Reumatol Clin. 2009;**5(5)**:197–208

Reumatología Clínica

www.reumatologiaclinica.org

Original Article

A bibliometric approach to the Spanish scientific production on rheumatology during the 1997–2006 period

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ARTICLE INFO

Article history:
Received July 28, 2008
Accepted November 19, 2008
Available online May 22, 2009

Keywords:
Bibliometrics
Rheumatology
Bibliometric analysis

ABSTRACT

Background: Bibliometric studies have shown their usefulness in the evaluation of science. This methodology was adopted for the analysis of Spanish rheumatologic scientific production during 1997–2006.
Methods: Search phrases were constructed for databases (PubMed, Science Citation Index [SCI], Índice Médico Español [IME]). The analysis was based on the results of SCI with bibliometric indicators for scientific production, collaboration, type of document, times cited and the measure of impact factor (FI).
Results: The scientific production in Spanish rheumatology recovered 602 documents in PubMed, 1073 in ISI, 627 in IME. The mapping of scientific productivity is similar to other studies (Madrid, Cataluña, Galicia). The "items citables" (citable items, articles and reviews) raised 54 to 98 and the international collaboration raised 3 to 33 documents (1997–2006). The FI for all documents in 1997–2001 was = 6.79 (0.54) and during 2002–2006 = 9.60 (1.24).
Conclusions: This confirms an upward trend in Spanish scientific production in rheumatology with regard to previous studies.

Aproximación bibliométrica a la producción científica reumatológica española durante el peíodo 1997–2006

Palabras clave:
Bibliometría
Reumatología
Análisis bibliométrico

RESUMEN

Fundamento y objetivo: Los estudios bibliométricos mostraron su utilidad en la evaluación de la producción científica, por lo que se evalúa la producción reumatológica española en el período de 1997 a 2006.
Método: Se crearon frases de búsqueda para las bases de datos utilizadas (PubMed, Science Citation Index [SCI], Índice Mé dico Español [IME]). El análisis se basó en los resultados de SCI con indicadores bibliométricos de producción científica, colaboración, tipo de documento, citas recibidas y factor de impacto (FI).
Resultados: La producción científica española en Reumatología, según la base bibliográfica, fue de 602 documentos en PubMed, 1.073 documentos en SCI, y 627 documentos en IME. La distribución geográfica es parecida a otros estudios (Madrid, Cataluña, Galicia). Los "items citables" (artículos y revisiones) aumentaron de 54 a 98 documentos y la colaboración internacional aumentó de 3 a 33 documentos, de 1997 a 2006. El FI para todos los documentos de 1997 a 2001 fue de 6,79 7 0,54 y de 9,60 7 1,24 para el período de 2002 a 2006.
Conclusiones: La producción científica española reumatológica continúa el ascenso de estudios previos.

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1699-258X/$ - see front matter

Introduction

The first bibliometric studies were performed at the beggining of the 20th century as manual recounts of scientific publications. They currently constitute an evaluation tool in scientific production that is applied to treatment and the study of quantitative data extrecated from science publications, assuming that the result of research generates new knowledge to be published.[1,2] Through the use of its respective indicators, production, circulation, consumption, and repercussion of publications is evaluated.[3] With this objective in mind, studies are performed analyzing the scientific production in Spain within the realm of biomedicine and health sciences,[4,5,6] as well as in other medical specialties[7,8] or their diffusion in scientific journals.[9] They are useful both for the researchers themselves as for supporting decision making processes and the study of the results of scientific activity by informing on the characteristics of research.[1,7]

Bibliometric studies in Spain began by the initiative of Terrada and López Piñero[3,10] who developed their study within the medical area, and were continued by other studies[4,6,11,12] which employed different biomedical bibliographic databases as sources for information, among them PubMed, Institute Scientific Information Web of Knowledge (ISI-WoK), and the Índice Médico Español (IME; Spanish Medical Index), for the retrieval of documents. Apart from some studies on scientific productivity in these bibliographic repertoires, some specific studies performed in their specific area have been done[1,5,13] as well as some comparing them.[14]

Very few bibliometric studies are found within the field of Rheumatology. As background, a 1990 study should be mentioned in which the objective was to analyze the contribution of Spanish Rheumatology to the international Rheumatology literature.[15] Afterward, another paper was published in 1998, analyzing Spanish documents published between 1990 and 1996 in 9 foreign journals related to the specialty and included in Medline.[16] A recent study[17] performed a productivity analysis (by year and author) and another one (by journal and thematic area) related to fibromyalgia, during a period ranging from 1980 to 2005. There is another paper within the field of this specialty[18] with the objective of studying doctoral thesis in Rheumatology presented in Spain between 1976 and 1997 and another study analyzing abstracts presented at congresses or meetings, their publication and time interval.[19]

In order to determine the tendency with respect to prior studies and know what the Spanish scientific production in Rheumatology is, the current study has the objectives of analyzing and quantifying documents recovered from bibliographic databases (PubMed, Science Citation Index [SCI], IME), during the study period (from 1997 to 2006) and compare it to the international scientific production. In addition, with regard to SCI, describe and quantify, according to the type of document, journal, language, co-authorship, and type of collaboration as well as the geographical distribution by autonomous community (CC.AA.) and centers of production. This production also takes into account the impact factor (FI) of the journals in which they are published and the number of citations received.

Material and methods

The bibliograaphic search databases employed were PubMed, IME, and ISI-WoK, in which Web of Science (WoS) was selected and, among this, SCI Expanded. Search phrases were adapted to the respective databases with appropriate MeSH terns used in the case of PubMed and the corresponding SCI terms (in which searches with TS=topic in "Field Tags" were employed, using the SAME operator, concretely for the case of syndromes) and IME (in which the search was performed by fields); all were limited to 1997-2006. Previous research was faced with the problem of how to make an exhaustive retrieval of data and applied, for the "affiliation" field, a methodology that allowed them to amplify the included terms with different synonyms for Spain, CC.AA., and provinces.[20] In the present study, this methodology was presumed to be needed in order to obtain the largest amount of retrieved documents in relation to the objective of the study and applied in the bibliographic databases under use. First, all of the documents in which a Spanish affiliation was seen were searched for in the "author affiliation" field (Table 1). Then, a search phrase that included rheumatic disease in general, apart from other specific searches according to different disease groups (those for PubMed are shown on Table 2 and from these, the ones employed for SCI and IME were derived). With the conjunction of

Table 1
Construction of the search phrase for the affiliation search field with the objective of recovering articles produced by Spanish researchers

