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Original Article

Comparison Between Two Five Year Periods (1998/2002 and 2003/2007) on the Production, Impact and co-Authorship of Publications on Tobacco and Smoking by Spanish Authors Using the Science Citation Index

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ABSTRACT

Objective: The aim of this study was to compare the production, impact and co-authorship of publications by Spanish authors on smoking and tobacco between two time periods (1998/2002 vs. 2003/2007) using Science Citation Index (SCI).
Methods: The literature search was performed in the SCI-Expanded on 20 November 2008. All types of documents by Spanish authors were selected. The search was restricted to the title, and the key words used were "smok*" and "tobac*". The statistical analysis was descriptive (95% CI).
Results: A total of 588 documents were retrieved, with 399 (67.85%) original papers, 54 (9.18%) letters to the editor and 35 (5.95%) editorials. Productivity increased from the 98/02 to the 03/07 period: 234 (39.8%) documents versus 354 (60.2%), respectively. We have found significant differences between the two periods (98/02 vs. 03/07) in total mean annual documents (47 ± 8 vs. 71 ± 16 [p = 0.024]) and total mean annual original papers (34 ± 6 vs. 46 ± 9 [p = 0.041]). The mean number of citations per document was 14.1 ± 2.1 for the 98/02 period and 5.6 ± 2.5 for the 03/07 period (p = 0.003). The co-authorship annual index had increased, with a mean of 6.77 signatures/document for the 98/02 period to a mean of 6.87 for the 03/07 period. Author and institution network collaborations had increased from one period to the next.
Conclusions: Spanish scientific production and co-authorship of documents on smoking and tobacco have increased from one period to the next. The documents from the earlier period receive more citations.

Comparación entre dos quinquenios (1998/2002 y 2003/2007) de la producción, repercusión y colaboración en tabaquismo de autores españoles a través del Science Citation Index

Palabras clave:
Tabaquismo
Bibliometría
Redes de colaboración
Publicaciones científicas

RESUMEN

Objetivo: El objetivo ha sido comparar entre dos quinquenios (1998 a 2002 con 2003 a 2007) la producción, repercusión y la colaboración de artículos sobre tabaquismo de autores españoles a través del Science Citation Index (SCI).
Método: La búsqueda se realizó en el SCI Expanded. Fueron seleccionados todos los tipos de documentos y la búsqueda se restringió al "título"; palabras clave: "smok*" y "tobac*".

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Resultados: Fueron un total de 588 artículos, de los que 399 (67,85%) fueron originales, 54 (9,18%) cartas al director y 35 (5,95%) editoriales. La producción ha crecido, pasando de 234 (39,8%) documentos (98/02) a 354 (60,2%) en 03/07. Al comparar la media anual del total de artículos por quinquenios 98/02 vs. 03/07 (47 ± 8 vs. 71 ± 16 [p = 0,024]) la diferencia es significativa, igual que si comparamos las medias anuales por quinquenios de los originales (34 ± 6 vs. 46 ± 9 [p = 0,041]). La media de citas/trabajo por quinquenios fue de 14,1 ± 2,1 para 98/02 y del 5,6 ± 2,5 para 03/07 (p = 0,003). El índice de colaboración anual aumentó, pasando la media de 6,77 firmas/trabajo en 98/02 a 6,87 firmas/trabajo en 03/07. Ha aumentado el número de redes de colaboración de instituciones y autores.

Conclusiones: Tanto la producción científica como la colaboración entre autores e instituciones han aumentado en el periodo estudiado. Son los artículos más antiguos los que más citas tienen.

Introduction

Smoking is the main health-care problem of the western societies. It is a growing, multi-disciplinary field of study, resulting in a great dispersion in studies and lines of research, taking into account that it is included in almost all those areas that have experienced the greatest increases in bioscience and healthcare science production.[1]

Bibliometrics can be defined as the science that deals in the treatment and study of quantitative data from scientific publications, employing bibliometric indicators.[2] In addition, it includes social network analysis (SNA), which identifies the groups or institutions of a specific discipline or knowledge area.[3]

Several bibliometric studies have been published over the last few years about biomedicine,[4-6] the respiratory system,[7-9] and smoking.[1,10-13] The conclusion of all of these could be summarized as the important growth that science has experienced both as a whole and in different specific topic areas.

