboration index (mean of authors per paper) during the history of the American Journal Respiratory and Critical Care Medicine.*

The distribution of the published manuscripts by author origin is shown in Table 1. Throughout the entire analyzed period, the largest producer was the United States, with participation in 47% of the analyzed documents, followed by the United Kingdom (12.4%), Canada (11.9%) and France (8.0%). Although the distribution of the countries with respect to scientific output coincides with that with respect to the total number of citations received, it does not coincide with the distribution with respect to the average number of citations received per article. Among countries with a medium-high outputs (more than 30 manuscripts during the analyzed period), those that achieved the highest average numbers of citations per article were Denmark (93.59), Spain (92.91), Italy (86.02) and Brazil (85.66) (Table 1).

***Table 1**. Distributions of the number of documents, number of citations and level of international cooperation by author origin country with more than 10 papers*

Country	Number of documents	Total citations	Citations/ article	Manuscripts with international cooperation, %
United States of America	4311	288228	66.86	30.2 %
United Kingdom	1141	95897	84.05	53.0 %
Canada	1091	77858	71.36	45.8 %
France	736	53285	72.40	40.1 %
Germany	556	37060	66.65	60.4 %
Japan	504	31507	62.51	28.4 %
The Netherlands	490	30457	62.16	51.4 %
Australia	415	29768	71.73	46.0 %
Italy	405	34863	86.08	57.5 %
Spain	316	29358	92.91	57.9 %
Belgium	264	19324	73.20	56.1 %
Sweden	252	20629	81.86	68.7 %
Switzerland	229	17642	77.04	71.6 %
Denmark	124	11605	93.59	63.7 %
China	112	6879	61.42	58.9 %
Brazil	90	7709	85.66	74.4 %
South Africa	85	6508	76.56	88.2 %
Greece	79	5146	65.14	59.5 %
Finland	77	4631	60.14	58.4 %
Taiwan	77	3702	48.08	39.0 %
South Korea	75	4266	56.88	61.3 %
Austria	69	3859	55.93	76.8 %
Norway	61	3806	62.39	68.9 %
Mexico	55	4572	83.13	72.7 %
New Zealand	53	4365	82.36	69.8 %
Israel	47	2565	54.57	63.8 %
Ireland	45	2821	62.69	55.6 %
Poland	35	2661	76.03	85.7 %
Czech Republic	24	1313	54.71	100 %
Singapore	23	1815	78.91	73.9 %
Iceland	21	2133	101.57	85.7 %
India	21	1147	54.62	76.2 %
Chile	20	1843	92.15	90.0 %
Hungary	20	1202	60.10	85.0 %
Argentina	19	1658	87.26	73.7 %
Portugal	19	1595	83.95	100.0 %
Turkey	16	1355	84.69	93.8 %
Russia	14	856	61.14	92.9 %
Uganda	14	686	49.00	100 %

Country	Number of documents	Total citations	Citations/ article	Manuscripts with international cooperation, %
Uruguay	13	1395	107.31	76.9 %
Saudi Arabia	10	750	75.00	90.0 %

*Only countries represented in at least 10 documents are shown.

The list of the articles that received the highest numbers of citations (on the date of download) is shown in Table 2.

***Table 2**. Manuscripts with a higher number of citations (hot papers)*

Manuscript	Cites
Hankinson JL, Odencrantz JR, Fedan KB. Spirometric reference values from a sample of the general US population. Am J Respir Crit Care Med 1999; 159(1): 179-187	1865
Pope CA, Thun MJ, Namboodiri MM, Dockery DW, Evans JS, Speizer FE, Heath CW. Particulate air-pollution as a predictor of mortality in a prospective-study of US adults. Am J Respir Crit Care Med 1995; 151(3): 669-674	1643
Shahar E, Whitney CW, Redline S, Lee ET, Newman AB, Nieto FJ, O´Connor GT, Boland LL, Schwartz JE, Samet JM. Sleep-disordered breathing and cardiovascular disease: Cross-sectional results of the sleep heart health study. Am J Respir Crit Care Med 2001; 163(1): 19-25	1453
Raghu G, Collard HR, Egan JJ, Martinez FJ, Behr J, Brown KK, Colby TV, Cordier JF, Flaherty KR, Lasky JA, Lynch DA, Ryu JH, Swigris JJ, Wells AU, Ancochea J, Bouros D, Carvalho C, Costabel U, Ebina M, Hansell DM, Johkoh T, Kim DS, King TE Jr, Kondoh Y, Myers J, Müller NL, Nicholson AG, Richeldi L, Selman M, Dudden RF, Griss BS, Protzko SL, Schünemann HJ; ATS/ERS/JRS/ALAT Committee on Idiopathic Pulmonary Fibrosis. An Official ATS/ERSARS/ALAT Statement: Idiopathic Pulmonary Fibrosis: Evidence-based Guidelines for Diagnosis and Management. Am J Respir Crit Care Med 2011; 183(6): 788-824	1418
Vestbo J, Hurd SS, Agusti AG, Jones PW, Vogelmeier C, Anzueto A, Barnes PJ, Fabbri LM, Martinez FJ, Nishimura M, Stockley RA, Sin DD, Rodriguez-Roisin R. Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Pulmonary Disease GOLD Executive Summary. Am J Respir Crit Care Med 2013; 187(4): 347-365	1365
Hamelmann E, Schwarze J, Takeda K, Oshiba A, Larsen GL, Irvin CG, Gelfand EW. Noninvasive measurement of airway responsiveness in allergic mice using barometric plethysmography. Am J Respir Crit Care Med 1997; 156(3): 766-775	972

Seemungal TAR, Donaldson GC, Paul EA, Bestall JC, Jeffries DJ, Wedzicha JA. Effect of exacerbation on quality of life in patients with chronic obstructive pulmonary disease. Am J Respir Crit Care Med 1998; 157(5): 1418-1422	961
Bateman ED, Boushey HA, Bousquet J, Busse WW, Clark TJH, Pauwels RA, Pedersen SE. Can guideline-defined asthma control be achieved? The gaining optimal asthma control study. Am J Respir Crit Care Med 2004; 170(8): 836-844	875
Keatings VM, Collins PD, Scott DM, Barnes, PJ. Differences in interleukin-8 and tumor necrosis factor-alpha in induced sputum from patients with chronic obstructive pulmonary disease or asthma. Am J Respir Crit Care Med 1996; 153(2): 530-534	873
Keatings VM, Collins PD, Scott DM, Barnes PJ. Differences in interleukin-8 and tumor necrosis factor-alpha in induced sputum from patients with chronic obstructive pulmonary disease or asthma. Am J Respir Crit Care Med 1996; 153(2): 530-534	873
Khan TZ, Wagener JS, Bost T, Martinez J, Accurso FJ, Riches DWH. Early pulmonary inflammation in infants with cystic-fibrosis. Am J Respir Crit Care Med 1995; 151(4): 1075-1082	798
Peters A, Wichmann HE, Tuch T, Heinrich J, Heyder J. Respiratory effects are associated with the number of ultrafine particles. Am J Respir Crit Care Med 1997; 155(4): 1376-1383	777
Sessler CN, Gosnell MS, Grap MJ, Brophy GM, O´Neal PV, Keane KA, Tesoro EP, Elswick RK. The Richmond Agitation-Sedation Scale - Validity and reliability in adult intensive care unit patients. Am J Respir Crit Care Med 2002; 166(10): 1338-1344	739
Humbert M, Sitbon O, Chaouat A, Bertocchi M, Habib G, Gressin V, Yaici A, Weitzenblum E, Cordier JF, Chabot F, Dromer C, Pison C, Reynaud-Gaubert M, Haloun A, Laurent M, Hachulla E, Simonneau G. Pulmonary arterial hypertension in France - Results from a national registry. Am J Respir Crit Care Med 2006; 173(9): 1023-1030	733
Enright PL, Sherrill DL. Reference equations for the six-minute walk in healthy adults. Am J Respir Crit Care Med 1998; 158(5): 1384-1387	706
Connors AF, Dawson NV, Thomas C, Harrell FE, Desbiens N, Fulkerson WJ, Kussin P, Bellamy P, Goldman L, Knaus WA. Outcomes following acute exacerbation of severe chronic obstructive lung disease. Am J Respir Crit Care Med 1996; 154(4): 959-967	705

3.1. Evolution of international collaboration

During the analyzed period, a very prominent rise in the level of international collaboration is observed (Figure 2); i.e., the percentage of articles signed by authors from at least two different countries is increasing over time. In fact, the international collaboration index rose from 9.9% in 1994 to 46.9% in 2016. Figure 3 (≥ 5 collaborations) shows the pattern of international collaboration in articles published in the journal; the figure shows a virtually universal distribution, with two main nodes centered in North America and Europe as well as significant collaboration nodes in Japan and Australia. Among countries with a medium-high output, those that achieved the highest rates of international collaboration in their manuscripts were South Africa (88.2%), Poland (85.7%), Austria (76.8%) and Brazil (74.4%) (Table 1).

