BIBLIOMETRICS

Spanish Production of Research Articles on Diagnostic Imaging in Cardiology and Radiology (1994-1998)

Alberto Miguel-Dasit,[a] Luis Martí-Bonmatí,[a] Rafael Aleixandre,[b] Pilar Sanfeliu,[c] and Juan C. Valderrama[b]

[a]Servicio de Radiología, Hospital Universitario Doctor Peset, Valencia, Spain.
[b]Instituto de Historia de la Ciencia y Documentación López Piñero, Universitat de València-CSIC, Valencia, Spain.
[c]Universidad Cardenal Herrera-CEU, Alfara, Valencia, Spain.

Introduction and objectives. The aim of this study was to evaluate the production of research papers by Spanish authors on diagnostic imaging published in the official journals of two Spanish scientific societies (REVISTA ESPAÑOLA DE CARDIOLOGÍA and *Radiología*) between 1994 and 1998, and to compare publication rates with those of research papers published in foreign cardiological and radiological journals included in *Journal Citation Reports*.

Material and method. Specific search profiles were devised to retrieve items from the *Índice Médico Español* (IME) and MEDLINE databases. The impact factor for non-Spanish journals devoted to different specialties was normalized for the number of papers published.

Results. 967 articles were analyzed (301 on cardiac imaging, 666 on radiology). In the former specialty, 50.5% of the items were published in *REVISTA ESPAÑOLA DE CARDIOLOGÍA*, and in the latter, 55.1% were published in *Radiología* (no statistically significant difference). Impact factor was 2.46 for cardiology and 0.98 for radiology. The percentage of papers published in journals ranked in the top quartile according to impact factor was 38.6% (cardiology) and 17.2% (radiology); the difference was significant at $P<.0001$.

Discussion. Although a tendency for radiologists to publish increasingly in foreign radiological journals has been observed, Spanish cardiologists and radiologists publish more than 50% of their research papers on diagnostic imaging in the official journals of their national societies. The differences in the percentage of articles by Spanish authors published in international specialty journals ranked in the first quartile (twice as great for cardiology as for radiology) suggests that Spanish radiologists are joining the scientific international community at a slower rate than Spanish cardiologists.

Key words: *Cardiology. Radiology. Journal Citation Reports. Impact factor.*

SEE EDITORIAL ON PAGES 799-802

Producción española sobre diagnóstico por la imagen en cardiología y radiología (1994-1998)

Introducción y objetivos. El propósito de este estudio es realizar un análisis comparativo de la productividad de los autores españoles en artículos sobre diagnóstico por la imagen en el período 1994-1998 en: *a)* las revistas oficiales de 2 sociedades médicas españolas, la de Cardiología (REVISTA ESPAÑOLA DE CARDIOLOGÍA) y la de Radiología Médica *(Radiología)*, y *b)* revistas extranjeras sobre las especialidades incluidas en *Journal Citation Reports*.

Material y método. Para la recuperación de los artículos se diseñaron perfiles de búsqueda específicos para las bases de datos IME y MEDLINE, y se valoró en las revistas extranjeras el factor de impacto por especialidad normalizado al número de trabajos publicados.

Resultados. Se analizaron 967 trabajos, 301 sobre imagen diagnóstica cardiovascular (el 50,5% publicado en REVISTA ESPAÑOLA DE CARDIOLOGÍA) y 666 sobre radiodiagnóstico (el 55,1% publicado en *Radiología*), con diferencias que no fueron significativas. El factor de impacto medio por especialidad fue de 2,46 para cardiología y 0,98 para radiodiagnóstico. El porcentaje de trabajos en el primer cuartil de las revistas de mayor impacto fue del 38,6% (cardiología) y del 17,2% (radiología), con diferencias significativas ($p < 0,0001$).

Discusión. La tendencia progresiva de los radiólogos hacia la publicación en revistas extranjeras (aunque cardiólogos y radiólogos publican la mitad de su producción en la revista de su sociedad nacional) y las diferencias en la producción internacional en revistas del primer cuartil de su disciplina (el doble en cardiología respecto a radiología) sugieren una incorporación a la comunidad científica internacional más tardía en radiología.