The objective of this study was to compare the scientific production, impact of the articles in the scientific literature and collaboration among authors and institutions of the articles on smoking by Spanish authors through the Science Citation Index (SCI). The time period studied was from 1998 to 2007, divided into two five-year study periods (1998 to 2002, and 2003 to 2007).

Material and Methods

Bibliographic Search

The bibliographic search was carried out with SCI Expanded through the Web of Knowledge platform (Thomson Reuters), on 20 November, 2008. The search strategy keywords were "smok*" OR "tobac*", based on a previous article.[14] The search was done using the "title" field to avoid retrieving non-pertinent entries. In the "address" field, we selected the term "Spain" in order to retrieve studies that included at least one Spanish author. The research period was limited to 1998-2007 and included all document types. We searched all the available abstracts of the entries in order to discern exactly what type of document they were. All the entries retrieved were manually examined by two researchers of our group in order to guarantee their pertinence. In those cases where there was some discrepancy between the examiners, or the article had no abstract available, the complete article was accessed and reviewed for proper classification.

Data Collection and Variables Analyzed

For each article recovered, the following variables were registered: year of publication, title, authors, institutional affiliation, country, specialty of the authors, topic subareas (according to the topic categories of the Journal Citation Report [JCR]), journal, journal language, document type, co-authorship and number of citations received.

Data Homogenization

The resulting database was processed using Microsoft Access® 2003 (Microsoft, Redman, Washington, USA), and we then manually filtered and homogenized the data for the different institutions and authors in the SCI Expanded in order to avoid one same institution or author from appearing with two or more variations.

Bibliometric Indicators

The bibliometric indicators used were: number of scientific agents, productivity per year, language, journal, topic subarea, document type, specialty of the authors, and institutions, as well as the number of citations received per year; the number of countries, citation analysis (total number of citations received, percentage of the total citations received and citations/article index). In addition, we analyzed the bibliometric transaction matrices and these were represented graphically (bibliometric map), studying the basic measurements of centrality (whose basic concepts have been previously explained[10]), using the following co-authorship indicators: inter-institutional and co-author collaboration.

Bibliometric Transaction Matrices

Once the database was filtered and homogenized, we selected articles on smoking that showed collaboration between different institutions and authors.

With the data obtained, one-mode symmetric co-occurrence matrices were elaborated, connected to the corresponding attribute matrices and defining the relationship between institutions and authors as "collaboration or co-authorship in one same scientific article". Bibliometric maps were created, which allowed the networks to be visualized. The intensity of the connection between institutions and authors was quantified in order to consider only consolidated relationships. The networks present the degree of connection between authors and institutions by numbers (of collaboration documents) that link the nodes. For all graphic representations, we used the Pajek network visualization and analysis program (http://pajek.imfm.si/doku.php).

Statistics

The statistical analysis was carried out with the Statistical Package for the Social Sciences program (SPSS, Inc., Chicago, Illinois, USA), version 11.0. The analysis was descriptive. The data are shown as means plus standard deviation, applying the Student's t test to compare the means of two groups for a continuous quantitative variable. Significance level was $p < 0.05$ (confidence interval 95%).

Table 1
Documents by type and annual distribution

	Annual distribution by document type										
Publication type	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total
Original	33	26	30	43	36	36	50	45	40	60	399
Corrections			1			1			1	1	4
Editorial	1	2	2	3	1	2	6	8	3	7	35
Letters	4	4	3	5	7	4	9	5	9	4	54
Conference Communications	1	7	4	3	8	2	3	8	20	12	68
New articles								1	1	1	3
Procedures	1	4		1	1	1	2			1	11
Reviews	1				2		3	3	1	4	14
TOTAL	41	43	40	55	55	46	73	70	75	90	588