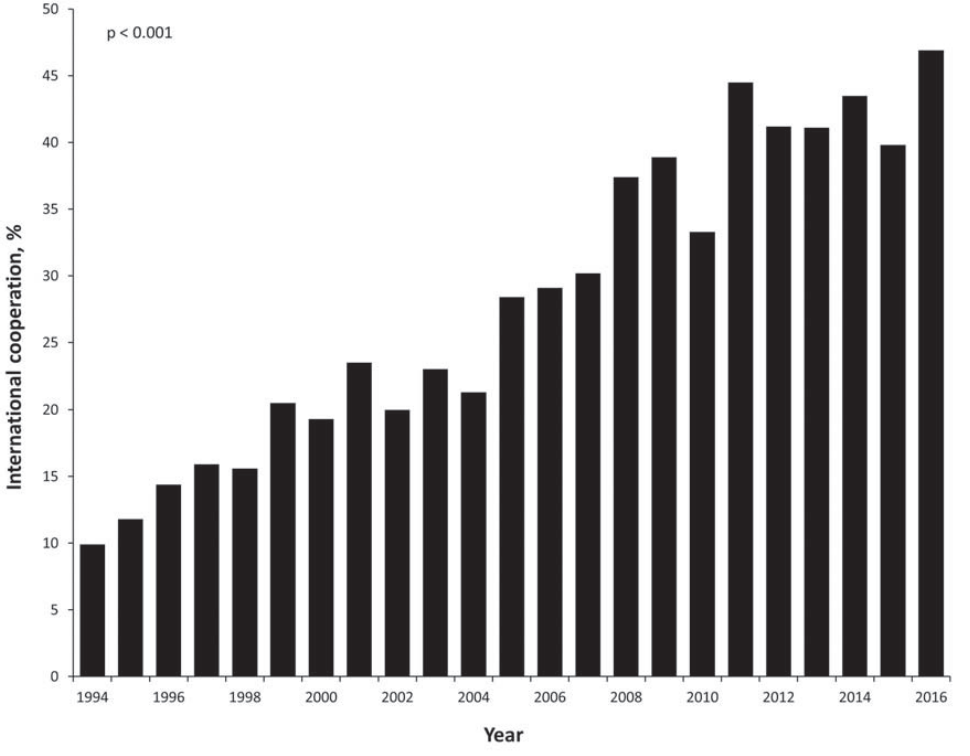
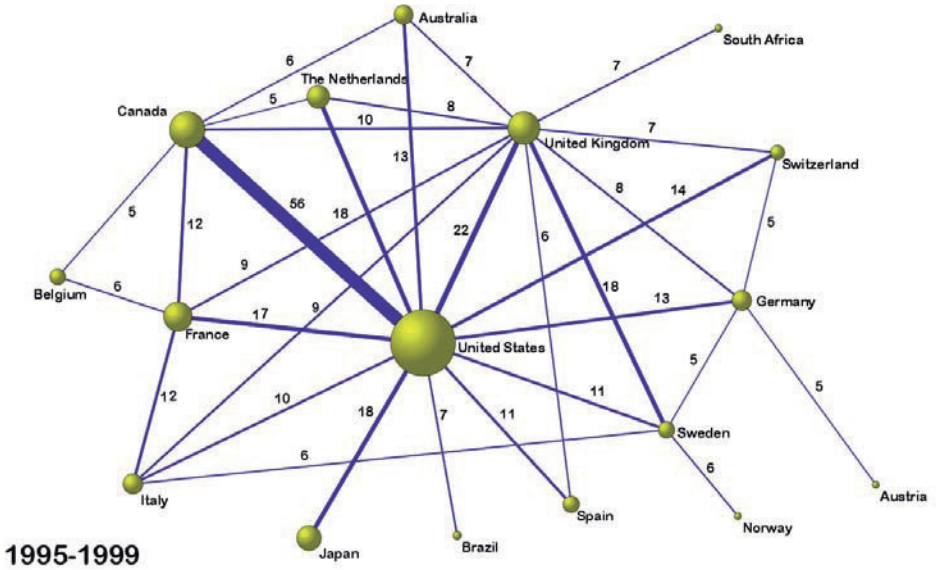
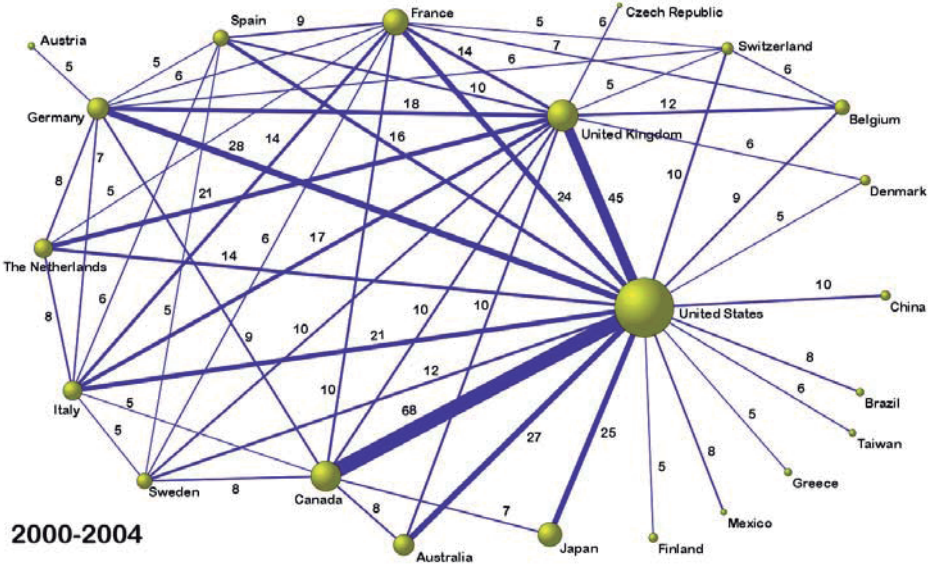


***Figure 2**. Annual evolution of the percentage of manuscripts published through international cooperation among authors from two or more countries.l.*

Figure 3. *Global distribution of international collaboration for articles published in the journal, after the application of a threshold of ≥ 5 collaborations (quantified as the number of papers signed)*

The evolution of the international collaboration networks over the four evaluated five-year periods is presented in Figure 4. Throughout the entire history of the AJRCCM, the level of collaboration between authors from the United States and Canada has been either maintained or strengthened. In addition, there is evidence of the progressive emergence of cooperation between American authors and authors from other countries, such as the United Kingdom, Germany, France, Spain and the Netherlands. Moreover, the growing establishment of collaboration circuits among other countries at more peripheral locations in the network is also observed.


Australia
South Africa
The Netherlands
Canada
United Kingdom
Switzerland
Belgium
Germany
France
United States
Sweden
Italy
Spain
Norway
Austria
Japan
Brazil
1995-1999


Spain
France
Czech Republic
Austria
Switzerland
Germany
Belgium
United Kingdom
Denmark
The Netherlands
China
United States
Italy
Brazil
Taiwan
Sweden
Canada
Greece
Mexico
Japan
Finland
Australia
2000-2004

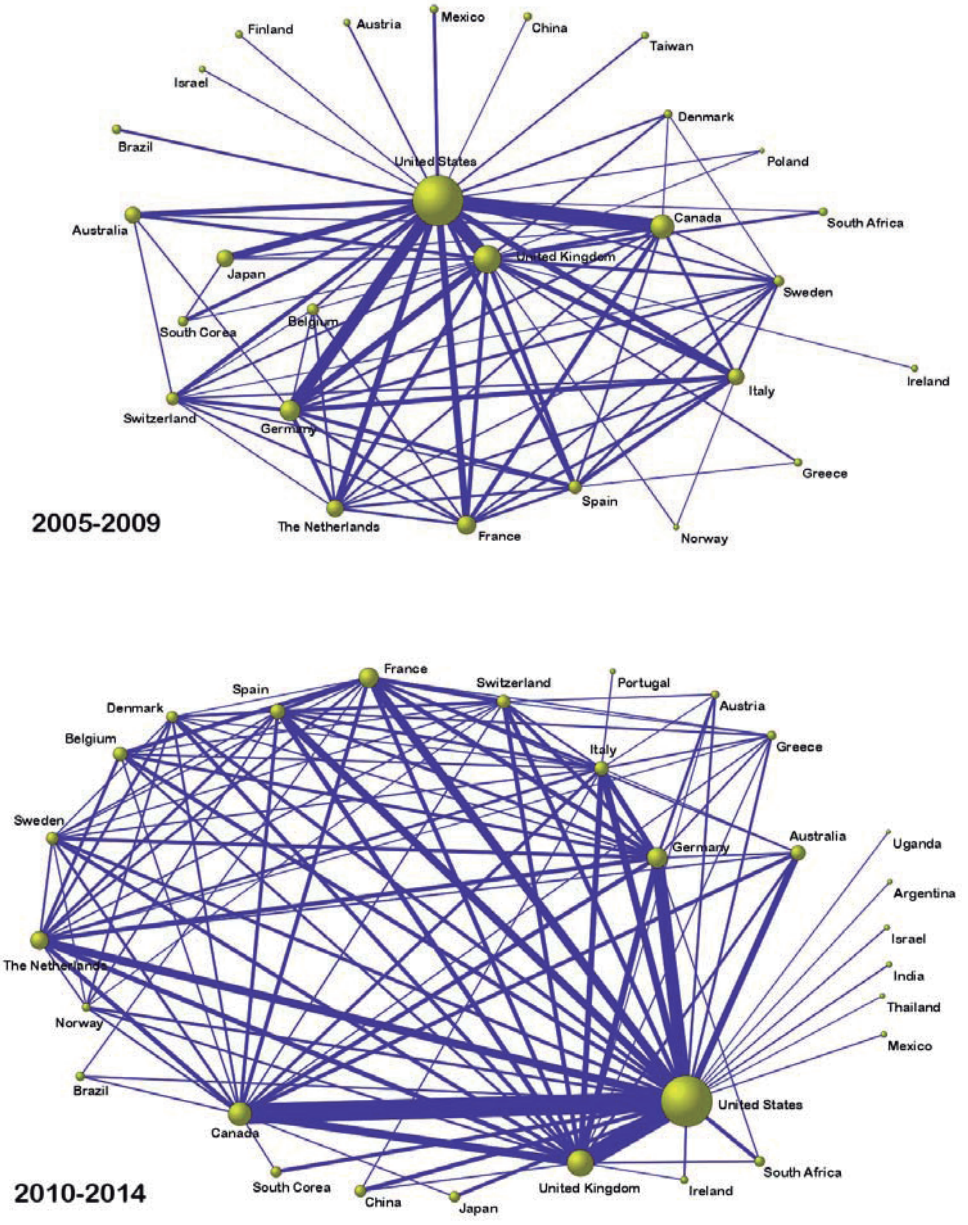


***Figure 4**. Evolution of international collaboration as represented by the main clusters of countries for each five-year period after the application of a threshold of five or more papers signed.*

International collaboration enables the generation of manuscripts with greater impact. Thus, the mean (± SEM) number of citations received, adjusted for the year of publication, is higher for manuscripts written through international collaboration than for those produced by authors from only a single country (76.96 ± 1.81 vs. 65.66 ± 1.03, p<0.001).

3.2. Evolution of scientific output by thematic area

Considering that 513 manuscripts were assigned to two or more thematic areas, the distribution of the papers published in the Blue Journal by thematic area is shown in Table 3. In the overall history of the journal, the most productive areas have been asthma and allergy (20.2%), chronic obstructive pulmonary disease (COPD) (9.4%), critical care (9.1%) and sleep and control of ventilation (7.5%).