Term strategy (search field: affiliation)	Description	Recovered registries
# 1	Spain	145 202
# 2 (nacional)	espagne OR espanha OR espanya OR espana OR espa?a	14 191
# 3	# 1 OR # 2	158 916
# 4 (autonomous)	galicia OR gallego OR galego OR asturi* OR cantabria OR eusk* OR "Pais Vasco" OR "basque country" OR navarr* OR aragon* OR catalun* OR catalonia OR catala* OR rioja* OR "comunidad valenciana" OR "comunitat valenciana" OR andalu* OR extremadura OR extreme* OR castilla OR madrid OR madrile* OR murcia* OR canar* OR balear* OR ceuta OR melilla	76.289
# 5	# 3 OR # 4	171 684
# 6 (provinces)	coruna OR lugo OR (ourense OR orense) OR guipuzcoa OR vizcaya OR alava OR zaragoza OR huesca OR teruel OR barcelona OR (lleida OR lerida) OR tarragona OR (girona OR gerona) OR logro* OR valencia OR castellon OR (alicante OR alacant) OR huelva OR cadiz OR sevilla OR cordoba OR granada OR jaen OR malaga OR almeria OR badajoz OR caceres OR "ciudad real" OR guadalajara OR cuenca OR toledo OR albacete OR zamora OR leon OR salamanca OR burgos OR palencia OR valladolid OR segovia OR avila OR soria OR tenerife OR "las palmas" OR mallorca OR menorca OR ibiza OR compostela OR vigo OR oviedo OR (xixon OR gijon) OR santander OR (vitoria OR gasteiz) OR (bilbao OR bilbo) OR (donostia OR "san sebastian") OR pamplona OR cartagena OR "palma de mallorca" OR mahon	142 197
# 7	# 5 OR # 6	206 001
# 8 Homonimal	(((cordoba[AD] AND argentina[AD]) OR (pamplona[AD] AND brazil[AD]) OR (pamplona[AD] AND brasil[AD]) OR (toledo[AD] AND ohio[AD]) OR (toledo[AD] AND OH[AD]) OR (zamora[AD] AND argentina[AD]) OR (cuenca[AD] AND ecuador[AD]) OR (vitoria[AD] AND brazil[AD]) OR (vitoria[AD] AND brasil[AD]) OR (guadalajara[AD] AND mexico[AD]) OR (leon[AD] AND french[AD]) OR (leon[AD] AND bordeaux[AD]) OR (leon[AD] AND lyon[AD]) OR (leon[AD] AND france[AD]) OR (leon[AD] AND mexico[AD]) OR (laguna[AD] AND philippines[AD]) OR (santander[AD] AND colombia[AD]) OR (granada[AD] AND colombia[AD]) OR (san sebastian[AD] AND chile[AD]) OR (valencia[AD] AND Venezuela[AD]) OR (cordoba[AD] AND Bogota[AD]) OR (lugo[AD] AND Italy[AD]) OR (avila[AD] AND Venezuela[AD]))))	11 759
# 9	# 7 NOT # 8	194 305

Table 2
Search phrases used for the retrieval of Rheumatology production in PubMed, of which terms for the SCI and Índice Médico Español derived

Rheumatic disease in general	"Rheumatology"[MeSH] OR "Rheumatic Diseases"[MeSH] OR "Connective Tissue Diseases"[MeSH] OR "Joint Diseases"[MeSH] OR "Spinal Diseases"[MeSH] OR "Bone Diseases, Metabolic"[MeSH] OR ("musculoskeletal diseases"[MeSH] OR Musculoskeletal Diseases[Text Word])
Rheumatoid arthritis	("Arthritis, Rheumatoid"[MeSH] OR (inflammatory[All Fields] AND (("arthritis"[TIAB] NOT Medline[SB]) OR "arthritis"[MeSH] OR polyarthritis[Text Word])))
Osteoarthritis	"Back Pain"[MeSH] OR "Low Back Pain"[MeSH:NoExp] OR "Sciatic Neuropathy"[MeSH:NoExp] OR "Sciatica"[MeSH] OR "Osteoarthritis"[MeSH] OR "Chondrocytes"[MeSH]
Systemic lupus erythematosus	((("Lupus Erythematosus, Systemic"[MeSH] OR "Lupus Vasculitis, Central Nervous System"[MeSH] OR "Lupus Nephritis"[MeSH] OR "Lupus Coagulation Inhibitor"[MeSH]) OR "Antibodies, Antineutrophil Cytoplasmic"[MeSH] OR "lupus AND pregnancy")
Crystal arthropathies	"Gout"[MeSH] OR "Arthritis, Gouty"[MeSH] OR "Hyperuricemia"[MeSH] OR "Lesch-Nyhan Syndrome"[MeSH] OR ("Chondrocalcinosis"[MeSH] OR "deposition disease"[All Fields] OR "CPPD"[All Fields] OR "Calcium pyrophosphate dihydrate" [All Fields] OR "periarticular calcification"[All Fields] OR "apatite deposit*"[All Fields] OR "hydroxyapatite deposit*"[All Fields] OR (crystal[All Fields] AND ("inflammation"[MeSH Terms] OR inflammation[Text Word])))
Inflammatory spondyloarthropathies	(("Spondylarthropathies"[MeSH] OR "Spondylarthritis"[MeSH] OR "HLA-B27 Antigen"[MeSH] OR "Spondylitis, Ankylosing"[MeSH] OR "Reiter Syndrome"[MeSH] OR "Arthritis, Reactive"[MeSH] OR "Arthritis, Psoriatic"[MeSH]) OR SAPHO OR undifferentiated spondylarthropat* OR (("Inflammatory Bowel Diseases"[MeSH] OR "Crohn Disease"[MeSH] OR "Whipple Disease"[MeSH] OR Celiac Disease"[MeSH] OR "Colitis, Collagenous"[MeSH] OR "Intestinal Diseases"[MeSH]) AND ("Arthritis"[MeSH])) AND ("Arthritis"[MeSH] OR "Arthritis, Infectious"[MeSH] OR "Arthritis, Reactive"[MeSH])))
Metabolic bone disease	Bone Diseases, Metabolic"[MeSH] OR "Osteoporosis"[MeSH] OR "Fractures, Spontaneous"[MeSH] OR "Diphosphonates"[MeSH] OR "Bone Density/drug effects"[MeSH] OR "Decalcification, Pathologic"[MeSH] OR "Bone Demineralization, Pathologic"[MeSH] OR "Osteomalacia"[MeSH] OR "Osteitis Deformans"[MeSH] OR (paget[All Fields]) OR "Hyperparathyroidism"[MeSH] OR "Renal Osteodystrophy"[MeSH] OR "Osteonecrosis"[MeSH] OR ("Osteochondritis"[MeSH] OR "Osteochondritis Dissecans"[MeSH] OR "Legg-Perthes Disease"[MeSH]) OR "Hyperostosis, Diffuse Idiopathic Skeletal"[MeSH] OR "Forestier's disease"
Systemic vasculitis	("Vasculitis"[MeSH] OR "vasculitides"[All Fields] OR "angiitides"[All Fields] OR "Vasculitis, Hypersensitivity"[MeSH] OR " Churg-Strauss Syndrome"[MeSH] OR "Purpura, Schoenlein-Henoch"[MeSH]) OR "Polyarteritis Nodosa"[MeSH] OR "Wegener Granulomatosis"[MeSH] OR "Behcet Syndrome"[MeSH] OR ("Temporal Arteritis"[MeSH] OR "Polymyalgia Rheumatica"[MeSH] OR "arteritis temporal"[All Fields])) OR "Takayasu's Arteritis"[MeSH] OR "Antibodies, Antineutrophil Cytoplasmic"[MeSH] OR ("vasculitis"[MeSH] OR vasculitis[Text Word]) AND leucocitoclastica[All Fields]) OR "Cryoglobulinemia"[MeSH] OR"Mucocutaneous Lymph Node[MeSH]
Infection related rheumatic diseases	("Arthritis, Infectious"[MeSH:NoExp] OR "Rheumatic Fever"[MeSH] OR "Soft Tissue Infections"[MeSH] OR "Osteitis"[MeSH] OR "Osteomyelitis"[MeSH] OR "Periostitis"[MeSH] OR "Discitis"[MeSH] OR "Tuberculosis, Spinal"[MeSH] OR "Tuberculosis, Osteoarticular"[MeSH:NoExp] OR "Lyme Disease"[MeSH] OR "rheumatic AND HIV" OR "rheumatic AND AIDS" OR "arthritis AND HIV" OR "arthropaty AND HIV" OR "rheumatic AND B19" OR "arthritis AND B19" OR "arthropaty AND B19" OR "rheumatic AND hepatitis" OR "arthritis AND hepatitis")
Fibromyalgia, chronic fatigue syndrome	("Fibromyalgia"[MeSH] OR "fibromialgia" OR "Fatigue Syndrome, Chronic"[MeSH] OR "Joint Instability"[MeSH] OR "laxitud articular")
Other rheumatic diseases: sarcoidosis, deposit arthropathy, etc.	"Sarcoidosis"[MeSH] OR ("Sarcoidosis"[All Fields] AND "arthropathy"[All Fields]) OR ("Hemochromatosis"[MeSH] OR ("Hemochromatosis"[All Fields] AND "arthropathy"[All Fields]) OR "Ochronosis"[MeSH] OR ("Ochronosis"[All Fields] AND "arthropathy"[All Fields]) OR "Amyloidosis"[MeSH] OR ("Amyloidosis"[All Fields] AND "arthropathy"[All Fields]) OR (("amyloid"[MeSH Terms] OR amyloid[Text Word]) AND (("joint diseases"[TIAB] NOT Medline[SB]) OR "joint diseases"[MeSH Terms] OR arthropathy[Text Word])) OR (synovial[All Fields] AND ("amyloidosis"[MeSH Terms] OR amyloidosis[Text Word])) OR (dyalisis[All Fields] AND arhropathy[All Fields]) OR "palindromic rheumatism"[All Fields] OR "intermittent hydrarthrosis" [All Fields] OR "Hydrarthrosis"[MeSH] OR "Arthropathy, Neurogenic"[MeSH] OR "Familial Mediterranean Fever"[MeSH]
Regional or soft tissue diseases	"thorn synovitis"[All Fields] OR "foreign body synovitis"[All Fields] OR "Tendinopathy"[MeSH] OR "Tendon Entrapment"[MeSH] OR "epicondylitis"[All Fields] OR "De Quervain Disease"[MeSH] OR "Dupuytren"[All Fields] OR ("Carpal Tunnel Syndrome"[MeSH] OR "Median Neuropathy"[MeSH]) OR "Trigger Finger isorder"[MeSH] OR "Reflex Sympathetic Dystrophy"[MeSH] OR "ShoulderPain"[MeSH] OR "Periarthritis"[MeSH] OR "Bursitis"[MeSH] OR "Pellegrini Stieda"[All Fields] OR "Hoffa"[All Fields] OR "Osgood Schlatter"[All fieds]
Musculoskeletal manifestations of neoplasia, paraneoplastic syndromes	Fibroma, Ossifying"[MeSH] OR "Osteosarcoma"[MeSH] OR "Sarcoma, Ewing's"[MeSH] OR "Osteoma"[MeSH] OR "Osteochondroma"[MeSH] OR "Osteoblastoma"[MeSH] OR "Giant Cell Tumor of Bone"[MeSH] OR "Osteochondromatosis" [MeSH] OR ("Osteoarthropathy, Secondary Hypertrophic"[MeSH] OR "Osteoarthropathy, Primary Hypertrophic"[MeSH]) OR "paraneoplastic syndrome" OR (rheuma* AND neoplasia) OR (arthritis AND neoplasia) OR (arthropat* AND neoplasia) in Humans
Experimental arthritis, epidemiology, disability, pharmacoeconomics in Rheumatology	(("Arthritis, Experimental"[MeSH] OR "Epidemiology"[MeSH: noexp] OR ("Health Care Economics and Organizations"[Mesh] OR "Economics, Medical"[MeSH]) OR "Disability Evaluation"[MeSH] OR "Sick Leave"[MeSH]) AND ("Rheumatology"[MeSH] OR "Rheumatic Diseases"[MeSH] OR "Connective Tissue Diseases"[MeSH] OR "Joint Diseases"[MeSH] OR "Spinal Diseases"[MeSH] OR "Bone Diseases, Metabolic"[MeSH] OR ("musculoskeletal diseases"[MeSH Terms] OR Musculoskeletal Diseases[Text Word])))