Palabras clave: *Cardiología. Radiología.* Journal Citation Reports*. Factor de impacto.*

Correspondence: Dr. L. Martí-Bonmatí.
Servicio de Radiología. Sección de Resonancia Magnética.
Hospital Universitario Dr. Peset.
Avda. Gaspar Aguilar, 90. 46017. Valencia. España.
E-mail: marti_lui@gva.es

Received November 19, 2003.
Accepted for publication May 6, 2004.

ABBREVIATIONS

IF: impact factor.
JCR: Journal Citation Reports.
SCS: Spanish Cardiology Society (*Sociedad Española de Cardiología* [SEC]).
SMI: Spanish Medical Index (*Índice Médico Español*).
SSMR: Spanish Society of Medical Radiology (*Sociedad Española de Radiología Médica* [SERAM]).

INTRODUCTION

A recent survey of articles that appeared between 1994 and 1998[1] showed that most papers on diagnostic imaging (31.3%) were published in radiology journals, followed by neurology journals, and then obstetrics-gynecology journals. The fourth most popular destination was cardiology journals, which accounted for 6.6% of the papers. Various bibliometric studies[1-5] have analyzed the Spanish publications on diagnostic radiology, focusing essentially on the journal *Radiología*—the official publication of the Spanish Society of Medical Radiology (SSMR).[2-7] With regard to cardiology, our compilation book *Bibliografía española e internacional de estudios bibliométricos* [Spanish and International Articles on Bibliometric Studies][8] identified 3 Spanish studies that carried out an analysis of Spanish publications in this field.[9-11]

The objective of this study was to analyze Spanish production in terms of articles on diagnostic imaging in the official publications of 2 Spanish scientific societies, the Spanish Cardiology Society (SCS), whose journal is REVISTA ESPAÑOLA DE CARDIOLOGÍA, and the SSMR, which publishes a journal called *Radiología*. We aimed to compare the 2 specialties over the period 1994 to 1998. We also aimed to compare the Spanish output on diagnostic imaging in foreign cardiology and radiology journals included in Journal Citation Reports (JCR) to assess the tendencies of Spanish cardiologists and radiologists. In particular, we looked for tendencies to publish in official journals of the societies despite not being included in the JCR, and to publish in foreign journals with an impact factor (IF) listed in the JCR. Another objective was to carry out an analysis of the IF of the JCR-indexed journals in which Spanish studies in both specialties were published.

MATERIALS AND METHODS

Data Sources Chosen and Search Strategy

Specific search profiles were designed to recover papers from the chosen data sources, namely the Spanish Medical Index (SMI) and the North American MEDLINE database. For searches of the SMI, the CD-ROM edition, published by Micronet, S.A., in 2002, was used. The SMI is structured into 13 fields.[1] The field "*lugar de trabajo"* (place of work) of the SMI includes all the institutions that participated in the publication, whereas the "Address" field of MEDLINE often only includes the institution of the first author. The fields "place of work," "*revista-título"* (journal title), "*título del trabajo"* (article title) and "*descriptors"* (descriptors) were searched in the SMI. The terms employed in the search of the field "place of work" were "*servicio de cardiología"* (Cardiology Service), "*departamento de cardiología"* (Department of Cardiology), "*servicio de radiología"* (Radiology Service), "*servicio de radiodiagnóstico"* (Diagnostic Radiology Service), "*servicio de diagnóstico por imagen"* (Diagnostic Imaging Service), "*departamento de radiología"* (Radiology Department) and "*departamento de radiodiagnóstico"* (Department of Diagnostic Radiology). The field "journal-title" was queried with the titles of the official journals, REVISTA ESPAÑOLA DE CARDIOLOGÍA and *Radiología,* as well as with the titles of the remaining journals on cardiovascular diseases included in the SMI journal index.[12] Given that there is no thesaurus of terms in the SMI, free language queries of the fields "article title" and "descriptors" were made using the terms echography, ultrasonography, echocardiography, ultrasound, US, Doppler, magnetic resonance imaging, MRI, computed tomography, computerized tomography, CT, and angiography. These terms were used because they correspond to the techniques of "echocardiography," "magnetic resonance imaging," "computed tomography," and "angiography" which, along with "nuclear medicine techniques," were found to have the highest number of articles related to cardiovascular diagnostic imaging in an article published in REVISTA ESPAÑOLA DE CARDIOLOGÍA.[13] Terms referring to techniques belonging to nuclear medicine were not used to query the SMI because this specialty has been independent from diagnostic radiology since 1988[14] and so may introduce a bias.