***Tabla 3**. Distribución los manuscritos por área temática y número de citas**

Áreas temáticas	Número de documentos	Total citas recibidas	Citas por
Airway biology	546 (5.6%)	26613 (4.2%)	48.7 ± 42.2
Asthma and allergy	1958 (20.2%)	146385 (23.3%)	74.8 ± 86.2†§¶□#≡
Chronic obstructive pulmonary disease	907 (9.4%)	77386 (12.3%)	85.3 ± 104.2†‡§¶□#$!!≡
Critical care	881 (9.1%)	63915 (10.2%)	72.6 ± 78.6§¶≡
Cystic fibrosis	320 (3.3%)	19711 (3.1 %)	61.6 ± 69.2
Environmental and occupational lung disease	273 (2.8%)	19893 (3.2 %)	72.9 ± 129.6†¶≡
Interstitial lung disease	546 (5.6%)	43557 (6.9%)	79.8 ± 99.0†§¶□#$!!≡
Lung cancer and oncologic disorders	197 (2.0%)	9023 (1.4%)	45.8 ± 53.0
Lung transplantation and surgery	222 (2.3%)	9383 (1.5%)	42.3 ± 39.1
Lung physiology	363 (3.7%)	19899 (3.2%)	54.8 ± 118.1
Pediatrics and lung development	381 (3.9%)	21699 (3.5%)	57.0 ± 64.8
Pulmonary infections	714 (7.4%)	44770 (7.1%)	62.7 ± 64.7≡
Pulmonary vascular disease	351 (3.6%)	23581 (3.8%)	67.2 ± 86.9≡
Sleep and control of ventilation	731 (7.5%)	62136 (9.9%)	85.0 ± 105.7†‡§¶□#$!!≡
Tuberculosis and mycobacterial disease	400 (4.1%)	23931 (3.8%)	59.8 ± 59.1
Miscellaneous	901 (9.3%)	42123 (6.7%)	46.8 ± 47.9

*Data are mean ± standard deviation or number (percentage).
Comparison of the number of citations per article by analysis of variance.
Abbreviations: p<0.05 for the comparisons with †Airway biology, ‡Cystic fibrosis, §Lung cancer and oncologic disorders, ¶Lung transplantation and surgery, □Lung physiology, #Pediatrics and lung development, $Pulmonary infections, !!Tuberculosis and mycobacterial disease, and ≡Miscellaneous

The evolution of the most active thematic areas shows a progressive decrease in the number of papers concerning asthma and allergy as well as an increase in the numbers of papers addressing COPD and critical care. By contrast, the

output in the area of sleep and control of ventilation has remained relatively stable ($p<0.001$ according to the chi-square test) (Figure 5).

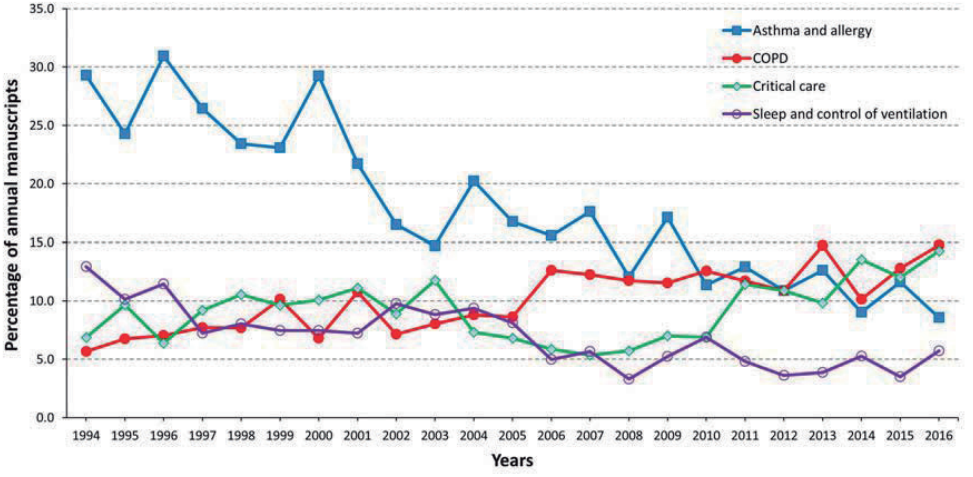


***Figure 5**. Annual evolution of the numbers of manuscripts published in the most productive thematic areas*

The evolution of areas with lower outputs reflects only a transient increase in the number of papers concerning airway biology between 2003 and 2011 and a slight increase in the number of papers related to pediatrics and lung development (Figure 6), without any other relevant changes (Figures 7 and 8).

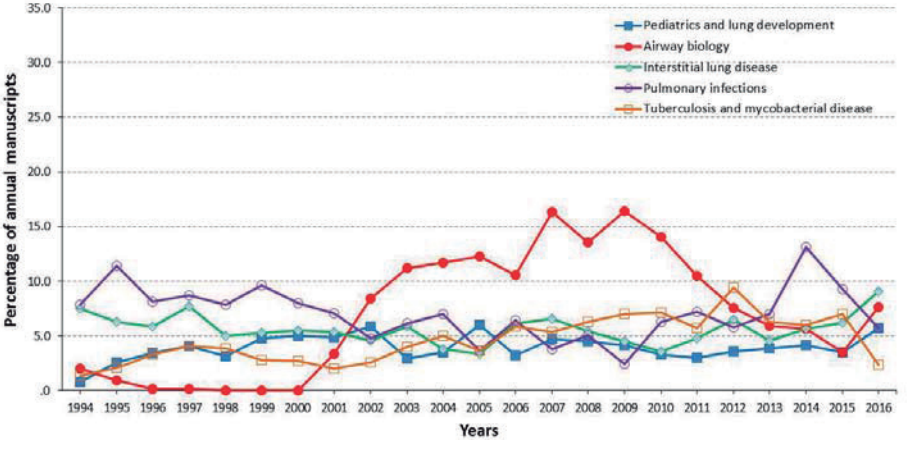


***Figure 6**. Evolution of the percentage of annual publications for the thematic areas with intermediate frequency*

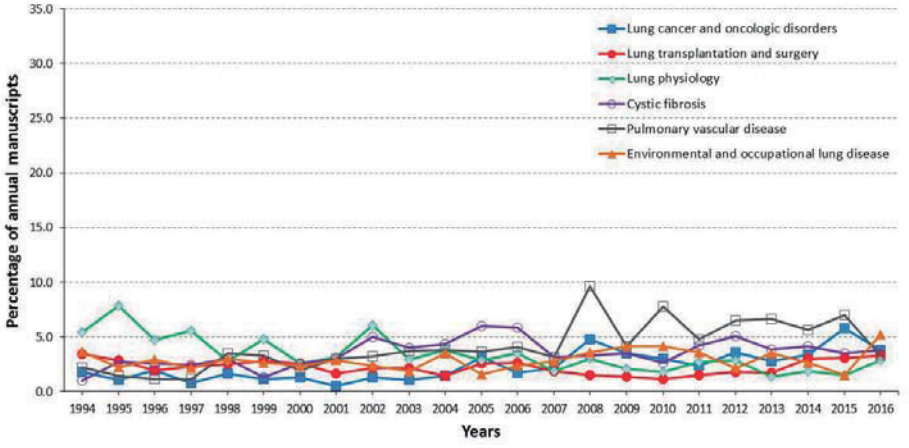


Figure 7. *Evolution of the percentage of annual publications for the lowest frequent thematic areas*

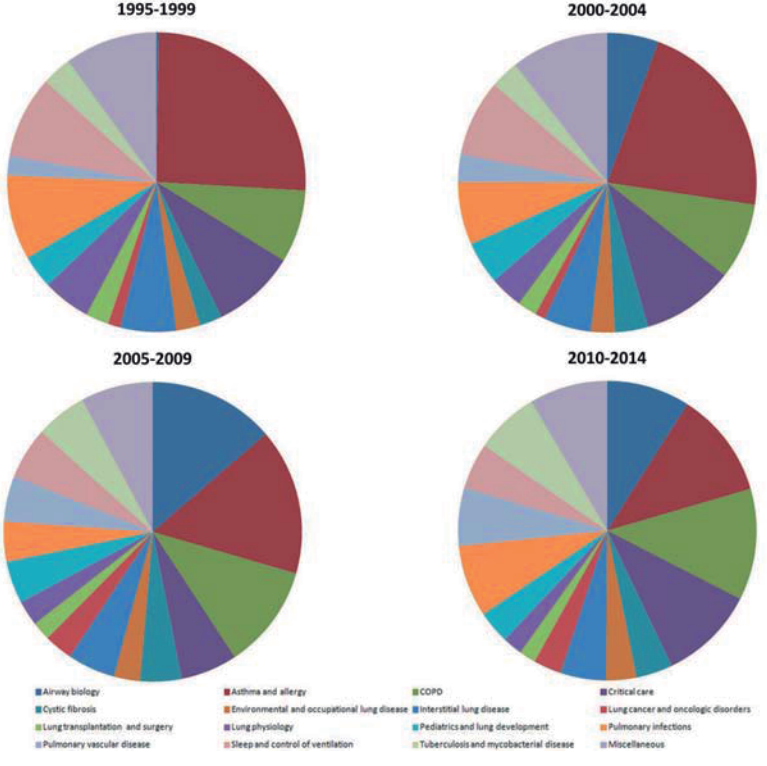


Figure 8. *Quinquennial distribution by thematic areas of the published manuscripts.*

3.3. International collaboration by thematic area

The percentages of documents published by authors from more than one country in each thematic area are shown in Table 4.

***Table 4**. Comparison of the international cooperation index between the different thematic areas*

Thematics areas	International cooperation
Airway biology	34.3 %
Asthma and allergy	24.6 %
Chronic obstructive pulmonary disease	29.8 %
Critical care	25.8 %
Cystic fibrosis	29.6 %
Environmental and occupational lung disease	25.7 %
Interstitial lung disease	25.4 %
Lung cancer and oncologic disorders	23.8 %
Lung transplantation and surgery	14.1 %
Lung physiology	20.6 %
Pediatrics and lung development	27.3 %
Pulmonary infections	22.3 %
Pulmonary vascular disease	25.9 %
Sleep and control of ventilation	14.9 %
Tuberculosis and mycobacterial disease	39.1 %
Miscellaneous	18.2 %

The area showing the greatest international cooperation is tuberculosis and mycobacterial disease (39.1%), followed by airway biology (34.3%), chronic obstructive pulmonary disease (29.8%) and cystic fibrosis (29.6%). More detailed distributions of the published documents by country and thematic area are presented in Table 5.