both searches, documents on scientific production in Rheumatology were included, complementing the work affiliation field with the Unit of Rheumatology (different terms such as "Arthritis Unit," "Rheumat Hosp Infantil," "Spanish Soc Rheumatol" were used) and with Spain as nationality (Figure 1). We also included documents that were incomplete in the work affiliation field (hospitals that did not specify the department), but in which the authors were specified to be Rheumatologists and of Spanish nationality. We excluded documents that dealt with rheumatic pathology but that were not identified as Spanish. Abstracts were not included either (as weren't doctoral thesis), because they did not form a part of the study objective and were not employed as a search criteria.

For the total recount of documents in each database, the results obtained with the search phrase for rheumatic disease in general was added to those recovered with the different specific phrases, excluding duplicates found among the results of the different searches (Figure 1). Duplicates were eliminated from the SCI database with a platform called EndNote Web 2.2, which was also used for the recount of the documents corresponding to every years; in PubMed we used the ProCite 5.0.3 tool for the years 1997 and 1998, although it was performed manually for other years. With respect to the adscription of the documents to their production centers, if any was performed by 2 units of Rheumatology, one document was assigned to each center, according to the total recount method.[5] The type of document included in PubMed was "article original," "review," "editorial," and "case report"; in SCI we included "article," "editorial," "review," and "letter." A "citable item" was considered with respect to the originals and the reviews (a criterion followed in ISI-WoS). The process of