For the search in MEDLINE, the following MeSH terms were used: ultrasonography, echocardiography, angiography, Doppler, tomography x-ray computed, and magnetic resonance imaging. Then, articles submitted by Spanish cardiology and radiology services and departments were recovered using the "Address" field of MEDLINE with the same terms as those used in Spanish in the "place of work" field of the SMI, and their translations into English (Department of Cardiology, Cardiology Department, Cardiology Service, Department of Radiology, Radiology Department, Department of Diagnostic Radiology and Radiology Service). This query of the "Address" field of MEDLINE covered all provinces of Spain, "*España"* (and "*Es-*

pana"), and a variety of translations (Spain, Spanha, Spanien, Espagne). All articles obtained were reviewed individually to confirm that they had been published by a Spanish group, and those that did not originate from Spain—for example articles published by groups in Toledo (Ohio) and Córdoba (Argentina) in which the name was confused with Spanish cities—were discarded. Duplications from the SMI database were also discarded.

Classification According to Journal Subject Matter, Type of Article Selected and Change Over Time in Production

The List of Journals Indexed in Index Medicus, published by the National Library of Medicine,[15] in the edition corresponding to the middle year (1996) of the period studied was the source used to classify foreign journals into cardiology and diagnostic radiology—the 2 specialties under study. In this source, journals about cardiology are included under "Cardiology" and "Vascular Diseases." The radiology journals are included in a single category denominated "Radiology and Diagnostic Imaging." The classification of subject matter of Spanish journals included in the SMI was carried out in accordance with the classification proposed in the Journal Index by Subject ("cardiovascular diseases" and "diagnostic radiology") of the journal index of the SMI.[12] Only original articles, review articles, and case reports were included in the analysis. We also studied the change over time of Spanish production in different journal groups during the period analyzed.

Sources and Method Used for Analysis of the Impact Factor

The annual IF (1995-1998) was obtained for foreign journals by consulting the JCR web page through the ISI Web of Science portal.[16] The IF for 1994 was consulted in its print edition.[17] The mean IF for each specialty was calculated by pooling the individual IF for each journal and normalizing to the total number of articles in each period, provided the IF of the journal was available for all years.

Classification of Production by Diagnostic Techniques

The manuscripts were classified according to the diagnostic technique used, both for the journals of the Spanish societies, and for the foreign journals included in the JCR. The data were obtained by querying the "description" field, both in the SMI and in MEDLINE with the name of the techniques selected for this study.

Statistical Analysis of the Data

The χ^2 test was used for statistical analysis. The number of articles published by Spanish cardiologists and radiologists in Spanish journals was compared with the number published in foreign specialist journals to assess tendencies in publication. The articles published in foreign journals were stratified according to whether the journal belonged to the upper quartile of journals (first 25% of cardiology and radiology journals by IF) to assess a possible tendency to publish in journals of highest impact in their specialty. Statistical significance was set at $P<.05$.

RESULTS

A total of 1076 articles were recovered from the SMI and from MEDLINE. Our methodology excluded 109 of these, leaving 967 articles, of which 666 (69.9%) were about diagnostic imaging in radiology and 301 (31.1%) were on cardiovascular diagnostic imaging. Table 1 and Figure 2 show the distribution and year-by-year change in the number of articles published in the official journals as well as those published in foreign cardiology and radiology journals included in the JCR. Also shown is the number of papers published in other Spanish cardiology journals included in the SMI. Given that *Radiología* is the only Spanish journal on radiology, data for Spanish articles on this specialty published in Spain are limited to this journal.

TABLE 1. **Year-by-Year Distribution of Articles Published in the Official Society Journals and in the Foreign Journals Included in Journal Citation Reports**

Journal	Articles	% of Total	Articles	% of Total	Articles	% of Total	Articles	% of Total	Articles	% of Total	Total
	1994		1995		1996		1997		1998		
Revista Española de Cardiología	30	19.7	27	17.8	30	19.7	33	21.7	32	21.1	152
Radiología	75	20.5	50	13.6	81	22.1	86	23.4	75	20.4	367
Foreign cardiology journals	33	22.2	25	16.8	23	15.4	34	22.8	34	22.8	149
Foreign radiology journals	32	10.7	46	15.4	63	21.1	66	22.1	92	30.7	299
Other Spanish cardiology journals*	8	40	4	20	3	15	2	10	3	15	20

*Included in the Spanish Medical Index. We have identified articles on cardiovascular diagnostic imaging in the *Revista Latina de Cardiología* (15 articles), *Clínica Cardiovascular*, and *Hipertensión*. The latter two account for 2 and 1 published articles, respectively, in 1998 and 1997.