Results

Production

A total of 588 documents were recovered in the period studied. Table 1 shows the breakdown by document type as well as the annual distribution by document type, observing a clear increase over time of original articles and decrease in medical conference communications, maintaining an undefined tendency in the remainder. Most of the manuscripts were original articles (399 in total, 67.85%), followed by letters to the editor (54, 9.18%) and editorials (35, 5.95%). When we distributed the articles by five-year periods, we observed the same ascending trend, going from 234 (39.8%) articles in the 1998/2002 five-year period to 354 (60.2%) in the 2003/2007 five-year period. When the annual average of total articles was compared by five-year periods (i.e. 1998/2002 vs. 2003/2007), a significant different was obtained (47 ± 8 versus 71 ± 16; p = 0.024). Likewise, when comparing the annual average of original articles between five-year periods (i.e. 1998/2002 vs. 2003/2007) the differences found were significant (34 ± 6 vs. 46 ± 9; p = 0.041). Out of the total number of documents, 448 (76.19%) were written in English, 137 (23.29%) in Spanish and 0.34% and 0.17% in French and German, respectively. The documents were published in a total of 233 journals, 12 of which are published in Spain, with a total of 141 (23.97%) papers (table 2). In the same manner, the production of articles published in Spanish journals increased between the five-year periods analyzed, going from 52 (36.88%) documents in the 1998/2002 period to 89 (63.12%) in the 2003/2007 period. When the annual average of national journals was compared between five-year periods, the differences were not significant (10 ± 5 vs. 18 ± 6; p = 0.073). Although the Spanish journals are the most productive, the foreign journals that stand out for number of articles are: International Journal of Cancer with 16

Table 2
Distribution of the documents published in Spanish journals included in the Science Citation Index

Spanish journals	Number of documents
Medicina Clínica	67
Archivos de Bronconeumología	46
Revista Clínica Española	6
Revista Española de Cardiología	6
Revista de Neurología	5
Atención Primaria	3
Revista Española de Enfermedades Digestivas	3
Nutrición Hospitalaria	1
Enfermedades Infecciosas y Microbiología Clínica	1
Neurología	1
Actas Luso-Españolas de Neurología, Psiquiatría y Ciencias Afines	1
Actas Españolas de Psiquiatría	1
TOTAL	141

Figure 1. Collaboration networks among institutions (≥ de 5 collaborations, 1998/2002).

Table 3
Total number of citations and papers by topic area over the entire period analyzed

Topic areas	Documents	Citations
Medicine, General & Internal	102	638
Public, Environmental & Occupational Health	94	994
Respiratory System	68	371
Plant Sciences	63	613
Oncology	59	1,358
Psychiatry	28	221
Clinical Neurology	24	351
Biochemistry & Molecular Biology	23	306
Peripheral Vascular Disease	20	11
Endocrinology & Metabolism	18	121
Neurosciences	17	177
Pharmacology & Pharmacy	17	121
Cardiac & Cardiovascular Systems	16	60
Food Science & Technology	12	51
Virology	11	111
Cell Biology	10	71
Pediatrics	10	30
Chemistry, Applied	9	42
Nutrition & Dietetics	9	98
Dentistry, Oral Surgery & Medicine	8	112
Immunology	8	20
Obstetrics & Gynecology	8	44
Toxicology	8	53
Biotechnology & Applied Microbiology	7	98
Psychology	7	17
Agriculture, Multidisciplinary	6	19
Gastroenterology & Hepatology	6	4
Health Care Sciences & Services	6	16
Agronomy	5	23
Allergy	5	14
Chemistry, Analytical	5	37
Critical Care Medicine	5	36
Economics	5	38
Environmental Sciences	5	18
Genetics & Heredity	5	26
Health Policy & Services	5	15
Infectious Diseases	5	27
Horticulture	4	22
Psychology, Biological	4	0
Substance Abuse	4	8
Biochemical Research Methods	3	25
Biophysics	3	66
Dermatology	3	14
Engineering, Chemical	3	24
Medicine, Research & Experimental	3	4
Physiology	3	0
Reproductive Biology	3	11
Surgery	3	50
Developmental Biology	2	10
Hematology	2	0
Meteorology & Atmospheric Sciences	2	11
Mycology	2	28
Psychology, Experimental	2	0
Social Sciences, Mathematical Methods	2	19
Statistics & Probability	2	3
Transplantation	2	2
Veterinary Sciences	2	4
Water Resources	2	11
Agricultural Economics & Policy	1	4
Astronomy & Astrophysics	1	12
Chemistry, Multidisciplinary	1	7
Computer Science, Theory & Methods	1	0
Ecology	1	15
Engineering, Biomedical	1	5
Entomology	1	6
Evolutionary Biology	1	15
Geriatrics & Gerontology	1	16
Mathematics, Applied	1	0
Mathematics, Interdisciplinary Applications	1	16
Medical Laboratory Technology	1	6
Microbiology	1	0
Nursing	1	1
Ophthalmology	1	13
Orthopedics	1	14
Otorhinolaryngology	1	4
Psychology, Clinical	1	47
Psychology, Developmental	1	1
Radiology, Nuclear Medicine & Medical Imaging	1	4
Rheumatology	1	0
Soil Science	1	1
Spectroscopy	1	8
Sport Sciences	1	0
Zoology	1	0
TOTAL	800	6,869