Table 5. *Distribution of manuscripts in international collaboration by countries and thematic areas*

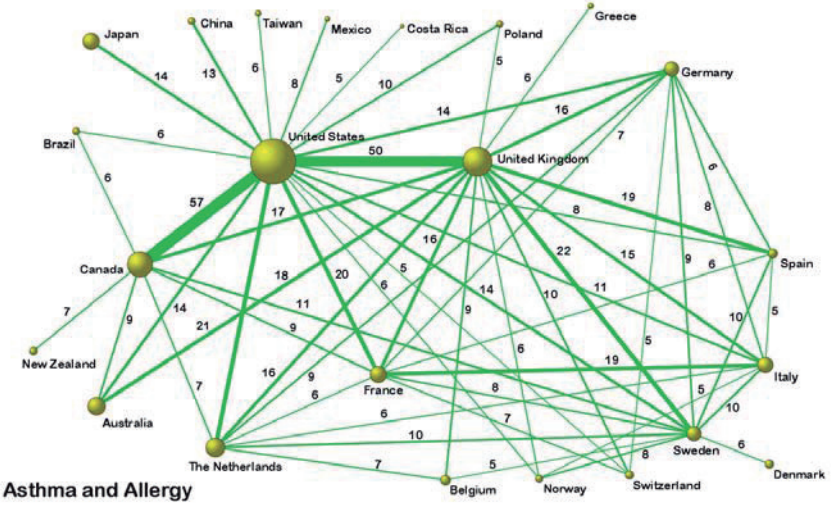
Country	Airway biology	Asthma and allergy	Chronic obstructive pulmonary disease	Critical care	Cystic fibrosis	Environmental and occupational lung disease	Interstitial lung disease	Lung cancer and oncologic disorders	Lung transplantation and surgery	Lung physiology	Pediatrics and lung development	Pulmonary infections	Pulmonary vascular disease	Sleep and control of ventilation	Tuberculosis and mycobacterial disease	Miscellaneous	Total
United States	291	767	346	403	159	128	268	99	114	143	132	315	166	310	232	438	4311
United Kingdom	55	318	164	56	47	20	76	13	14	29	46	60	33	48	63	99	1141
Canada	59	240	154	128	38	31	43	12	28	35	30	46	23	109	31	84	1091
France	34	101	38	117	25	9	41	18	20	25	21	75	60	61	25	66	736
Germany	51	78	43	65	28	10	53	9	14	10	14	45	38	27	19	52	556
Japan	55	102	51	35	4	9	74	12	10	5	4	36	18	19	13	57	504
The Netherlands	23	137	84	35	15	16	12	15	6	14	20	41	20	6	20	26	490
Australia	28	117	18	29	28	3	11	2	14	11	26	24	6	64	6	28	415
Italy	17	91	65	53	10	8	28	14	2	12	12	17	10	18	14	34	405
Spain	7	34	72	40	-	6	6	7	4	8	8	42	6	45	9	22	316
Belgium	9	36	51	27	14	8	10	7	11	18	2	14	10	17	10	20	264
Sweden	12	78	29	20	3	16	13	3	-	14	8	9	1	19	3	24	252
Switzerland	14	27	17	33	5	6	13	3	5	11	8	28	10	8	20	21	229
Denmark	2	27	39	6	3	3	1	1	-	3	11	7	3	1	9	8	124
China	8	20	3	11	-	7	4	6	-	5	2	12	3	4	17	10	112
Brazil	7	19	7	14	-	2	3	-	-	4	2	7	4	4	10	7	90
South Africa	1	5	-	1	1	2	3	-	-	1	2	9	-	-	55	5	85
Greece	1	12	4	13	-	4	6	4	1	8	-	7	1	7	2	9	79
Finland	5	22	3	4	1	4	9	1	2	1	7	5	2	4	1	6	77
Taiwan	7	13	3	10	-	2	1	18	2	-	-	6	-	1	4	10	77
South Korea	15	13	7	7	-	-	8	2	-	-	1	3	4	1	8	6	75
Austria	4	9	5	8	4	1	2	1	1	2	5	9	10	3	1	4	69
Norway	1	20	17	2	-	2	1	1	-	4	4	-	1	1	2	5	61
Mexico	1	10	4	3	-	6	13	-	-	1	3	1	3	-	5	5	55
New Zealand	2	23	5	4	5	-	3	-	-	1	2	5	-	1	1	1	53
Israel	9	5	2	5	5	3	-	-	1	2	1	2	-	8	1	3	47
Ireland	3	6	5	3	13	1	3	-	-	-	-	1	1	2	2	5	45
Poland	1	16	5	3	-	-	1	2	-	1	2	-	3	-	1	-	35
Czech Republic	1	2	-	3	2	1	9	2	-	1	1	1	-	-	1	-	24
Singapore	3	6	2	2	-	2	1	-	-	-	1	1	-	2	3	-	23
Iceland	-	5	5	1	1	-	-	1	-	1	1	2	-	4	-	-	21
India	-	2	2	4	-	-	-	-	-	1	-	1	-	-	11	-	21
Chile	-	-	-	11	-	-	2	-	-	1	-	4	-	-	1	1	20
Hungary	-	4	1	4	-	-	-	3	-	2	4	-	-	-	-	2	20
Argentina	-	2	-	5	-	-	-	-	-	1	2	7	-	-	1	1	19
Portugal	-	-	-	7	1	-	-	-	-	-	-	5	1	-	3	2	19

Country	Airway biology	Asthma and allergy	Chronic obstructive pulmonary disease	Critical care	Cystic fibrosis	Environmental and occupational lung disease	Interstitial lung disease	Lung cancer and oncologic disorders	Lung transplantation and surgery	Lung physiology	Pediatrics and lung development	Pulmonary infections	Pulmonary vascular disease	Sleep and control of ventilation	Tuberculosis and mycobacterial disease	Miscellaneous	Total
Turkey	-	2	1	4	-	2	-	1	-	-	-	1	-	2	2	1	16
Russia	-	2	2	-	-	-	1	2	-	-	-	-	-	3	4	-	14
Uganda	-	-	-	-	-	-	-	-	-	-	-	1	-	-	13	-	14
Uruguay	2	3	-	4	-	-	-	-	-	-	-	1	-	-	-	3	13
Saudi Arabia	-	1	1	4	-	-	-	-	-	-	-	1	1	-	1	1	10
Thailand	1	-	1	-	-	-	-	-	-	-	-	2	-	-	3	2	9
Colombia	-	2	1	5	-	-	-	-	-	-	-	-	-	-	-	-	8
Costa Rica	1	5	-	-	-	-	-	-	-	-	1	-	-	-	-	-	7
Romania	-	-	-	1	-	1	-	4	-	-	-	-	-	-	1	-	7
Tunisia	-	-	1	4	-	-	-	-	-	-	-	1	-	-	-	1	7
Slovakia	-	1	-	1	-	-	-	2	-	1	-	-	-	-	1	-	6
Venezuela	1	1	1	2	-	-	-	-	-	-	-	-	-	-	1	-	6
Ecuador	-	2	-	3	-	-	-	-	-	-	-	-	-	-	-	-	5
Estonia	-	3	-	-	-	-	-	-	-	-	1	-	-	1	-	-	5
Peru	-	-	-	1	-	-	-	-	-	-	1	-	1	-	1	1	5
Slovenia	-	-	-	1	-	1	-	-	-	-	-	1	-	-	-	2	5
Vietnam	-	-	-	-	-	-	-	-	-	-	-	1	-	-	4	-	5
Egypt	-	-	2	-	-	-	-	-	-	-	-	-	-	2	-	-	4
Gambia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	4
Malaysia	-	-	1	-	-	-	-	-	-	1	-	2	-	-	-	-	4
Bulgary	-	-	-	-	-	-	-	-	-	1	-	-	-	-	2	-	3
Ethiopia	-	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	3
Guinea	-	-	-	1	-	-	-	-	-	-	-	-	-	-	2	-	3
Guinea Bissau	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3
Kenya	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	1	3
Malawi	-	-	1	-	-	-	-	-	-	-	-	-	-	-	2	-	3
Namibia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3
Phillippines	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2	-	3
Tanzania	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2	-	3
Bangladesh	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	2
Bolivia	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	2
Botswana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2
Cyprus	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	2
Iran	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	2
Kuwait	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2
Malta	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	2
Oman	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	2
Rwanda	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	2

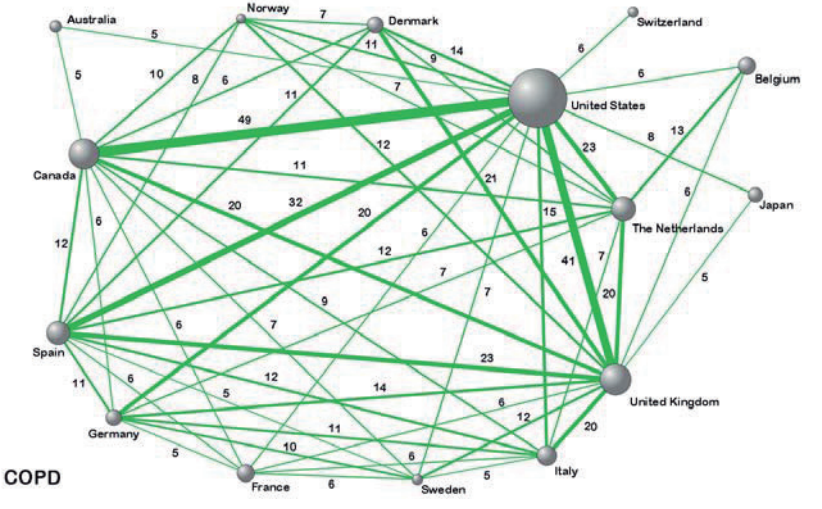
Country	Airway biology	Asthma and allergy	Chronic obstructive pulmonary disease	Critical care	Cystic fibrosis	Environmental and occupational lung disease	Interstitial lung disease	Lung cancer and oncologic disorders	Lung transplantation and surgery	Lung physiology	Pediatrics and lung development	Pulmonary infections	Pulmonary vascular disease	Sleep and control of ventilation	Tuberculosis and mycobacterial disease	Miscellaneous	Total
Senegal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2
Trinidad and Tobago	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Zimbabwe	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	2
Azerbaijan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Barbados	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Burundi	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Cambodia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Croatia	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
Fiji	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
French Polynesia	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Ghana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Haiti	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Indonesia	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Ivory Coast	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Kyrgyzstan	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Lebanon	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Luxembourg	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Macedonia	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Monaco	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Morocco	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1
Mozambique	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Pakistan	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Qatar	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
Republic of Georgia	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Reunion	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Serbia	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
Ukraine	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
United Arab Emirates	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Zambia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1

Figure 9 shows the international collaboration networks for the four most productive areas. The main nodes in the asthma network are the USA, Canada and the UK, followed by the Netherlands, Australia, France and Sweden. In the network for COPD, the nodes representing the USA, Canada, the United Kingdom and Spain predominate, in addition to a high number of collaborations at the periphery of the network. Likewise, the area of critical

care shows an important number of collaborations among peripheral nodes, with the USA, France and Canada being highlighted as the most important cooperation nuclei. By contrast, the area of sleep and control of ventilation shows a very incipient international collaboration network, in which the USA, Australia, Canada, Spain and France are responsible for most of the little international collaboration.