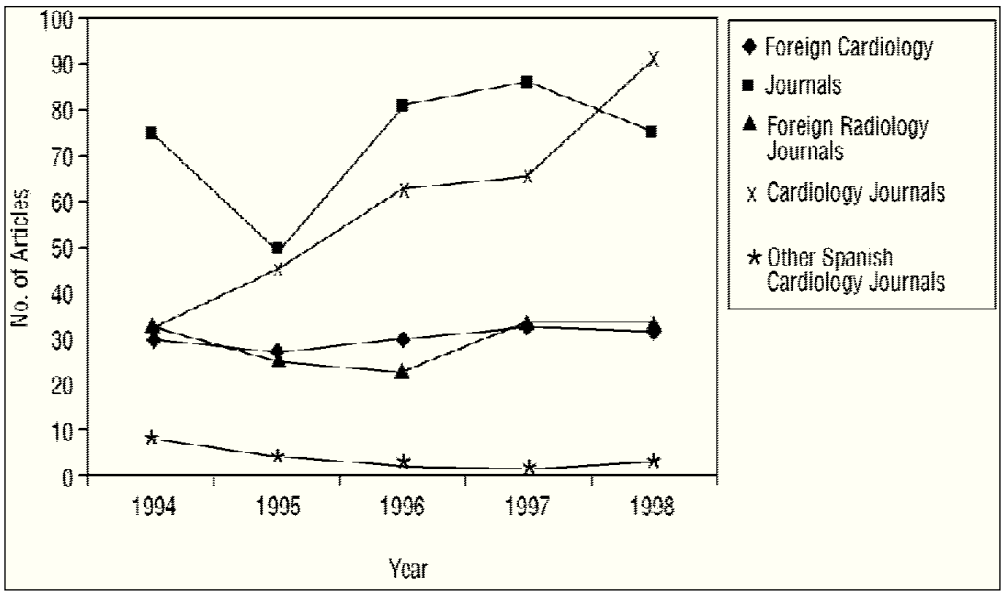

Fig. 1. Year-by-year variation in production.

Distribution in Journals: Impact Factor for Cardiology

As shown in Table 1, of the 301 articles published by Spanish cardiologists, 152 (50.5%) appeared in REVISTA ESPAÑOLA DE CARDIOLOGÍA. The remaining 149 articles (49.5%) were published in 21 foreign cardiology journals included in the JCR (Table 2). Of these 21 journals, 19 had an IF available for all years of the study period (corresponding to a total of 140 articles). The mean IF (1994-1998) of these 19 cardiology journals is shown in Table 2. The annual trend in IF normalized to the number of cardiology articles published showed a slight increase (Table 2). The mean IF in the period 1994-1998 for this specialty was 2.46.

TABLE 2. **Year-by-Year Distribution of Articles and Impact Factor of Foreign Journals Included in the Journal Citation Reports on Cardiology (in Decreasing Order of Total Articles Published; 1994-1998)***