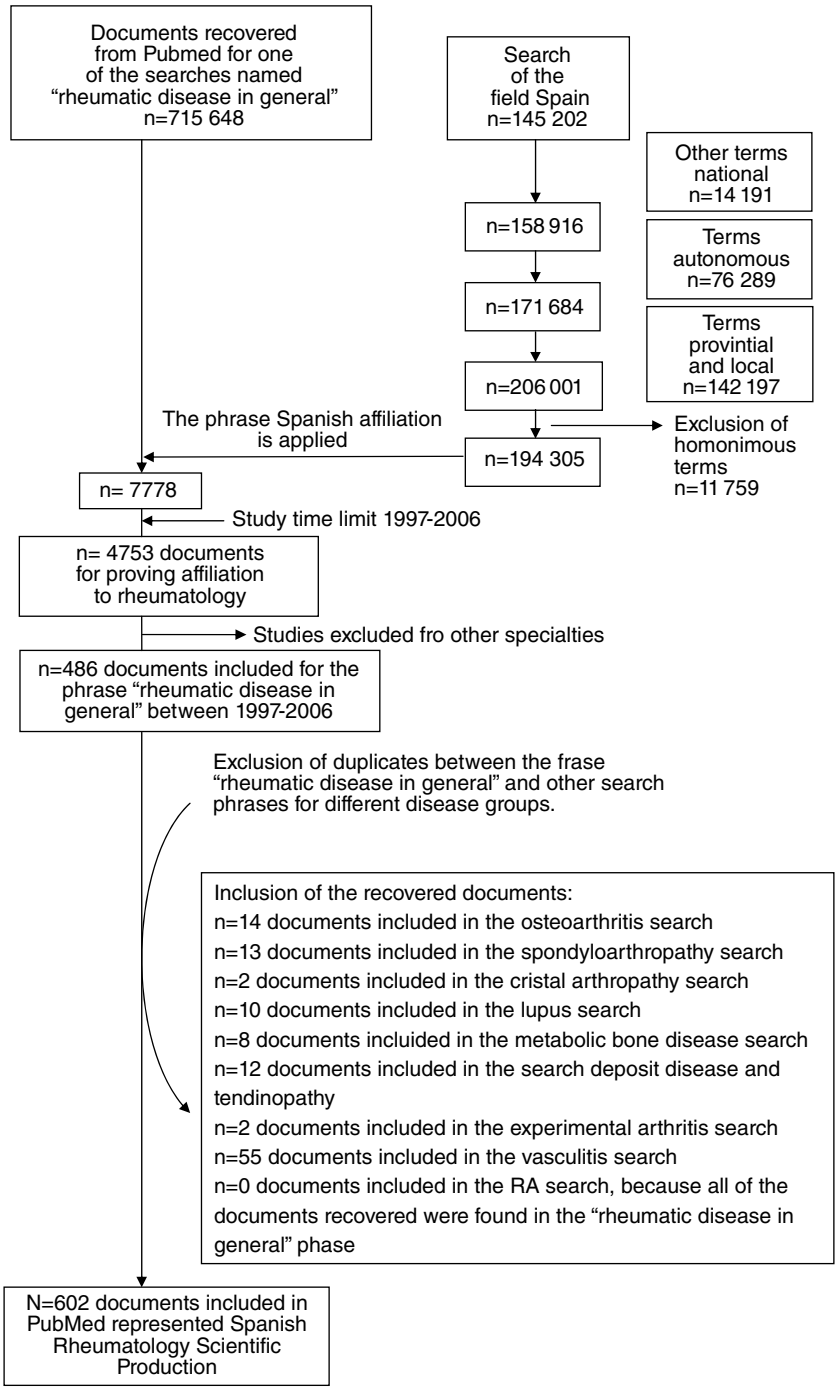


Figure 1. Diagram for the search strategy in PubMed of one of the phrases used that was called "rheumatic disease in general" with its geographical and time limitations (1997–2006).

data introduction and analysis was performed in Excel. The results were analyzed according to the different bibliometric indicators of production, visibility (FI and citations per article). A FI according to the year the journal in which they were published (considering the FI of a journal in one year, the quotient between the number of citations during that year by the documents published in the 2 previous years by the journal).[1] With the total production in SCI of documents and journals, the number of documents and the FI of each journal we calculated the mean FI for each year and every 5-year period. With the production of 10 or more documents in Rheumatology journals, selected using the Rheumatology theme, the mean by year and journal was determined. The listing of journals and their FI of 1998 to 2006 in Journal Citation Report (JCR) Science Edition[21] was employed. We also adjusted the number of documents per year according to the Price law[3,22] (according to which there is an exponential growth that duplicates scientific knowledge every 10 to 15 years). In addition, we also adjusted for Lotka´s law (which states that, according to specialized journals, independent of the discipline and with the sole condition that the bibliography is as complete as possible and covers an ample enough period of time, describing the distribution of the

frequency of publication by autor, according to which there is a great deal of authors with few publications and a lesser number of authors with a great deal of publications[3,22,23]). The percentage of scientific production growth was calculated. The coauthorship was calculated in order to measure the degree of collaboration, done by determining the quotient between the sum of firms and the total number of documents per year. Production was also determined by CC.AA. (its graphic representation was carried out with Epi Map) and the interautonomous collaboration (considered when a document had 2 or more different CC.AA.), as well as international collaboration if one of the centers was foreign). Different socioeconomic parameters were used to determine the relativity of scientific production by CC.AA., the number of inhabitants (data from the National Institute of Statistics [INE] from the January 2001 census),[24] research and development budget (I+D) during 2002 (data from INE from 2002)[25] and the number of Rheumatology specialists (data from the year 1997).[26] In order to compare results, the topic was reviewed in PubMed, with a search of "Bibliometrics" [MeSH] and ("Rheumatology" [MeSH] or "Musculoskeletal Diseases" [MeSH]) and all related studies were included.[27,28]

Results

The results obtained as well as the number of documents for different search phrases, according to the bibliographic database employed is shown in Table 3. With them, after applying the described methodology, we calculated the bibliometric production indicators for scientific activity along with their geographical distribution, the collaboration indicators as well as dispersion, visibility, and international diffusion.

Indicators of scientific production

In PubMed, the production for Spanish rheumatic scientific activity recovered a total of 602 documents, divided by year (Figure 2), with a growth percentage with respect to 1997 from 2006 of 56%. The equation that was better adjusted to the tendency was linear (regression coefficient r^2=0.6837).

In SCI there was a total 1073 documents recovered divided by year (Figure 2), with a growth percentage with respect to 1997 from 2006 of 80%. The equation better adjusted to the tendency was linear (r^2=0.7765). In both databases there was an observed increase in time in the number of documents that was close to what is stated in Price's law regarding the duplication of scientific knowledge every 10 years.[22] In the first 5 years, in SCI there were 475 documents recovered and in the second 5 years, 598 documents were recovered.

In contrast to the results presented before, the IME database documents, recovered and distributed by year, (Figure 2) indicated a decrease with respect to 1997 from 2006 of 17%. The equation better adjusted for this tendency was exponential (r^2=0.0045).

In SCI the geographic distribution of rheumatology scientific production is shown in Figure 3, its adjustment by socioeconomical parameters are shown in Table 4 and the production per center is shown in Table 5. The number of "citable items" was distributed per year according to what is shown in Figure 4. According to the language (Spanish or English), the yearly distribution of the documents from 1997 to 2006 corresponded to 13 documents in Spanish versus 57 documents in English (18.57%), 14 versus 86, 17 versus 77, 18 versus 91, 21 versus 80, 11 versus 96, 8 versus 97, 17 versus 105, 20 versus 118, 12 versus 114 (9.37%), successively, where there was a tendency to growth among English language publications. The distribution according to the type of document is shown in Figure 5.

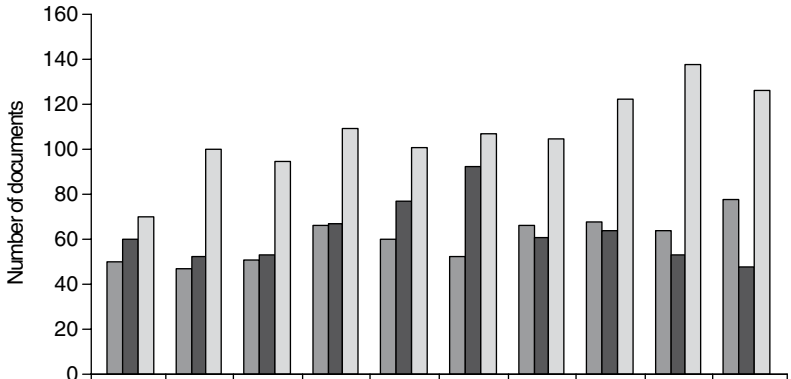
Collaboration and dispersion indicators

In SCI, the results obtained through the coauthorship index had a mean value of 6.28 (0.6) and are shown in Figure 4 next to the number of documents in which international collaboration was detected. International collaboration from 1997 to 2006 recovered 181 (17.05%) documents, which received 34.64 (39.92) citations. Interautonomous collaboration from 1997 to 2006 recovered 65 (5.87%) documents that received 21.73 (28.94) citations; 40 of these came from Madrid, 25 from Galicia, 17 from Cataluña, 17 from Andalucía, and 10 from Cantabria (CC.AA. with 10 or more collaborations). When the distribution in the journals in which the papers were published