documents (2.72%), European Journal of Public Health with 11 (1.87%) and Journal of Epidemiology and Community Health and Journal of Hypertension with 10 documents (1.70%) each. The smoking articles were published in a total of 83 topic areas, the most productive (with more than 50 articles) being: Medicine, General & Internal with 102 documents; Public, Environmental & Occupational Health with 94; Respiratory System with 68; Plant Sciences with 63; and Oncology with 59 (table 3).

Impact Factor

The total number of citations of all the journals over the entire period studied was 5,032 citations/total journals. We found 4 article with more than 100 citations and 165 articles with 0 citations. The total number citations by topic area was 6,869 (index of citations by topic area, table 3). This number of citations does not coincide with the previous number because there are entries linked to various areas, which varies the number of citations. The area of Oncology, with 59 documents, received a total of 1,358 citations (23.01 citations/paper), followed by Biophysics with a citation/paper index of 22, and Surgery with 16.66 citations/paper. Table 4 demonstrates the index of citations per paper and per production year. When we compared the index of citations per paper by five-year period (14.1 ± 2.1 for the 1998/2002 period vs. 5.6 ± 2.5 for the 2003/2007 period [$p < 0.05$]), we found a statistically significant difference.

Co-Authorship

In the 1998/2002 five-year period, there was a total of 1,585 signatures on 234 documents, while in the 2003/2007 period there were 2,433 signatures on 354 documents (table 5). We have found that the annual collaboration index (ACI) has increased over the years analyzed (the year with a greatest ACI was 2002, with 9.49, but this is due to an article published that year with 220 signing authors) going from a mean ACI in the 1998/2002 period of 6.77 to 6.87 in the 2003/2007 period (table 6). Figure 1 shows the bibliometric maps of smoking research collaboration between institutions with 5 or more collaborations in the 1998/2002 period; the same is observed in figure 2 for the 2003/2007 period. As for the co-authorship networks, we have found a total of 14 networks (≥ 3 collaborations) for the 1998/2002 period and 21 networks for the 2003/2007 period. In figure 3, the co-authorship networks can be observed (≥ 3 collaborations) for the 1998/2002 period, and figure 4 shows the co-authorship networks between 2003/2007. Figures 5 (≥ 3 collaborations, 1998/2002) and 6 (≥ 3 collaborations, 2003/2007) represent the main global co-authorship networks for each of the five-year periods.

Discussion

In terms of scientific production, Spain is currently the country with greatest dynamic growth, holding the eleventh place worldwide,[15] with a research progression in both capacity and production that have been without precedent in recent history.[6,16,17] It is also among the top 20 countries with the greatest number of publications and citations.[16] Our study has corroborated this fact in the area of smoking. It has been previously commented1 that the production of

Figure 2. Collaboration networks among institutions (≥ 5 collaborations, 2003/2007).

Figura 3. Co-authorship networks (≥ 3 collaborations) in the 1998/2002 period.

Table 4
Index of citations per paper and per production year

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total
Number of documents	41	43	40	55	55	46	73	70	75	90	588
Number of citations	609	467	740	685	766	500	452	419	233	161	5,032
Citations/ document	14.85	10.86	18.50	12.45	13.93	10.87	6.19	5.99	3.11	1.79	8.56

smoking research in our country is developing adequately in terms of production. The prior study only incorporated the perspective of a five-year period. Now, however, after having added another five-year period to the study, we can now affirm that there is a clear upward trend, as the number of total and original articles from the beginning to the end of the period studied has doubled. The same is true for other scientific disciplines within Spanish production. In the cardiovascular area, Spain has presented a moderate increase in productivity.[18] Likewise, constant growth has been shown in disciplines such as radiology and neuroimaging,[19] respiratory system[7,9] oncology, gastroenterology, surgery and transplantation, internal and general medicine, urology, nephrology and infectious diseases[4] (all included in the ten most productive areas in medicine) as well as bioethics.[20] On the contrary, other disciplines do not present a defined trend, maintaining their stable production, such as dermatology[21] and tuberculosis.[22]