Asthma and Allergy



COPD

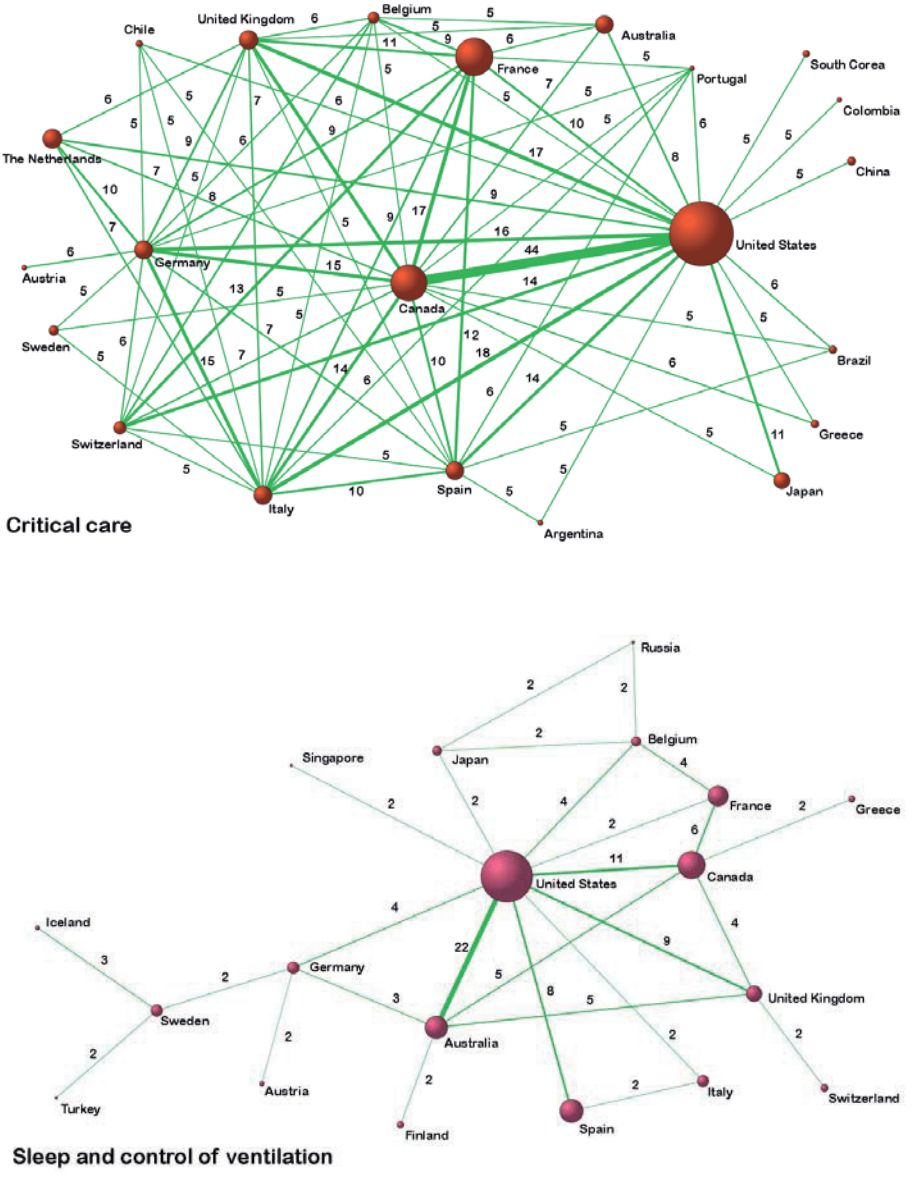


Figure 9. *International collaboration in the most productive thematic areas as represented by the main clusters of countries after the application of a threshold of five or more papers signed (or two or more papers for the area of sleep and control of ventilation)*

3.4. Citation analysis by thematic area

The manuscripts published in the Blue Journal between 1994 and 2016 have received a total of 627392 citations, with an average of 67 ± 84 citations per article. Over the entire analyzed period, the area that has received the highest number of citations per article is COPD, followed by sleep and control of ventilation, interstitial lung disease, asthma and allergy, environmental and occupational lung disease, and critical care. The numbers of citations received by manuscripts in other areas are below the mean citation index (Table 3 and Figure 10).

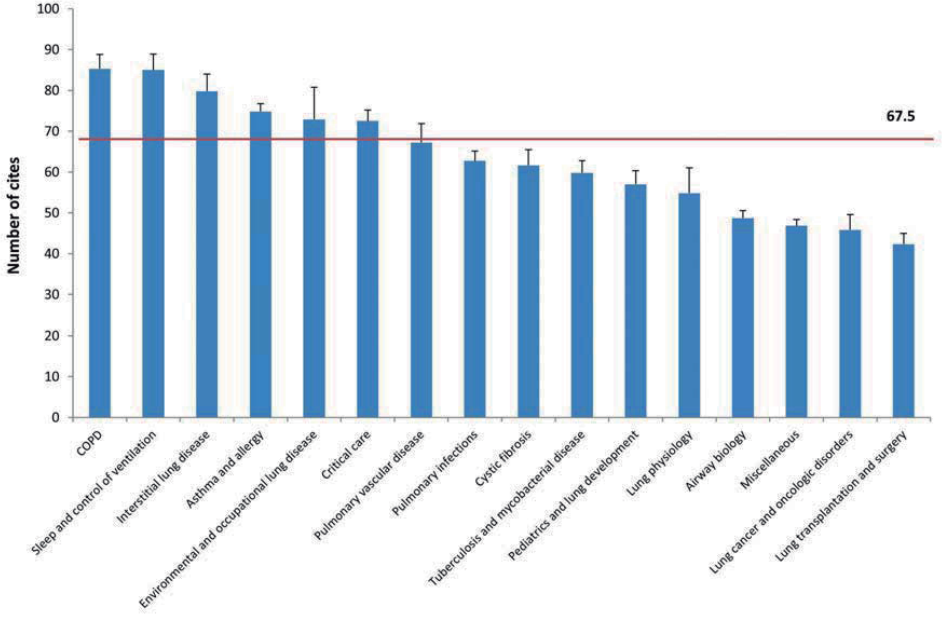


Figure 10. *Distribution of the number of citations per article by thematic area. The horizontal line represents the mean overall index for all manuscripts, and the vertical error bars represent the standard errors on the mean values. For statistical comparisons, see Table 3*

Because an older manuscript has had more time to be cited than a recent one and it was found that the outputs of the different thematic areas have varied over time, a comparison of the citations received by articles in different areas was performed based on five-year publication periods. This analysis reveals that articles in the COPD area received the most citations during the periods of 1995-1999 and 2000-2004, whereas from 2005 to 2009, the area with the highest number of citations per article was interstitial lung

disease (Table 6 and Figure 11). In fact, an evaluation of the three thematic areas with the greatest impact per article shows that up through 2004, the area of COPD predominated, followed by sleep and control of ventilation. Since 2005, articles published in the area of interstitial lung disease have received the highest number of citations, followed by COPD and then sleep and control of ventilation in the third position (Figure 12).

Table 6. *Comparison of citations between thematic areas along five-year periods**

Thematics areas	1995-1999	2000-2004	2005-2009	2010-2014
Airway biology	36.5 ± 21.9	63.9 ± 54.1	55.6 ± 37.9	31.4 ± 24.4
Asthma and allergy	81.3 ± 94.1□£	80.8 ± 86.5£	81.4 ± 76.4†	45.7 ± 65.9
COPD	108.9 ± 130.3‡g¶□#$!!□£	111.8 ± 92.1†‡§□#$!!£	89.2 ± 73.7†£	53.2 ± 107.7
Critical care	82.9 ± 88.7£	88.0 ± 83.7£	92.3 ± 78.6†£	44.2 ± 36.5
Cystic fibrosis	67.9 ± 107.5	71.4 ± 49.6	63.9 ± 48.4	42.9 ± 30.8
Environmental and occupational lung disease	94.8 ± 210.1□£	86.7 ± 80.1	81.9 ± 95.6	36.2 ± 36.4
Interstitial lung disease	69.5 ± 71.9	98.7 ± 90.4#£	116.4 ± 85.3†‡§¶□≡£	71.0 ± 168.1†¶£
Lung cancer and oncologic disorders	50.8 ± 38.4	82.8 ± 91.3	85.6 ± 52.5	26.9 ± 23.7
Lung transplantation and surgery	39.3 ± 27.7	55.3 ± 48.4≡	52.1 ± 44.4	34.7 ± 37.4
Lung physiology	57.3 ± 163.9	55.0 ± 56.3	71.2 ± 71.2	49.2 ± 86.3
Pediatrics and lung development	51.5 ± 64.6	63.5 ± 60.3	87.2 ± 82.5	34.4 ± 27.8
Pulmonary infections	63.2 ± 55.1	79.1 ± 82.7	85.8 ± 80.2	42.8 ± 42.0
Pulmonary vascular disease	66.7 ± 69.7	100.6 ± 116.4£	94.9 ± 106.3†£	37.4 ± 28.3
Sleep and control of ventilation	83.6 ± 92.2□£	104.4 ± 135.7†□#$£	79.2 ± 74.9	46.7 ± 52.6
Tuberculosis and mycobacterial disease	59.8 ± 60.2	80.2 ± 73.0	81.1 ± 59.2	37.9 ± 35.7
Miscellaneous	48.0 ± 49.3	51.9 ± 53.5	56.4 ± 43.6	32.8 ± 34.2

*Data are mean ± standard deviation.
Comparison of the number of cites between thematic areas within each five-year period by analysis of variance.
Abbreviatures: $p<0.05$ for the comparison with †Airway biology, ‡Asthma and allergy, §Cystic fibrosis, ¶Lung cancer and oncologic disorders, □Lung transplantation and surgery, #Lung physiology, $Pediatrics and lung development, !!Pulmonary infections, ≡Sleep and control of ventilation, □Tuberculosis and mycobacterial disease, and £Miscellaneous
.

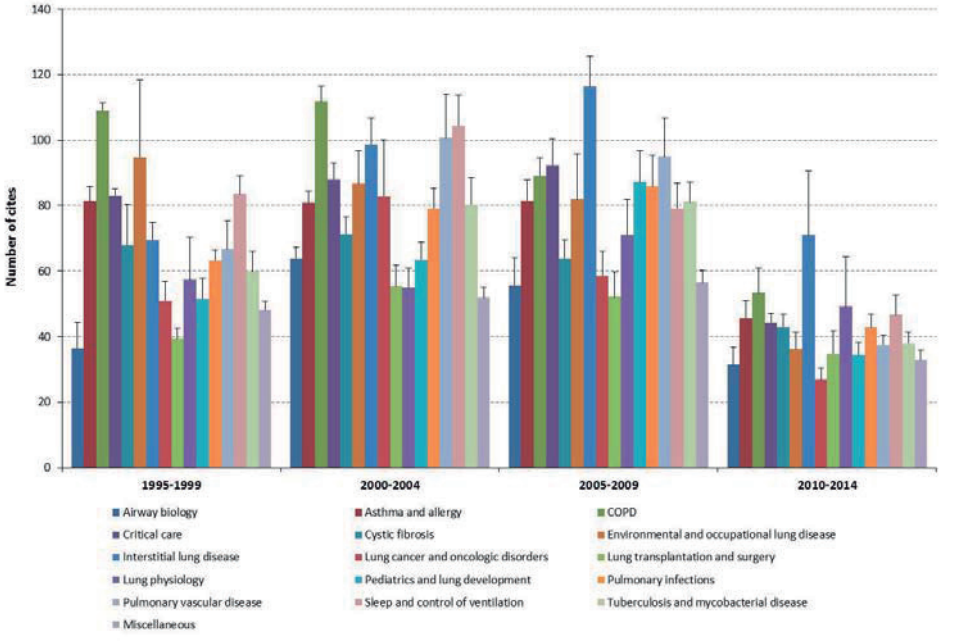


Figure 11. *Distribution by five-year periods of the citations received by the manuscript published in each thematic area.Vertical bar errors represent standard error of mean. For statistical comparisons see Table 6*