Table 3
Number of documents recovered from the Spanish rheumatology production, with the search phrases used in the consulted databases consulted during the study period (1997–2006)

No. of documents recovered according to the search phrase and database PubMed						SCI (Web of Science)				IME.		
	PCI		R	I	%	PCI with a limit between 1997 and 2006	R	I	%	PCN	I	%
	No time limit	With a limit between 1997 and 2006										
Rheumatic disease in general	707 133	220 438	4725	487	0.22	43 962	1363	588	1.34	490	252	51
Rheumatoid arthritis	95 675	24 290	649	202	0.69	33 452	931	369	1.10	250	143	57
Osteoarthritis	58 659	27 444	346	51	0.19	31 744	514	121	0.30	115	55	48
Lupus	41 811	14 066	375	57	0.41	21 237	845	136	0.64	112	34	30
Crystal arthropathies	11 715	2645	85	22	0.83	3741	196	52	1.39	45	13	29
Spondyloarthropathies	17 225	5343	190	60	1.12	5726	242	113	1.97	72	45	63
Bone disease	142 199	52 830	1184	85	0.16	44 759	1125	131	0.29	84	40	48
Systemic vasculitis	71 265	19 126	624	91	0.48	15 152	829	200	0.13	407	35	9
Infectious joint disease	69 616	15 784	485	51	0.31	14 027	452	71	0.51	122	44	36
Fibromyalgia, chronic fatigue syndrome	15 939	8680	109	17	0.20	4538	81	35	0.77	129	48	37
Sarcoidosis, deposit arthropathy	43 266	12 407	344	21	0.17	12 363	532	47	0.38	32	10	31
Regional disease, soft-tissue rheumatism	18 811	7054	116	22	0.31	8.344	184	40	0.48	131	14	11
Neoplasia, paraneoplastic syndrome	40 318	12 539	327	23	0.18	9120	279	13	0.14	230	14	2
Experimental arthritis, epidemiology, disability	17 747	9179	153	22	0.24	58 969	1014	32	0.05	73	30	41

I indicates number of documents included by manual review, of Spanish scientific production, without yet excluding the duplicates between phrases; PCI, total number of documents recovered of international scientific production, according to the database employed (PubMed or SCI); PCN, total number of documents recovered of national scientific production; R, number of documents recovered after cross-referencing with the phrase indicating Spanish production (excluding homonimals) and limiting by the time of study 1997-2006; %, percentage with respect to the PCI column of international scientific production, or with respect to the number of documents recovered in IME, with the study period with the 1997-2006 time limit.



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
PubMed	50	47	51	66	60	52	66	68	64	78
I.M.E.	60	52	53	67	77	92	61	64	53	48
I.S.I.	70	100	95	109	101	107	105	122	138	126

Figure 2. Evolution of the Spanish rheumatology scientific production in the 3 databases employed.

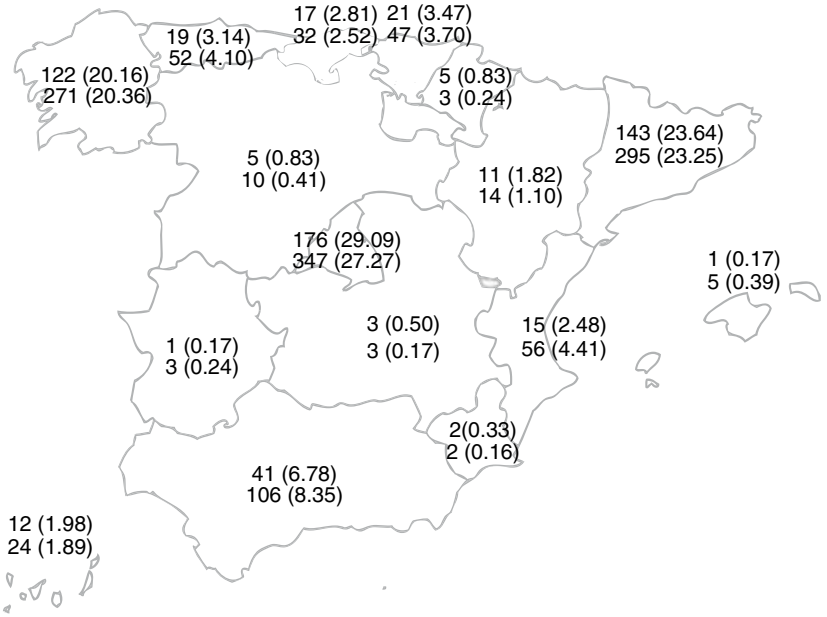


Figure 3. Geographical distribution of Spanish Rheumatology scientific production by autonomous communities and databases, PubMed (upper line) and SCI (lower line), for the period of 1997 to 2006 (not included are those sites that could not be related to a center or CC.AA., 11 (17%) in PubMed and 34 (2.6%) en SCI).

were taken into account, 50% of the documents in the decade of the study were in 6 journals (132 documents in *J Rheumatol*, 93 in *Med Clin* (Barc), 93 in *Ann Rheum Dis*, 89 in *Clin Exp Rheumatol*, 66 in *Rheumatology*, and 65 in *Arthritis Rheum*).

Visibility and international diffusion indicators

The progression in the number of citations received per document or times cited for the total number of documents, from 1997 to 2006, is shown in Figure 6; for its interpretation one must take into account that between 3 and 5 years are necessary to obtain more or less definite information of the citations received by the documents due to the delay in processing and indexing, in addition to the delay of time needed in order to cite the document[1,4,12] (with a standard deviation [SD] from 1997 to 2006 of 18.25; 63.42; 22.83; 27.20; 14.50; 26.70; 26.14; 31.53; 10.32; and 4.38). Among the international articles with more than 200 citations, there are 3 documents in 1998, one document in 2000 and one in 2004. In addition, Figure 6 shows the evolution according to FI per year for the total of included documents (with an SD from 1997 to 2006 of 7.96; 13.1; 9.18; 13.29; 9.16; 13.26; 13.29; 14.21; 19.21; and 21.51). The FI that was found in the first 5 year period was 6.79 (0.54), while during

Table 4
Adjustment of Spanish Rheumatology scientific production according to geographical distribution, population in autonomous communities,24 research and development expenses,25 and number of rheumatologists (year 1997),26 in 2 databases (SCI and PubMed)