There are several motives that influence the increase in a country's scientific production, among these being wealth, meaning that the nation could financially support research, and the number of inhabitants, meaning that with more inhabitants it is more likely that a greater number of inhabitants would be interested in any given field.[23] Another aspect to take into account is the fact that "research attracts research", thus countries with a tradition of research that offer a well-oiled scientific infrastructure attract new projects. Likewise, one must consider the growing interest of certain scientists in research and what this entails in their professional promotion and projection.[23] In the case of Spanish production in smoking research, and with the limitation of having done a search in only one database, we could say that, based on basic theories of growth in science, Spanish smoking research is still not in a state of saturation, but instead it is growing in knowledge.[24]

In the aforementioned previous study,[1] carried out with the same design as the present study and which analyzed the five-year period from 1999 to 2003, it was found that collaboration studies received a greater number of citations, and are therefore more visible. Likewise, a positive correlation was found between the number of countries that intervened in international collaboration articles and the number of citations that said articles received. Factors associated with a greater number of citations were: the article being published in English, the foreign nationality of the first signing author and the international collaboration of the publication. It is known that the gradual growth of international collaboration in biomedicine and life sciences over the last few years is an important factor in attracting citations.[4,25] Likewise, it has been observed that there is a positive

Table 5
Distribution of documents by number of signing authors, separated by five-year periods

N signatures	Documents 1998-2002	Signatures 1998-2002	Documents 2003-2007	Signatures 2003-2007	Total articles	% articles	Total signatures	% signatures
1	14	14	24	24	38	6.46%	38	0.95%
2	29	58	25	50	54	9.18%	108	2.69%
3	18	54	44	132	62	10.54%	186	4.63%
4	36	144	46	184	82	13.95%	328	8.16%
5	23	115	41	205	64	10.88%	320	7.96%
6	47	282	60	360	107	18.20%	642	15.98%
7	25	175	26	182	51	8.67%	357	8.89%
8	10	80	25	200	35	5.95%	280	6.97%
9	6	54	11	99	17	2.89%	153	3.81%
10	4	40	12	120	16	2.72%	160	3.98%
11	3	33	5	55	8	1.36%	88	2.19%
12	3	36	7	84	10	1.70%	120	2.99%
13	3	39	2	26	5	0.85%	65	1.62%
14	–	–	4	56	4	0.68%	56	1.39%
15	3	45	–	–	3	0.51%	45	1.12%
16	1	16	2	32	3	0,51%	48	1.19%
17	2	34	2	34	4	0.68%	68	1.69%
18	1	18	2	36	3	0.51%	54	1.34%
19	1	19	1	19	2	0.34%	38	0.95%
20	–	–	2	40	2	0.34%	40	1.00%
22	–	–	1	22	1	0.17%	22	0.55%
23	1	23	–	–	1	0.17%	23	0.57%
25	–	–	2	50	2	0.34%	50	1.24%
26	1	26	–	–	1	0.17%	26	0.65%
27	1	27	–	–	1	0.17%	27	0.67%
32	–	–	1	32	1	0.17%	32	0.80%
33	1	33	1	33	2	0.34%	66	1.64%
34	–	–	1	34	1	0.17%	34	0.85%
36	–	–	1	36	1	0.17%	36	0.90%
37	–	–	1	37	1	0.17%	37	0.92%
44	–	–	2	88	2	0.34%	88	2.19%
46	–	–	1	46	1	0.17%	46	1.14%
47	–	–	1	47	1	0.17%	47	1.17%
70	–	–	1	70	1	0.17%	70	1.74%
220	1	220	–	–	1	0.17%	220	5.48%
TOTAL	234	1,585	354	2,433	588	100%	4,018	100%

Figure 4. Co-authorship networks (≥ 3 collaborations) in the 2003/2007 period.

correlation between the number of authors per document and the number of citations received.[26] As can be seen in table 5, when we compared both five-year periods of this present study, there was an important increase in the number of signing authors per article in the last five years analyzed.