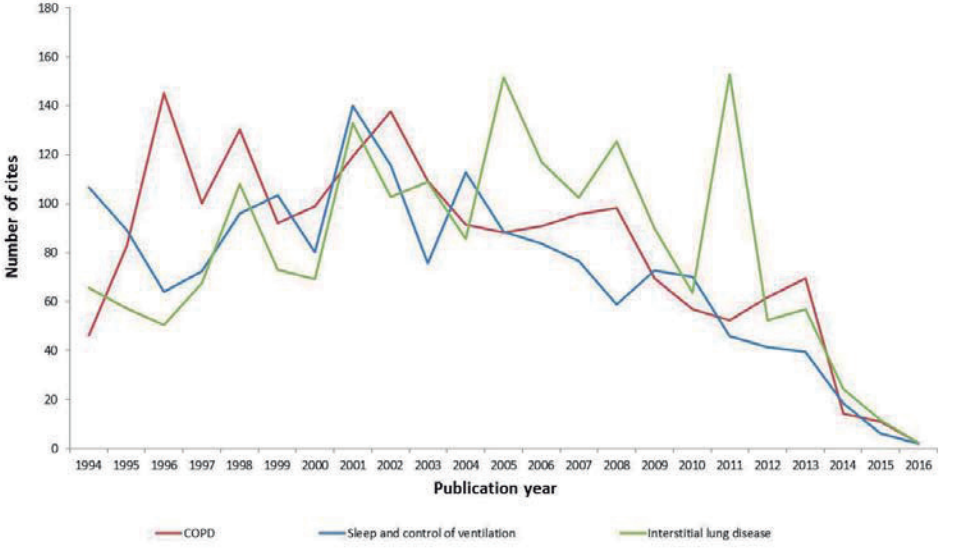


Figure 12. *Evolution of the citations received by the manuscits published each year in the three thematic areas with more impact*

3.5. Productivity, repercussion and collaboration of smoking research

Of the 9178 articles published between 1994 and 2016 in Blue Journal, 1046 papers correspond to articles on smoking. Figure 13 shows the evolution of the number of articles on the topic of smoking during the period studied. Table 7 shows the data by area (on this occasion the global data do not apply to 1046 documents but to 1125, that there are documents that were assigned to two different areas) of the articles on smoking and Figure 14 shows the distribution of smoking papers in different areas.

Table 7: *Participation of smoking thematic by different Blue Journal areas*

Thematics areas	Smoking Search	Number of articles of smoking by area	% articles of Smoking per area	TTotal smoking received cites	Total received citess	% Cites of smoking per area	Cites per article
Airway biology	52	546	9,52%	2884	26613	10,84%	55,5
Asthma and allergy	211	1958	10,78%	18074	146385	12,35%	85,7
Chronic obstructive pulmonary disease	342	907	37,71%	30732	77386	39,71%	89,9
Critical care	13	881	1,48%	921	63915	1,44%	70,8
Cystic fibrosis	7	320	2,19%	569	19711	2,89%	81,3
Environmental and occupational lung disease	90	273	32,97%	8145	19893	40,94%	90,5
Interstitial lung disease	64	546	11,72%	5415	43557	12,43%	84,6
Lung cancer and oncologic disorders	41	197	20,81%	2224	9023	24,65%	54,2
Lung physiology	83	363	22,87%	6230	19899	31,31%	75,1
Lung transplantation and surgery	6	222	2,70%	442	9383	4,71%	73,7
Miscellaneous	102	901	11,32%	6314	42123	14,99%	61,9
Pediatrics and lungdevelopment	51	381	13,39%	3461	21699	15,95%	67,9
Pulmonary infections	31	714	4,34%	2388	44770	5,33%	77,0
Pulmonary vascular disease	2	351	0,57%	193	23581	0,82%	96,5
Sleep and control of ventilation	24	731	3,28%	3508	62136	5,65%	146,2
Tuberculosis and mycobacterial disease	6	400	1,50%	341	23931	1,42%	56,8

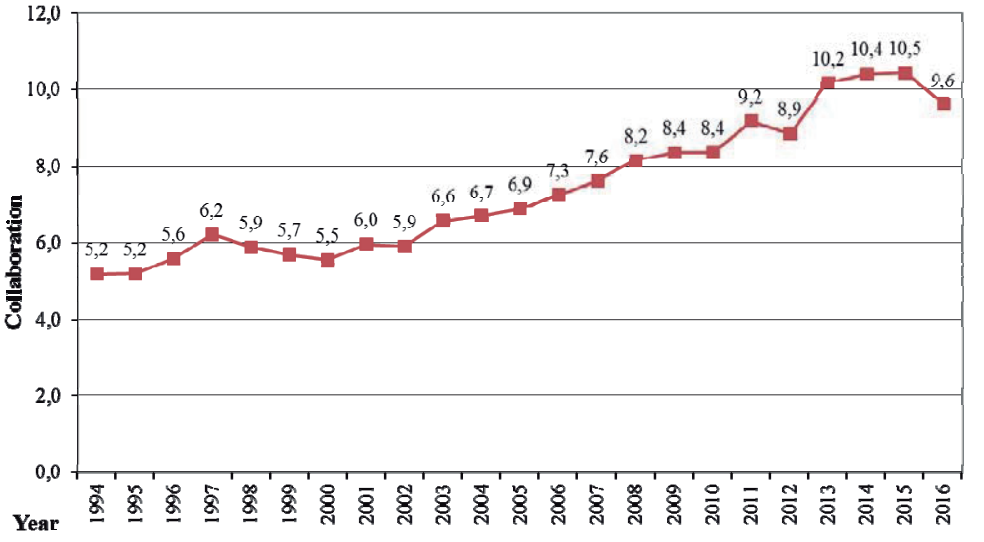


***Figure 13**: Evolution of articles on smoking per years of publication*

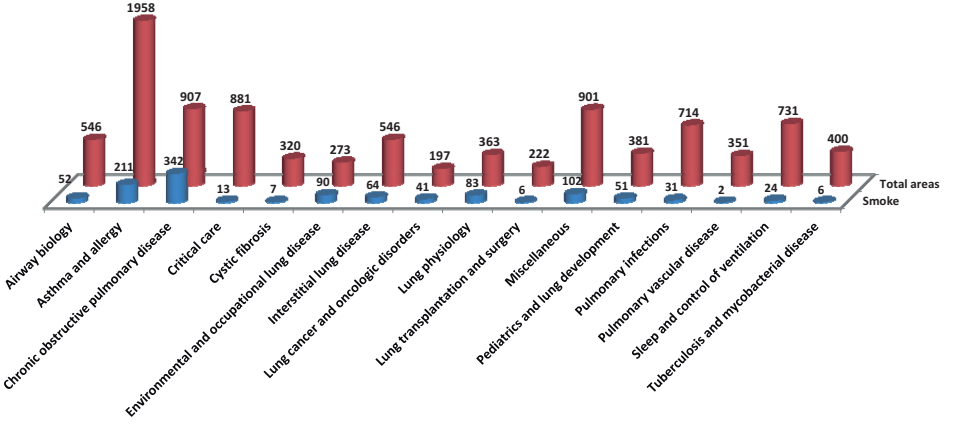


***Figure 14:** Distribution of articles on smoking in different areas*

Table 8 shows the number of articles, citations and the average number of citations per article on smoking by country. There are 51 countries in the originals on smoking being the total of countries in the study of 103. Figure 15 shows the international collaboration of smoking research area (after the

application of a threshold of three or more papers signed). The thickness of the balls allows to identifying the countries that have a greater participation, for example the United States has participated in 510 articles, whereas the United Kingdom does in 170.

***Table 8**: Distribution of articles on smoking by country*

Country	Number of articles	Cites	Cites per article
Australia	42	2349	55,9
Austria	31	2488	80,3
Bangladesh	8	512	64
Belgium	1	19	19
Brazil	33	1163	35,2
Bulgary	2	326	163
Canada	1	111	111
Chile	139	8675	62,4
China	2	92	46
Costa Rica	12	914	76,2
Czech Republic	1	6	6
Denmark	39	3670	94,1
Ecuador	1	13	13
Egypt	2	53	26,5
Estonia	3	195	65
Finland	1	53	53
France	60	3949	65,8
Germany	510	22719	44,5
Greece	2	251	125,5
Hungary	11	802	72,9
Iceland	57	3445	60,4
India	7	610	87,1
Ireland	4	240	60
Israel	1	45	45
Italy	5	267	53,4
Japan	10	567	56,7
Macedonia	3	173	57,7
Malawi	77	6585	85,5
Malaysia	48	3488	72,7
Mexico	1	240	240
New Zealand	2	112	56
Norway	1	3	3
Poland	11	704	64
Qatar	25	1412	56,5
Romania	8	609	76,1
Russia	90	5469	60,8
Singapore	4	219	54,8

Country	Number of articles	Cites	Cites per article
Slovakia	1	1	1
Slovenia	170	13579	79,9
South Africa	3	195	65
South Corea	17	939	55,2
Spain	2	84	42
Sweden	3	113	37,7
Switzerland	3	210	70
Taiwan	2	153	76,5
Thailand	53	3365	63,5
The Netherlands	23	1653	71,9
Trinidad and Tobago	1	11	11
Turkey	8	416	52
United Kingdom	1	171	171
United States	2	335	167,5
Total	1544	93773	60,7

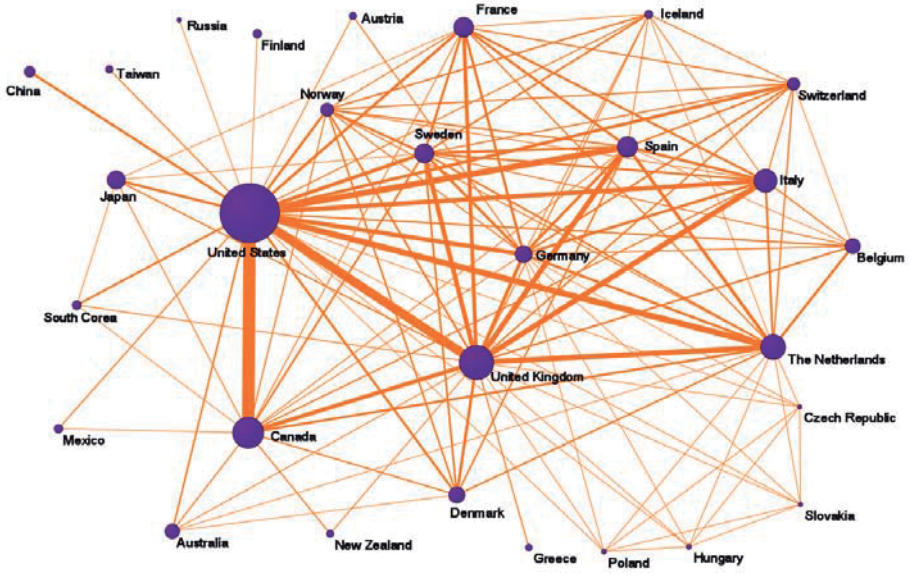


Figure 15: *International collaboration in smoking area as represented by the main clusters of countries after the application of a threshold of three or more papers signed*

The list of the articles on smoking research that received the highest numbers of citations (on the date of download) is shown in Table 9.