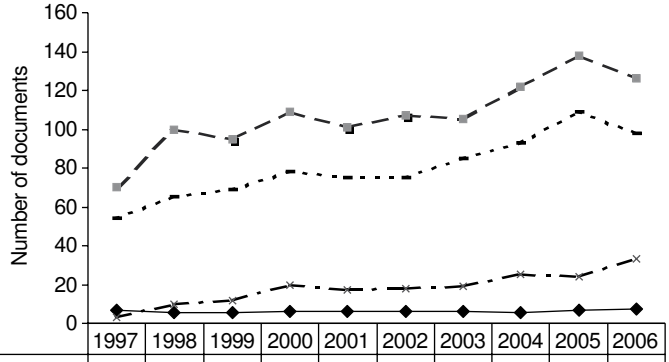
CC.AA.	ISI total No. of D per CC.AA.		PubMed total No. of D per CC.AA.		Total population (2002)	ISI No. of D per 100 000 inhabitants		PubMed No. of D per 100 000 inhabitants		Internal expense (thousands of €) in I+D/ CC.AA.	PubMed No. D per internal expense I+D		ISI No. D per internal expense in I+D		Rheuma tologists (1997)	PubMed No. D per rheuma tologist		ISI No. D per rheuma tologists	
Galicia	271	[3]	122	[3]	2 693 733	10.06	[1]	4.53	[1]	293 195	0,000416	[1]	0.00092	[2]	31	3.94	[2]	8.74	[2]
Principado de Asturias	32	[8]	17	[7]	1 061 942	3.01	[5]	1.60	[5]	98 933	0.000172	[3]	0.00032	[3]	3	5.67	[1]	10.67	[1]
Cantabria	52	[6]	19	[6]	534 915	9.72	[2]	3.55	[2]	48 348	0.000393	[2]	0,00107	[1]	8	2.38	[3]	6.50	[3]
País Vasco	47	[7]	21	[5]	2 082 258	2.26	[6]	1.01	[6]	581 744	0.000036	[10]	0.00008	[11]	19	1.11	[7]	2.47	[7]
Comunidad Foral de Navarra	3	[13]	5	[11]	555 879	0.54	[12]	0.90	[8]	130 881	0.000038	[9]	0.00002	[15]	4	1.25	[6]	0.75	[12]
Cataluña	295	[2]	143	[2]	6 343 786	4.65	[4]	2.25	[4]	1 628 042	0.000088	[4]	0.00018	[4]	82	1.74	[5]	3.60	[5]
Aragón	14	[10]	11	[10]	1 203 660	1,16	[9]	0.91	[7]	160 346	0.000068	[8]	0.00008	[10]	15	0.73	[8]	0.93	[11]
Castilla y León	10	[11]	5	[11]	2 454 546	0.41	[13]	0.20	[12]	317 673	0.000016	[15]	0.00003	[13]	21	0.24	[13]	0.48	[13]
Castilla La Mancha	3	[14]	3	[12]	1 760 162	0.17	[15]	0.17	[13]	105 296	0.000028	[11]	0.00002	[14]	18	0.17	[14]	0.17	[16]
Comunidad de Madrid	347	[1]	176	[1]	5 426 248	6.38	[3]	3.24	[3]	2 277 822	0.000077	[5]	0.00015	[6]	86	2.05	[4]	4.02	[4]
Comunidad Valenciana	56	[5]	15	[8]	4 163 094	1.345	[10]	0.36	[11]	547 944	0.000027	[12]	0.00010	[9]	34	0.44	[12]	1.65	[9]
Región de Murcia	2	[15]	2	[13]	1 198 606	0.17	[16]	0.17	[13]	97 633	0.000020	[14]	0.00002	[16]	13	0.15	[15]	0.15	[15]
Islas Baleares	5	[12]	1	[14]	872 836	0.57	[11]	0.11	[14]	45 271	0.000022	[13]	0.00011	[8]	2	0.50	[11]	2.50	[6]
Extremadura	3	[13]	1	[15]	1 058 418	0,28	[14]	0.09	[15]	71 380	0.000014	[16]	0.00004	[12]	12	0.08	[16]	0.25	[14]
Andalucía	106	[4]	41	[4]	7 360 469	1.44	[7]	0.56	[10]	585 667	0.000070	[6]	0.00018	[5]	61	0.672	[9]	1.74	[8]
Islas Canarias	24	[9]	12	[9]	1 779 169	1.349	[8]	0.67	[9]	173 088	0.000069	[7]	0.00014	[7]	18	0.667	[10]	1.33	[10]
Totals and means (SD)	1270		594		39 491 303	2.72 (3.3)		1.27 (1.39)		40 549 451					427	1.42		2.87 (3.17)	

CC.AA indicates autonomous communities; D, documents; SD, standard deviation; (not included were locations that could not be affiliated to a center or CC.AA., 11 [17%] in PubMed and 34 [2.6%] in SCI).

Table 5
Number of documents included of Spanish Rheumatology scientific production per center, (shown are PubMed and SCI center with more than 51% and 53% respectively)

PubMed		SCI			
Name of the center	No. (%)	Name of the center	No. (%)	1997–2001	2002–2006
				No. D	No. D
C.H. Xeral Calde. Lugo	67 (11.07)	C.H. Xeral Calde. Lugo	198 (15.60)	85	113
C.S. Clinic. Barcelona	54 (8.93)	H.U. La Paz. Madrid	103 (8.12)	46	57
H.U. La Paz. Madrid	41 (6.78)	C.S. Clinic. Barcelona	86 (5.99)	29	57
C.S. Bellvitge. L'Hospitalet de Llobregat. Barcelona	35 (5.79)	C.S. Bellvitge. L'Hospitalet de Llobregat. Barcelona	65 (4.89)	37	28
H.U. 12 de Octubre. Madrid	29 (4.79)	H.U. Germans Trias i Pujol. Barcelona	45 (3.55)	24	21
H.G.U. Gregorio Marañón. Madrid	22 (3.64)	H.U. Marqués de Valdecilla. Santander	44 (3.47)	21	23
H.C.U. de Santiago. Santiago de Compostela (A Coruña)	22 (3.64)	H.C.U. de Santiago. Santiago de Compostela (A Coruña)	40 (3.15)	10	30
C.H.U Juan Canalejo. A Coruña	20 (3.31)	H. 12 de Octubre. Madrid	39 (3.07)	12	27
H.U. de La Princesa. Madrid	18 (2.98)	H.U. Reina Sofía. Córdoba	38 (2.99)	11	27
Total	308 (51.55%)		658 (53.82%)	275	383

D indicates type of document in PubMed is "article original," "review," "editorial," "case report," and in SCI "article" "editorial" "review" "letter."



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Collaboration index (IC)	6.59	5.69	5.55	6.23	6.19	6.17	6.10	5.84	6.92	7.57
Total of documents in SCI	70	100	95	109	101	107	105	122	138	126
Citable items (articles + reviews)	54	65	69	78	75	75	85	93	109	98
International collaboration	3	10	12	20	17	18	19	25	24	33

Figure 4. Progression of the collaboration index, international collaboration, "citable items" (articles and reviews) and total of documents included in the Institute Scientific Information Web of Science for Spanish Rheumatology scientific production.

the second 5 year period it increased to 9.60 (1.24). The mean FI, only for documents published in Rheumatology journals according to the JCR21 listing, do reach more than 10 documents (and in 5 year periods also) as is shown on Table 6. Not included in the Table are the journals *Best Pract Res Clin Rheumatol* (7 documents: one in 1999, one per year from 2001 to 2006), *Rev Rhum* (4 documents: one in 1998, 3 in 1999), *Curr Opin Rheumatol* (3 documents: one in 2000, 2004, 2005), *Rheum Dis Clin North Am* (2 documents: one in 1998, one in 2001). The 5 year period FI with these documents was 2.116 (1.58) between 1997 and 2001 and 2.541 (2.13) between 2002 and 2006.