One of the interesting aspects of the SNA is its powerful analytical and interpretive capabilities derived from its graphic representations.[27,28] In our study, when we compare the co-authorship networks between institutions (≥ 5 colaboraciones) in the 1998/2002 period (fig. 1) with the 2003/2007 period (fig. 2), it can be clearly and graphically observed that there has been an increase in collaboration networks, going from 2 in the first five-year period (Catalonian with other European institutions, and the Complejo Universitario of Salamanca with the La Princesa Hospital) to three in the second five-year period (an increased number of collaborations of the Catalonian institutions; Complejo Universitario of Salamanca and a specialized smoking unit in Madrid; a solid collaboration in Galicia) with greater cohesion and more participants. The same occurs in the networks between authors, which increases between the two five-year periods analyzed (figs. 3-6). In observing these figures, one can see a positive relationship between productivity and collaboration as the most productive authors (on the linking lines between authors, the number of collaborations are indicated) are those with a greater number of collaborations in the second five-year period, thus increasing their visibility.[29] Therefore, the growth of international collaboration is recognized as an important factor in attracting citations and it increases the number of citations per article.[25,30,31] 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.[32,33] In addition, the most productive authors and institutions participate in various workgroups at the same time, functioning as a link among groups that work in the same field, and there is a positive significant correlation between the production of an author and centrality.[34] Nowadays, 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.[10]

One previously-commented finding[10] that has been reported by other authors in previous studies[35] is that the probability that an article is cited by others is greater in the first few years after its publication. Nevertheless, there are quality studies that continue to

Table 6
Distribution of the annual collaboration index per production year

Year	Number of signatures	Number of documents	Annual collaboration index
1998	208	41	5.07
1999	268	43	6.23
2000	232	40	5.80
2001	355	55	6.45
2002	522	55	9.49
TOTAL	**1,585**	**234**	**6.77**
2003	268	46	5.83
2004	445	73	6.10
2005	476	70	6.80
2006	590	75	7.87
2007	654	90	7.27
TOTAL	2,433	354	6.87
TOTAL 1998-2007	**4,018**	**588**	**6.83**

Figure 5. Main co-authorship network (≥ 3 collaborations) in the 1998/2002 period.

receive increasing numbers of citations over time and do not stabilize after the first 5 years as they continue to be cited even thereafter. In this study, we have observed that there is a statistically significant difference in the number of citations per study between the two five-year periods, favoring the earlier 1998/2002 period. Not all authors, however, have found this same finding. Qiu et al.[13] completed a bibliometric study on smoking research in China from 1991 to 2007, finding a gradual increase in the number of citations per study. This is probably due to the fact that 29.5% of their articles have been done in collaboration. This increase remained more or less stable when the study period was divided into 5 periods of 3 to 5 years, and this percentage is generally recognized as normal in different thriving research settings.[31] Another recognized factor for attracting citations is the specialization of the research instituciones,[31] and perhaps China has increased its specialization as it has clearly progressed in research, innovation and development. Another interesting aspect about citations is that not all research settings have the same possibilities to be cited. This was demonstrated by Harris et al.[36] in a study in which they attempted to understand how public health problems progress from findings in basic scientific research to clinical applications in the population. In doing so, they analyzed the citation networks in passive smoking research and they found that the majority of the most-cited articles dealt in basic clinical research. The authors conclude that there is a lack of cross-citation between the two aspects of science, and the link is deficient between basic research and technological development on the one hand and the clinical applications (translational science) on the other. It is unlikely for a basic research article to cite another on clinical application, whereas it is more likely to cite articles of the same type of research. This former aspect could equally influence an article's receiving more or less citations and could perhaps also explain the Chinese finding. Neither we nor they have analyzed the intrinsic characteristics that favor citations, which needs to be analyzed more thoroughly.

As for the medical specialties that publish articles on smoking, there is a good correlation between production and visibility, and the most productive specialties have greater impact.[11] Likewise, there is a positive correlation between co-authorship and impact, and the specialties, authors or institutions with greater collaboration achieve greater visibility.[10,11] Previous studies have situated certain disciplines or specialties, such as general & internal medicine, as being the most cited and by the greatest number of specialties, which can be explained by their being basic disciplines or by being connected to the clinical practice of many other specialties, as is the case of anesthesiology or surgery.[37] This premise holds true in our study, as the specialties that received more citations/article are essentially general topic areas, such as oncology and surgery, closely followed by general & internal medicine, public, environmental & occupational health and respiratory system.

All the bibliometric aspects provided in this study and in others should be used by politicians responsible for the economic policies of each country to award research grants and enact laws promoting or influencing public health.[38]

The limitations of this study include the database selection, the derivatives of its normalization (for this reason we carried out an exhaustive data-quality control), and finally those related with the time period studied, meaning that the only articles visible to the study were those found in publications that were sourced at that moment in the SCI.