Tabla 9: *Manuscritos con mayor número de citas sobre investigación en tabaquismo (hot papers)*

Authors	Title	AJRCCM	Cites ISI
Hankinson, JL; Odencrantz, JR; Fedan, KB	Spirometric reference values from a sample of the general US population	1999; 159(1): 179-187	1865
Pope, CA; Thun, MJ; Namboodiri, MM; Dockery, DW; Evans, JS; Speizer, FE; Heath, CW	Particulate air-pollution as a predictor of mortality in a prospective-study of us adults	1995; 151(3): 669-674	1643
Keatings, VM; Collins, PD; Scott, DM; Barnes, PJ	Differences in interleukin-8 and tumor necrosis factor-alpha in induced sputum from patients with chronic obstructive pulmonary disease or asthma	1996; 153(2): 530-534	873
Peters, A; Wichmann, HE; Tuch, T; Heinrich, J; Heyder, J	Respiratory effects are associated with the number of ultrafine particles	1997; 155(4): 1376-1383	777
Pizzichini, E; Pizzichini, MMM; Efthimiadis, A; Evans, S; Morris, MM; Squillace, D; Gleich, GJ; Dolovich, J; Hargreave, FE	Indices of airway inflammation in induced sputum: Reproducibility and validity of cell and fluid-phase measurements	1996; 154(2): 308-317	650
Schols, AMWJ; Slangen, J; Volovics, L; Wouters, EFM	Weight loss is a reversible factor in the prognosis of chronic obstructive pulmonary disease	1998; 157(6): 1791-1797	551
Duran, J; Esnaola, S; Rubio, R; Iztueta, A	Obstructive sleep apnea-hypopnea and related clinical features in a population-based sample of subjects aged 30 to 70 yr	2001; 163(3): 685-689	523
Jatakanon, A; Uasuf, C; Maziak, W; Lim, S; Chung, KF; Barnes, PJ	Neutrophilic inflammation in severe persistent asthma	1999; 160(5): 1532-1539	480
Rahman, I; Morrison, D; Donaldson, K; MacNee, W	Systemic oxidative stress in asthma, COPD, and smokers	1996; 154(4): 1055-1060	474
Landbo, C; Prescott, E; Lange, P; Vestbo, J; Almdal, TP	Prognostic value of nutritional status in chronic obstructive pulmonary disease	1999; 160(6): 1856-1861	459
Saetta, M; Di Stefano, A; Turato, G; Facchini, FM; Corbino, L; Mapp, CE; Maestrelli, P; Ciaccia, A; Fabbri, LM	CD8+ T-lymphocytes in peripheral airways of smokers with chronic obstructive pulmonary disease	1998; 157(3): 822-826	441
Jeffery, PK	Remodeling in asthma and chronic obstructive lung disease	2001; 164(10): S28-S38	436
Benayoun, L; Druilhe, A; Dombret, MC; Aubier, M; Pretolani, M	Airway structural alterations selectively associated with severe asthma	2003; 167(10): 1360-1368	434
OShaughnessy, TC; Ansari, TW; Barnes, NC; Jeffery, PK	Inflammation in bronchial biopsies of subjects with chronic bronchitis: Inverse relationship of CD8(+) T lymphocytes with FEV(1)	1997; 155(3): 852-857	429
Swensen, SJ; Jett, JR; Sloan, JA; Midthun, DE; Hartman, TE; Sykes, AM; Aughenbaugh, GL; Zink, FE; Hillman, SL; Noetzel, GR; Marks, RS; Clayton, AC; Pairolero, PC	Screening for lung cancer with low-dose spiral computed tomography	2002; 165(4): 508-513	426
King, TE; Tooze, JA; Schwarz, MI; Brown, KR; Cherniack, RM	Predicting survival in idiopathic pulmonary fibrosis: Scoring system and survival model	2001; 164(7): 1171-1181	423
Christ-Crain, M; Stolz, D; Bingisser, R; Muller, C; Miedinger, D; Huber, PR; Zimmerli, W; Harbarth, S; Tamm, M; Muller, B	Procalcitonin guidance of antibiotic therapy in community-acquired pneumonia a Randomized trial	2006; 174(1): 84-93	418
Arcasoy, SM; Christie, JD; Ferrari, VA; Sutton, MS; Zisman, DA; Blumenthal, NP; Pochettino, A; Kotloff, RM	Echocardiographic assessment of pulmonary hypertension in patients with advanced lung disease	2003; 167(5): 735-740	417
Peker, Y; Hedner, J; Norum, J; Kraiczi, H; Carlson, J	Increased incidence of cardiovascular disease in middle-aged men with obstructive sleep apnea - A 7-year follow-up	2002; 166(2): 159-165	405

4. DISCUSSION

The most relevant findings of our study are the increase in the level of international collaboration and the expansion of collaboration networks to represent nearly the entire world. The percentage of articles produced through international collaboration has quadrupled during the analyzed period and now accounts for almost half of the manuscripts published in recent years. This growth rate is consistent with that reported for science in general, although it is somewhat superior. Since the beginning of the century, global spending on research and development has nearly doubled, and the number of scientific publications has grown by almost one third (13). In parallel with the growth and spread of science, there has been an enormous increase in international scientific collaboration. Today, fewer than 26% of papers are the product of one institution alone, and for more than one third, multiple nationalities are represented among their authorship (13) (14).

Another important aspect of our study is the finding that manuscripts produced through collaboration have received a greater number of citations than manuscripts from a single country; that is, international collaboration increases the impact of research. This finding is also consistent with previous reports, which describe a positive correlation between the number of countries involved in an article and the number of citations received (8,15). However, although it is known that scientific collaboration among countries increases research impact, this increase in impact is not the same for all collaborating countries. In fact, although collaboration generally leads to an increase in citations, some countries receive greater increases in citations than others, and the latter tend to be countries that had already shown high impact in the past (15) (16). Moreover, some authors have found that a higher citation rate does not always indicate a higher quality of work (17), and not all citations have the same value in all collaboration networks but rather vary in value between thematic areas and affiliation sectors (18).

Various approaches have been used to analyze international collaboration on scientific articles, but none of them has been able to fully explain its rapid growth. Applying network analysis tools reveals that the growth of international collaboration can be explained based on the principle of the preferential organization of files as expressed by the Barabási-Albert model (19), which states that the nodes in a collaboration network that already

have many connections will be preferentially chosen by new research groups for the initiation of scientific collaboration (20,21); that is, a node rich in connections (collaborations) will increase in influence more quickly because of its role as a leader in that field. This model might be applicable to the AJRCCM by virtue of its sustained leadership in the respiratory system field. It is recognized that a high citation ratio is related to greater numbers of authors and institutions participating in a work, and therefore, authors who are better able to collaborate and manage these relationships obtain better final results (22), being better able to identify researchers with similar interests with whom to formalize contacts and thus to expand their existing networks (23,24). Although some authors doubt its value (17), scientific collaboration is generally acknowledged to accelerate research while increasing its quality (25) (26) (positive collaboration) and is therefore considered fundamental for scientific progress, since it enables the sharing of resources, the compensation of shortcomings and the promotion of synergies to gain the necessary knowledge.

The most productive thematic area in the AJRCCM has been asthma and allergy, followed by COPD, critical care, and sleep and control ventilation. During the analyzed years, however, the level of output related to asthma and allergy has experienced a sharp decline, whereas those related to COPD and critical care have increased. The predominance of the asthma area in the last years of the 20th century has been previously recognized. In a study of the worldwide research output related to the respiratory system between 1996 and 2001, Rippon et al. (3) identified the area of asthma as the most productive, followed by cancer and respiratory diseases in children. Other studies have identified the areas with the greatest impact during this period as those of COPD and asthma (27) (28).

As previously mentioned, there is a positive relationship between productivity and scientific collaboration (7). The analysis of this relationship among the different areas covered by the AJRCCM could be considered to show a disagreement with this general principle, since of the thematic areas with high international collaboration (tuberculosis and mycobacterial disease, airway biology, COPD and cystic fibrosis), only COPD is among the most productive. However, it is necessary to consider that the scientific output of a thematic area also depends on other aspects, such as the relative size of the critical mass of researchers involved in a given area or the available funding. Another interesting aspect of the collaboration analysis by thematic

area is the very low level of international collaboration in the area of sleep and control of ventilation, although there is already evidence of incipient relationships between the USA, Australia, Canada, Spain and France. This finding is consistent with previous reports. In an analysis of the worldwide research output concerning sleep apnea between 1991 and 2006, Huang et al. (29) found that the productivity increased significantly and demonstrated that the level of international collaboration also increased, with the USA and Canada being the highest producers and also those with the greatest numbers of articles produced through international collaboration. In parallel, Huamani et al. (30) analyzed scientific investigations of sleep apnea between 1991 and 2012 using the Scopus database and found a significant increase in output, with the USA and Canada being the main producers, whereas the countries with the greatest numbers of scientific collaborations were the USA, Germany and Canada.

Although it is acknowledged to have limitations, the number of citations received by a paper in other published scientific documents is typically used to gauge the impact or visibility of papers among the international community (31). In this study, the areas with the highest citation index values were found to be COPD, sleep and control of ventilation, interstitial lung disease, asthma and allergy, environmental and occupational lung disease, and critical care. Although there may not be an exact equivalence between the number of citations of an article published in a journal and its relevance, usefulness or availability, it can be assumed that references to articles, and therefore to journals, do reflect these characteristics to some extent, such that a greater number of citations indicates greater interest in a journal and, in turn, its subject area and the articles published in it. Smith LC (32) identified several limitations of the citation index, such as fluctuations in the counting of citations between one year and another and variations among different thematic areas. Nevertheless, even considering these limitations, our results seem to indicate the predominance in importance of certain areas over time (COPD between 1995 and 2004 and interstitial lung disease from 2005 to 2014).

In addition to the citation index, numerous other indices are available for measuring the impact or repercussions of the various journals published in the field of biomedicine (33). A very popular alternative is the h index, which aims to simultaneously measure the quality and quantity of scientific output. In the words of Hirsch himself, it is a better indicator of quality than those that tabulate the number of works, total number of citations, number of

citations per work or number of citations of the works most cited (34). Of the six journals with the greatest impact in the respiratory system field in 2015, the AJRCCM received the greatest number of citations and, importantly, also had the highest h index (h index: 75), which is a comprehensive measure of its trajectory and quality.