Discussion

These results indicate that the Spanish rheumatology scientific production, both in PubMed and in SCI, show a growing tendency that coincides with studies performed in previous years on biomedicine and health sciences examining diverse areas and specialties[4-6,11] or with studies that focus on specialties such as Cardiology,[7] and which are consistent with the bibliometric map proposed by Camí et al during the period of 1996 to 2004 in Rheumatology.[29] These can be compared to other references in the national Rheumatology scene, among specialties and with themselves, as well as with Rheumatology

studies in the international scene. In this manner, a 1993 study by Camí et al mentions that the scientific area of rheumatology (along with another 8 specialties) is an area with high activity and great attraction.[6] There were 2 later studies published, one by Ruiz et al and another by Batlle et al, on the scientific activity of Spanish Rheumatology in foreign journals with greater visibility and between both studies there is an increase from 23 documents to 49, in 7 international specialized journals after homogenizing according to the type of document, with a predominance of original articles over letters.[15,16] These are the background of the results obtained, with 70 (6.52%) documents in 1997. Also, an according to Trilla et al, the scientific activity of Rheumatology reaches more acceptable results according to the FI achieved by the articles and has 5th place among 10 specialties.[30] Another point of reference is found in the study by Gómez Caridad et al, with a position of 15 respect to 37 specialties in the area of clinical medicine, according to the net number of 774 documents of Rheumatology (with an increase of 31.3% de 1999 with respect to 1994). If we take into account the "citable items," it occupies place 23 of 323 (with an increase of 26.5% of 49 to 62 documents),[5] the latter result being coherent to the 54, 65, and 69 "citable items" in Figure 4 from 1997 to 1999 (although their study includes notes).

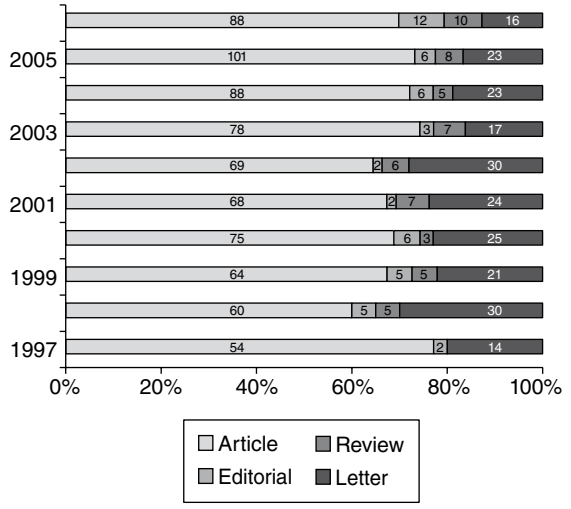


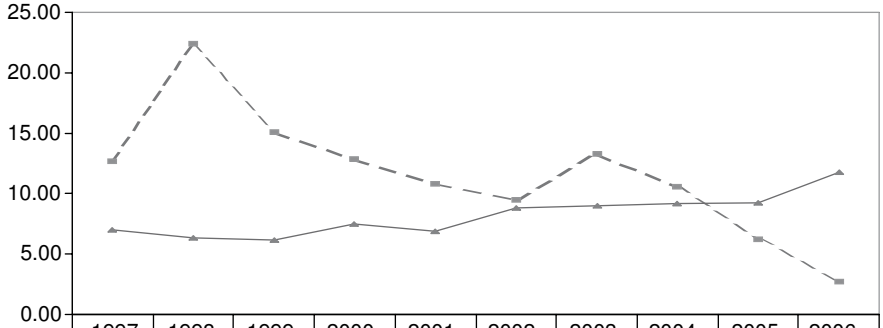
Figure 5. Distribution according to the type of document of Spanish Rheumatology scientific production in Institute Scientific Information and in Science Citation Index.

However, this tendency does not seem to be on the rise in the results found when using the IME. This database was used because it was necessary to get a profound knowledge of the rheumatology scientific production in Spain. There is a decrease in those documents recovered in the IME, which can be partially explained by a reduction in serial publications in Rheumatology in 2003 (Rheuma journal) and, as a consequence, the documents indexed under musculoskeletal diseases are reduced since 2002 from 32 to 21 documents in 2003, 8 in 2004, and 7 documents in 2005.

In the international field, according to the review by Mela et al, regarding Rheumatology research in Europe, in 1995 there were 75 documents (5.7%), consistent with the results in Figure 4; in ISI, with 16 countries and 17 specialized journals, Spanish Rheumatology scientific activity reaches the sixth place and the mean FI of 2 reaches seventh place; the number of documents on the world stage is 2331, and 1316 (56.5%) correspond to the European Union.[28] In other research, according to Lewison et al, regarding research on Arthritis in England, between 1988 and 1995 there were 872 Spanish publications in the field of Rheumatology, with a high index of yearly growth (16.9), with this explaining the increase in the presence of Spanish Rheumatology through the fact that researchers publish a greater output of their scientific work in international journals.[27] This process can be influenced by factors such as investment in I+D[7] and the promotion of research through scientific societies.[31]

Apart from this orientation in data, the results in PubMed and SCI differ in the number of documents, in a similar manner to the study by Pestaña which compared both databases, where there were 176 Rheumatology documents (articles and reviews) in 12 Medline-indexed journals, while ISI had 229 documents in 9 journals, showing a pattern similar to that of Dermatology, Pediatrics, Psychiatry, Geriatrics, and different from other areas of specialty. The difference is explained by the different criteria employed by PubMed with respect to ISI to include the institutions address according to the type of document, because the latter is registered for any type of document.[1,14]

The geographical distribution of the scientific production of Rheumatology shows results which are similar to those from other studies on scientific production in Medicine[5,11,12] and other specialties (such as cardiovascular disease and microbiology),[7,8] where most of the production is situated in the CC.AA. of Madrid, followed by Cataluña and Andalucía. This distribution is interpreted, according to the studies, by the coincidence of several factors, such as teaching and research institutions as well as human and economic resources, a greater population or because these regions concentrate more than



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Mean number of "times cited"	12.66	22.40	15.10	12.84	10.83	9.47	13.26	10.54	6.24	2.73
Mean FI for all documents in JCR journal	7.03	6.348	6.182	7.516	6.857	8.795	9.003	9.162	9.262	11.798

Figure 6. Progression of the impact factor and citations received in Spanish Rheumatology scientific production in SCI.

Table 4
Number of documents published in Rheumatology journals (according to the list by the Journal Citation Report Science Edition[20]) with 10 or more documents and an impact facto corresponding to each journal according to year and 5 year period of the study.