In conclusion, we can affirm that Spanish production in smoking research has increased in the 2003/2007 five-year period when

Figure 6. Main co-authorship networks (≥ 3 collaborations) in the 2003/2007 period.

compared with the 1998/2002 five-year period, and the most widely-used journals for publishing tobacco habit research documents were those published in Spain included in the SCI. We observed that the citations increase over time and that there was a significant difference favoring the 1998/2002 period. The oldest articles are those that received more citations, and citations are dynamic and do not come to a standstill within the periods studied. Co-authorship and collaboration between institutions has increased from one period to the next, and there are established networks with fluid collaboration.

References

1. Granda-Orive JI, García Río F, Aleixandre Benavent R, Valderrama Zurián JC, Jiménez Ruiz CA, Solano Reina S, et al. Producción española en tabaquismo a través del Science Citation Index (1999-2003). Situación en el contexto mundial y de la Unión Europea. Arch Bronconeumol. 2007;43:212-8.
2. Bordons M, Zulueta MA. Evaluación de la actividad científica a través de indicadores bibliométricos. Rev Esp Cardiol. 1999;52:790-800.
3. González Alcaide G, Aleixandre Benavent R, Granda Orive JI. Caracterización bibliométrica y temática de los grupos de investigación de Archivos de Bronconeumología (2003-2007). Arch Bronconeumol. 2010;46:78-84.
4. Camí J, Suñen Piñol E, Méndez Vásquez R. Mapa bibliométrico de España 1994-2002: biomedicina y ciencias de la salud. Informe del Instituto de Salud Carlos III-Fondo de Investigación Sanitaria [accessed 2010 May 10]. Available from: http://www.isciii.es/mapabiomedico.
5. Camí J, Suñen Piñol E, Méndez Vázquez R. Mapa bibliométrico de España 1994-2002; biomedicina y ciencias de la salud. Med Clin (Barc). 2005;124:93-101.
6. Jiménez Contreras E, Moya Anegón FD, Delgado López-Cozaar E. The evolution of research activity in Spain. The impact of National Commission for the Evaluation of Research Activities (CNEAI). Res Policy. 2003;32:123-42.
7. Granda Orive JI, García Río F, Roig Vázquez F, Aleixandre Benavent R, Valderrama Zurían JC, Martínez Albiach JM, et al. Caracterización de las áreas de sistema respiratorio en España. An Med Interna. 2006;23:513-8.
8. García F, Mayoralas S, Dorgham A, Granda JI, Perpiñá M, Casan P, et al. Análisis de repercusión de Archivos de Bronconeumología a través del Science Citation Index. Arch Bronconeumol. 2001;37:465-70.
9. Rippon I, Lewison G, Partridge MR. Reserach outputs in respiratory medicine. Thorax. 2005;60:63-7.
10. Granda Orive JI, Villanueva Serrano S, Aleixandre Benavent R, Valderrama Zurían JC, Alonso Arroyo A, García Río F, et al. Redes de colaboración científica internacional en tabaquismo. Análisis de co-autorías a través del Science Citation Index durante el periodo 1999-2003. Gac Sanit. 2009;23:222.e34-43.
11. 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.
12. García López JA. Bibliometric analysis of Spanish scientific publications in tobacco during the period 1970-1996. Eur J Epidemiol. 1999;15:23-8.
13. Qiu H, Chen YF. Bibliometric analysis of nicotine research in China during the period of 1991-2007. Inhal Toxicol. 2009;21:965-71.
14. Granda-Orive JI, García Río F, Roig Vázquez F, Escobar Sacristán JA, Gutiérrez Jiménez T, Callol Sánchez L. Las palabras clave como herramientas imprescindibles en las búsquedas bibliográficas. Análisis de las áreas de sistema respiratorio a través de Archivos de Bronconeumología. Arch Bronconeumol. 2005;41:78-83.
15. Glänzel W, Leza J, Thies B. Science in Brazil. Part 1: A macro-level comparative study. Scientometrics. 2006;67:67-85.
16. REIST-2. Third European report on science and technology indicators. 2003. European Commission [accessed 2010 May 10]. Available from: http://www.labs-associados.org/docs/3RD_REPO.PDF.
17. Bolaños Pizarro M, Thijs B, Glänzel W. Cardiovascular research in Spain. A comparative scientometric study. Scientometrics. 2010. doi:10.100/S11192-009-0155-2.
18. Aleixandre Benavent R, Alonso Arroyo A, Chorro Gascó FJ, Alonso Manterola FJ, González Alcaide G, Salvador Taboada MJ, et al. Cardiovascular Scientific Production in Spain in the European and global context (2003-2007). Rev Esp Cardiol. 2009;62:1404-17.
19. Bordons M, Murillo F, Fernández MT, Gómez I. Internacionalización de la producción científica en España en Radiología y Neuroimagen (1996-2003). Radiología. 2006;48:137-46.
20. Belinchón I, Ramos JM, Bellver V. La producción científica española en bioética a través de MedLine. Gac Sanit. 2007;21:408-11.
21. Belinchón I, Ramos JM. Producción científica de los servicios de dermatología españoles en revistas internacionales: 1997-2006. Acta Dermosifiliogr. 2008;99:373-9.
22. Ramos JM, Masiá M, Padilla S, García Pachón E, Gutiérrez F. Producción española sobre tuberculosis a través del MEDLINE (1997-2006). Arch Bronconeumol. 2009;45:271-8.