Currently, it is indisputable that smoking and its related subjects have gained importance over the last few decades, which has sparked great interest and resulted in an increase in the production of scientific studies in the different active lines of research. Smoking is multidisciplinary, and therefore there is a great variety of medical specialists and those of other healthcare and non-healthcare disciplines, centers and institutions working on the subject. There is therefore a great dispersion of studies and lines of research, keeping in mind that smoking research is included in almost all those areas that have increased their production in biomedicine and the health sciences (7). Those areas included in the Blue Journal that have most participated with smoking articles have been COPD, environmental and occupational lung disease, lung physiology and lung cancer and oncologic disorders, being these same areas those that have received a greater number of cites highlighting instead the areas sleep and control ventilation, pulmonary vascular diseases, environmental and occupational lung disease and COPD when we analyze the number of citations per article.

It can be seen how the smoking area on Blue Journal presents a well-established consolidated network of collaboration. The growth of international collaboration is recognized as an important factor in attracting citations and it increases the number of citations per article (35,36). As we can see in the network on smoking research on Blue Journal there are two large centralized nodes corresponding to the United States and Great Britain and it is known that international collaboration has greater growth between those nodes that already have many connections, which, due to their role as leader in the field, will be chosen preferentially by new research groups to initiate scientific collaboration (19,22). Thanks to the centre–periphery assignation model, it is possible to identify the most influential and better- connected specialties, being a clear indicator of prestige, influence and accessibility. In a study whose objective it was to analyze the relationship between the citation rate and the extension of scientific collaboration as well as to analyze the number of authors/article and the number of institutions/ article, Figg et al. (22) found that more citations are generated when the numbers of

authors and institutions are greater in a study. They also concluded that those authors who collaborate more and manage better these relationships obtain better final results. Hou et al. (37) found a positive and significant correlation between the production of an author and centrality, revealing that the most productive authors are also active in collaboration networks. The importance of establishing scientific networks has been recognized in order to increase efficiency and reduce redundancy in research, challenging researchers to make contacts and identify other authors with similar interests in order to widen their existing networks (8).

4.1. Limitations of the study

This study has several limitations that should be considered. First, it was not our intention to measure the quality of articles published in the AJRCCM. We have only presented data related to content and changes in content over time. Second, although we used a comprehensive coding system, we were still limited in terms of the information captured. Third, the main methodological limitation of the study is that the databases used often exhibit significant quality fluctuations, either because the authors themselves do not always sign their work in the same way or because of errors or a lack of uniformity at the time of the processing of the information. It should be noted that an exhaustive and complete view of the groups and research related to the respiratory system must consider the works published in all related scientific publications as well as all studies collected in multidisciplinary journals or those with other specialties, whereas our only intention was to analyze this single important journal, which we believe is generally representative of research on the respiratory system.

5. CONCLUSIONS

In conclusion, the extent of international collaboration among the authors of the Blue Journal has increased significantly over the past 23 years, with two main nodes centered in North America and Europe, although notable changes in the evolution of collaboration networks have occurred. Moreover, significant changes in output, collaboration networks and impact in terms of citations received among the different thematic areas covered by the journal have been identified. Research in smoking through the Blue Journal is active while maintaining a cohesive collaboration and significant impact.

6. REFERENCES

1. American Thoracic Society. ATS Journals. About the AJRCCM. [Accessed 23th, February 2017] Avaiblable from: http://www.atsjournals.org/page/ajrccm/about

2. Moed HF, de Bruin RE, Nederhof AJ, van Raan AFJ, Tijssen RJW. State of the art of bibliometric macroindicators. An overview of demand and supply. Commission of the European Community. Luxemburg, European Community Official Publications Office, 1992.

3. Rippon I, Lewison G, Partridge MR. Research outputs in respiratory medicine. Thorax 2005;60:63-67.

4. García-Río F, Serrano S, Dorgham A, Alvarez-Sala R, Ruiz Peña A, Pino JM, Alvarez-Sala JL, Villamor J. A bibliometric evaluation of European Union research of the respiratory system from 1987-1998. Eur Respir J 2001;17:1175-1180.

5. Tacon CE, Abbas H, Zhang S, Nicholls B, Crater G, Su Z. Trends in Canadian respiratory clinical trials from 2001 to 2011. Can Respir J 2014;21:181-184.

6. González Alcaide G, Gómez Ferri J. La colaboración científica: principales líneas de investigación y retos de futuro. Revista Española de Documentación Científica. 2014;37:e062. doi: http://dx.doi.org/10.3989/redc.2014.4.1186

7. Granda Orive JI, Villanueva Serrano S, Aleixandre Benavent R, Valderrama Zurían JC, Alonso Arroyo A, García Río F, et al. World-wide collaboration among medical specialties in smoking research: production, collaboration, visibility and influence. Research Evaluation. 2009;18:3-12.

8. Granda Orive JI, Villanueva Serrano S, Aleixandre Benavent R, Valderrama Zurían JC, Alonso Arroyo A, García Río F, et al. Network of international scientific collaboration on smoking: analysis of coauthorship through the Science Citation Index (1999-2003). Gac Sanit. 2009;23:222.e34-e43.

9. Glänzel W. Bibliometrics as a research field. A course on theory and application of bibliometric indicators. Course Handouts. [Accessed:

10th, February 2017]. Available: http://nsdl.niscair.res.in/jspui/bitstream/123456789/968/1/Bib_Module_KUL.pdf

10. Camí J. Impactolatría: diagnóstico y tratamiento. Med Clin (Barc). 1997;109:515-24.

11. Garfield E. How can impact factor be improved? BMJ 1996;313:411-413.

12. Li L, Catalá-López F, Alonso-Arroyo A, Tian J, Aleixandre-Benavent R, Pieper D, et al. The Global Research Collaboration of Network Meta-Analysis: A Social Network Analysis. PLoS One. 2016 Sep 29;11(9):e0163239. doi: 10.1371/journal.pone.0163239.

13. Knowledge, networks and Nations. Global Scientific collaboration en de 21th century. The Royal Society 2011. [Accessed 23th, February 2017] Available in https://www.snowballmetrics.com/wp-content/uploads/4294976134.pdf

14. Newman MEJ. Coauthorship networks and patterns of scientific collaboration. PNAS. 2004; 101:5200-5.

15. Guerrero Bote VP, Olmeda Gómez C, Moya Anegón F. Quantifying the benefits of international scientific collaboration. J Am Soc Inf Sci Technol. 2013;64:392-404.

16. Lancho Barrantes BS, Guerrero Bote VP, Moya Anegón F. Citation increments between collaborating countries. Scientometrics. 2013;94:817-31.

17. Bornmann L. Is collaboration among scientists related to the citation impact of papers because their quality increases with collaboration? An analysis based on data from F1000Prime and normalized citation scores. [Accessed 25th, February 2017] Available in: https://arxiv.org/ftp/arxiv/papers/1602/1602.00419.pdf

18. Sooryamoorthy, R. Do types of collaboration change citation? Collaboration and citation patterns of South African science publications. Scientometrics. 2009;81:177. doi:10.1007/s11192-009-2126-z.

19. Barabási AL, Albert R. Emergente of scaling in random networks. Science. 1999;286:509-11.

20. Scharnhorst A. Complex networks and web: insights from non linear physics. JCMC [Electronic journal]. 2003;8 [Accessed 26th February, 2017].

Available in: http://onlinelibrary.wiley.com/doi/10.1111/j.1083-6101.2003.tb00222.x/full

21. Wagner CS, Leydesdorff L. Networks structure, self-organization, and the growth of international collaboration in science. Res Policy. 2005;34:1608-18.

22. Figg WD, Duna L, Liewehr DJ, Steinberg SH, Thurman DW, Barrett JC, et al. Scientific collaboration results in higher citations rates of publisher articles. Pharmacotherapy. 2006;26:759-67.

23. Yu W, Yesupriya A, Wulf A, Qu J, Gwinn M, Khoury MJ. An automatic method to generate domain-specific investigator networks using PubMed abstracts. BMC Med Inform Decis Mak. 2007;7:17.

24. Georghiou L. Global cooperation in research. Res Policy. 1998;27:611-26.

25. Teasley S, Wolinsky S. Communication. Scientific collaborations at a distance. Science. 2001;292:2254-5.

26. Collins FS, Patrinos A, Jordan E, Chakravarti A, Gesteland R, Walters L. New goals for the US Human Genome Project: 1998–2003. Science. 1998;282:682-9.

27. Seriwala HM, Khan MS, Shuaib W, Shah SR. Bibliometric analysis of the top 50 cited respiratory articles. Expert Rev Respir Med. 2015;9:817-24.

28. Michalopoulos A, Falagas ME. A Bibliometric Analysis of Global Research Production in Respiratory Medicine. CHEST. 2005;128:3993-8.

29. Huang CP. Bibliometrics analysis of obstructive sleep apnea research trends. J Chin Med Assoc. 2009;72:117-23.

30. Huamaní C, Rey de Castro J, González-Alcaide G, Polesel DN, Tufik S, Andersen ML Scientific research in obstructive sleep apnea syndrome: bibliometric analysis in SCOPUS, 1991-2012. Sleep Breath. 2015;19(1):109-14.

31. Granda-Orive JI, Alonso-Arroyo A, García-Río F, Villanueva-Serrano S, Pandiella A, Aleixandre-Benavent R. Scientific literature among smoking and respiratory system: repercussion and collaboration. Arch Bronconeumol. 2013;49:282-8.

32. Smith LC. Citation Analysis. [Accessed 24th, February 2017]. Available: https://www.ideals.illinois.edu/bitstream/handle/2142/7190/?sequence=1

33. Bollen J, Van de Sompel H, Hagberg A, Chute R. A principal component analysis of 39 scientific impact measures. PLoS ONE. 2009;4(6). [Accessed 24th, February 2017]. Available: http://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0006022

34. Hirsch JE. An index to quantify an individual´s scientific research output. Proc Natl Acad Sci U S A. 2005;102(46):16569-7.

35. Glänzel W, Schubert A, Czerwon HJ. A bibliometric analysis of international scientific cooperation of the European Union (1985-1995). Scientometrics.1999;45:185-202.

36. Narin F, Stevens K, Whitlow ES. Scientific cooperation in Europe and the citation of multinationally authored papers. Scientometric. 1991;21:313-23.

37. Hou, H., Kretschmer, H. & Liu, Z. Scientometrics. 2008;75:189. doi:10.1007/s11192-007-1771-3.


AJUNTAMENT DE VALENCIA
REGIDORIA DE SANITAT, SALUT I ESPORTS


ingenio
CSIC-UPV
Instituto de gestión de la innovación
y del conocimiento


PLAN MUNICIPAL DE
DROGODEPENDENCIAS


IdiPAZ
Instituto de Investigación
Hospital Universitario La Paz


UPCCA
VALÈNCIA


UAM
UNIVERSIDAD AUTONOMA
DE MADRID


VNIVERSITAT
DE VALÈNCIA


UNIVERSIDAD COMPLUTENSE
MADRID


CSIC


SaludMadrid
Hospital Universitario
12 de Octubre


UISYS
Unidad de Información e
Investigación Social y Sanitaria


i+12
Instituto de Investigación
Hospital 12 de Octubre