Name of the journal according to JCR Science Edition	1997		1998		1999		2000		2001		2002		2003		2004		2005		2006		Total no D	FI 1997–2001	FI 2002–2006
	D	FI	D	FI	D	FI	D	FI	D	FI	D	FI	D	FI	D	FI	D	FI	D	FI			
Arthritis Rheum	4	6.910	11	6.766	5	7.054	8	6.841	4	7.389	6	7.379	5	7.190	10	7.414	8	7.421	7	7.751	68	6.88	7.44
Arth Rheum/Ar C Res	0	0.533	1[a]	1.065	0	1.569	0	1.398	0	1.060	4	1.811	6	7.190	5	7.414	4	7.421	6	7.751	26	1.07	6.51
Ann Rheum Dis	4	2.006	6	2.043	1	1.968	5	2.444	9	3.188	14	3.593	8	3.827	9	3.916	17	6.956	20	5.767	93	2.53	5.14
Rheumatology	0	–	0	–	8	2.799	8	2.537	4	3.062	7	3.251	14	3.760	8	4.102	10	4.226	8	4.502	67	2.75	3.97
Osteoarthr Cartilage	0	2.112	0	2.014	0	2.21	0	2.000	1	2.219	0	3.436	1	2.964	2	3.572	2	4.215	5	4.017	11	2.22	3.86
Arthritis Res Ther	0	–	0	–	0	–	0	–	1	4.793	0	3.436	0	5.036	0	4.551	3	3.482	10	3.801	14	4.79	3.73
Semin Arthritis Rheum	0	2.597	2	2.198	2	2.996	1	3.066	3	3.066	7	2.750	3	2.598	4	3.013	3	3.580	4	3.440	29	2.83	3.03
J Rheumatol	7	2.545	10	2.211	14	2.879	19	2.910	14	2.591	14	2.987	13	2.674	11	2.860	17	3.010	13	2.940	132	2.68	2.90
Lupus	2	1.671	2	1.878	4	1.464	1	2.514	1	1.875	1	1.774	5	1.808	1	1.942	2	2.400	3	2.366	22	1.73	2.05
Scand J Rheumatol	1	1.139	5	1.108	1	1.169	1	1.396	1	1.483	6	2.000	2	1.821	2	1.685	1	1.687	1	2.273	21	1.19	1.91
Clin Exp Rheumatol	5	1.309	7	1.270	7	1.348	13	1.638	14	1.614	8	1.284	7	1.919	14	1.504	4	2.366	9	2.189	88	1.49	1.76
Clin Rheumatol	6	0.624	2	0.633	4	0.615	6	0.724	1	0.838	3	0.976	3	0.850	0	1.154	1	1.261	2	1.459	28	0.67	1.07
Joint Bone Spine[c]	0	–	0	–	0	–	6	0.523	1	0.371	1	0.675	3	0.869	2	0.899	2	1.105	1	1.398	16	0.50	0.97
Rheumatol Int	0	0.554	0	0.800	0	1.108	0	1.162	2	0.893	4	1.000	0	1.013	2	1.038	2	1.477	1	1.070	11	0.90	1.12
JCR-J Clin Rheumatol[d]	0	–	4	0.358	3	0.358	1	0.384	0	0.333	1	0.455	1	0.298	0	0.274	2	0.344	0	0.472	12	0.36	0.36
Brit J Rheumatol[b]	11	2.600	13	2.354	0	2.845	0	3.949	0	–	0	–	0	–	0	–	0	–	0	–	24	2.46	0.00
Total D and mean FI FI (SD) per year	40	2.351 (1.96)	63	1.989 (1.72)	49	2.265 (1.92)	69	2.271 (1.79)	55	2.382 (1.83)	76	2.303 (1.83)	71	2.905 (2.17)	69	3.280 (2.21)	78	3.397 (2.30)	90	3.623 (2.17)	660	2.19 (1.69)	2.86 (2.15)

D indicates documents; FI, impact factor; SD, standard deviation.

[a] This document and its impact factor belong to the journal *Arthr Care Res*; the rest of the documents on this line belong to *Arth Rheum/Ar C Res*.

[b] In 1999 the name of *Brit J Rheumatol changed to Rheumatology*, therefore no data on the impact factor is available after 2000.

[c] In the Journal Citation Report of the ISI the name of *Rev Rheum changed to Joint Bone Spine* in 2000.

[d] The impact factor in Journal Citation Report starts in 2000, the impact factor in the Table in 1998 and 1999 is the mean of the impact factor in 2000 and 2001.

40% of human resources dedicated to research.[7,9] Although the place in which each community with a greater production is located is similar (Table 4) Galicia, however, occupies a third place (being a community with data that differs according to the citation, with the exception of Camí et al[29]), followed by Andalucía and the Comunidad Valenciana or the País Vasco, with one of the latter 2 coinciding with the database considered. According to experts in this field, it is important to put the number of publications in perspective with relation to researchers or resources for R+D in order to localize those centers or regions with a smaller size or larger activity1. In that manner, when the studies are adjusted for the number of inhabitants of the CC.AA., the first place is redistributed and we find it to be Madrid, Cataluña, País Vasco, Cantabria,[8] but when relating it ot its investment in R+D, Cantabria and Navarra stand out in the cardiovascular disease area.[7] When adjusting to number of inhabitants, a homogeneous behavior is seen in the first places for both databases, because the first 6 CC.AA. are found both in ISI as in PubMed.

The results according to the type of collaboration are in agreement with those communicated in Spanish scientific production studies in biomedicine and health sciences, where most citations come from international collaborations12. The result of the coauthorship index is similar to that of other specialties, with an increase from 5 authors in 1996 to 6 authors in 2003 in radiology.[32] The increase, according to the studies, started between 1950 to 1955, increasing during the 1970's and showing a reduction in individual articles in favor of larger groups.[33,34] Then, from 1981 to 2002, it increased with a mean yearly growth of 7.6% of authors per document[4] and a mean (between 1996 and 2004) of 6.17 authors per document in clinical medicine.[12]

This increase in the number of authors per document seems to coincide with the reduced number observed in articles signed by a single author, being n=41 (3.86%) and far from the number expected with a reduced number of authors described in the distribution of authors that the Law of Lotka dictates. This discrepancy with theory could be explained due to the need of a wider window of opportunity to recover those articles with a greater number of signatures or could indicate that they are in a consolidation phase, this group constituting what Price called a transitory index, in other words, the percentage that corresponds to transitory or occasional authors (those with just one article) in one set of publications, which is reduced in well consolidated themes, countries or scientific disciplines.[3]

The limitations we encountered are those of bibliometric studies and database analysis which are detailed in specialized references,[1,2,14] and among them that the FI is an indirect indicator of the quality of the studies, making feasible future research on scientific quality and study design, basic or clinical characteristics of the study, thematic areas and their geographical distribution, something that would help limit the profile of rheumatology scientific production. In addition, there are specific limitations to this study, such as the search limit of 50 terms in SCI and the existence, in some cases, of several names for one center (documents that could not be traced due to lack of data, such as the rheumatology unit they belonged to, were not included in productive centers or in the CC.AA., and numbered 11 [1.8%] in PubMed and 34 [2.6%] in SCI2). The results were considered within the context of the process of internationalization proposed for the scientific community in a country, which consists of 3 phases (first phase: publication in international specialized journals; second phase: concentration in English-language journals, and third phase: publications in better quality journals among the international ones with a relatively high FI), with different rhythms according to area and specialty. As a consequence, the upward trend found in international collaboration studies could be explained, as well as English-language documents and a tendency towards "citable items" and FI.[35] In conclusion, from a group and integral vision of the results from different indicators, Spanish Rheumatology scientific production, for the period between 1997 to 2006, continues the trend seen in previous studies[15,16] and is probably in a consolidation phase within an internationalization process.[35]

Conflict of interest

The author declares no conflict of interest with the opinions expressed in the present manuscript.

Acknowledgments

This study would not have been possible without the support of research of the Spanish Society of Rheumatology. To the document researchers of the Cajal-Ilustre Library at the Colegio Oficial de Médicos de Madrid, María José Rebollo Rodríguez for reviewing the bilbiographic searches, who together with Cristina Marín, obtained the bibliography. To the Doctral Course in Documentation "Evaluación de la Ciencia y la Tecnología" and its team, imparted at the Universidad Carlos III. To the suggestions of anonymous reviewers.

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