23. DeMaria Anthony. Research productivity among nations. Rev Esp Cardiol. 2009;62:1347-9.
24. Holton G. Models for understanding the growth of research. Thematic origins of scientific thought. Cambridge: Harvard University Press; 1973. p. 415-50.
25. Glänzel W, Schubert A, Czerwon HJ. A bibliometric analysis of international scientific cooperation of the European Union (1985-1995). Scientometrics. 1999;45:185-202.
26. Bridgstock M. The quality of multiple authored papers, an unresolved problem. Scientometrics. 1991;21:37-48.
27. González Alcaide G, Valderrama Zurián JC, Ramos Rincón JM. Producción científica, colaboración y ámbitos de investigación en Enfermedades Infecciosas y Microbiología Clínica (2003-2007). Enferm Infecc Microbiol Clin. 2010;28:509-16.
28. Sanz Menéndez L. Análisis de redes sociales: o cómo representar las estructuras sociales subyacentes. 2003 [accessed 2010 May 21]. Available from: www.iesam.csic.es/doctrab2/dt-0307.pdf.
29. Peñaranda Ortega M, López Serrano R, Quiñones Vidal E, López García JJ. Los "Small Worlds" y el algoritmo de Floyd: una manera de estudiar la colaboración científica. Psicothema. 2006;18:78-83.
30. Narin F, Stevens K, Whitlow ES. Scientific cooperation in Europe and the citation of multinationally authored papers. Scientometric. 1991;21:313-23.
31. Moya Anegón F, Chinchilla Rodríguez Z, Corera Álvarez E, Gómez Crisóstomo R, González Molina A, Muñoz Fernández FJ, et al; Scimago Research Group. Indicadores bibliométricos de la actividad científica española: 1990-2004. Madrid: FECYT; 2007 [accessed 2010 May 21]. Available from: www.scimago.es.
32. Barabasi AL, Albert R. Emergence of scaling in random Networks. Science. 1999;286:509-11.
33. Figg WD, Duna L, Liewehr DJ, Steinberg SH, Thurman DW, Barret JC, et al. Scientific collaboration results in higher citations rates of publisher articles. Pharmacotherapy. 2006;26:759-67.
34. Hou H, Kretschmer H, Liu Z. The structure of scientific collaboration networks in Scientometrics [accessed 2010 May 21). Available from: http://eprints.rclis.org/6101/1/446D95.pdf.
35. Tobin MJ. Thirty years of impact factor and the journal. Am J Respir Crit Care Med. 2004;170:351-2.
36. Harris JK, Luke DA, Zuckerman RB, Shelton SC. Forty years of secondhand smoke research. The gap between discovery and delivery. Am J Prev Med. 2009;36:538-48.
37. González Alcaide G, Bolaños Pizarro M, Villanueva Serrano SJ, Ruiz Ros V, González de Dios J, Granda Orive JI, et al. Medida y evaluación de los flujos de conocimiento interdisciplinario de la medicina clínica española. Papeles Médicos. 2010;19:32-42.
38. Jiménez Ruiz CA, Ruiz Manzano J. La sociedad española de neumología y cirugía torácica. SEPAR ante la nueva ley reguladora del consumo del tabaco en España. Arch Bronconeumol. 2010;46:402-4.