Cardiology Journals	Articles 1994	IF 1994	Articles 1995	IF 1995	Articles 1996	IF 1996	Articles 1997	IF 1997	Articles 1998	IF 1998	Total Articles	Mean IF (1994-1998)
American Heart Journal	5	1.450	6	1.290	4	1.850	4	1.990	5	1.850	24	1.686
American Journal of Cardiology	7	2.250	4	2.230	1	2.370	6	2.400	6	2.130	24	2.276
Journal of the American College of Cardiology	3	6.010	3	5.790	3	5.980	5	6.700	4	7.280	18	6.352
International Journal of Cardiology	3	0.454	5	0.418	1	0.513	3	0.610	2	0.573	14	0.514
European Heart Journal	3	1.420	4	1.680	2	1.680	1	2.130	1	3.630	11	2.108
Circulation	2	8.634	1	8.822	1	9.094	1	9.762	3	9.173	8	9.097
Cardiovascular and Interventional Radiology	2	1.073	1	0.690	0	0.912	2	0.865	3	1.184	8	0.945
Catheterization and Cardiovascular Diagnosis	1	0.832	0	0.874	2	1.329	3	1.106	1	1.345	7	1.097
Clinical Cardiology	0	0.528	0	0.653	2	0.672	3	0.818	0	0.864	5	0.707
Journal of Heart Valve Disease	2	–	0	–	2	–	1	–	0	0.741	5	–
Cardiology	1	0.538	0	0.425	0	0.676	2	0.692	1	0.784	4	0.623
Heart	0	–	0	–	1	–	1	1.443	2	2.060	4	–
Acta Cardiologica	1	0.366	0	0.556	0	0.276	0	0.279	2	0.308	3	0.357
American Journal of Hypertension	1	1.907	0	1.880	0	2.257	1	2.566	1	2.103	3	2.143
Texas Heart Institute Journal	1	0.204	0	0.377	2	0.548	0	0.508	0	0.359	3	0.399
Coronary Artery Disease	0	0.688	0	0.872	2	0.809	0	0.653	0	0.879	2	0.780
Pediatric Cardiology	0	0.302	1	0.278	0	0.363	0	0.390	1	0.582	2	0.383
Cardiovascular Drugs and Therapy	1	0.975	0	1.230	0	1.209	0	1.098	0	1.139	1	1.130
Journal of Cardiovascular Electrophysiology	0	1.554	0	2.101	0	1.957	0	1.781	1	2.076	1	1.894
Journal of Human Hypertension	0	0.637	0	0.673	0	0.914	0	0.813	1	0.715	1	0.750
Journal of Hypertension	0	2.071	0	2.318	0	2.611	1	2.801	0	3.066	1	2.573
Total articles and yearly IF	33	2.32	25	2.10	23	2.37	34	2.53	34	2.97	149	2.46

*IF: indicates impact factor.

TABLE 3. **Year-by-Year Distribution of Articles and Impact Factor of Foreign Journals Included in the Journal Citation Reports on Radiology (in Decreasing Order of Total Articles Published; 1994-1998)***

Radiology Journals	Articles 1994	IF 1994	Articles 1995	IF 1995	Articles 1996	IF 1996	Articles 1997	IF 1997	Articles 1998	IF 1998	Total Articles	Mean FI (1994-1998)
European Radiology	0	–	00	–	7	0.430	21	0.560	22	0.780	50	–
European Journal of Radiology	3	0.418	5	0.449	8	0.358	4	0.537	8	0.537	28	0.500
Neuroradiology	5	0.900	2	0.850	8	0.990	5	0.750	3	1.020	23	0.902
British Journal of Radiology	1	0.760	5	0.670	4	0.790	1	0.810	9	0.860	20	0.778
Abdominal Imaging	3	0.510	3	0.490	4	0.730	4	0.610	5	0.740	19	0.616
Journal of Computer Assisted Tomography	6	1.541	1	1.349	5	1.402	3	1.263	4	1.322	19	1.375
Journal of Ultrasound in Medicine	1	0.807	6	0.798	3	0.915	4	0.994	1	0.921	15	0.887
Skeletal Radiology	0	0.490	2	0.430	3	0.620	4	0.710	4	0.680	13	0.586
American Journal of Roentgenology	0	1.783	0	1.932	2	2.351	2	2.332	8	2.179	12	2.115
Acta Radiologica	1	0.620	1	0.600	2	0.880	4	0.640	3	0.730	11	0.694
American Journal of Neuroradiology	1	1.733	3	1.556	4	1.750	1	1.707	2	1.869	11	1.723
Radiology	2	3.800	2	3.890	3	4.690	1	4.980	2	4.750	10	4.422
Journal of Clinical Ultrasound	2	0.430	1	0.548	0	0.551	4	0.620	2	0.573	9	0.544
Pediatric Radiology	1	0.458	2	0.467	1	0.489	1	0.619	4	0.626	9	0.532
Investigative Radiology	2	0.841	1	0.712	3	0.890	0	0.915	2	0.922	8	0.856
Clinical Radiology	2	0.704	1	0.787	0	0.923	1	0.946	2	1.114	6	0.895
Radiographics	2	1.078	1	1.073	1	1.068	0	1.073	1	1.042	5	1.067
Computerized Medical Imaging and Graphics	0	0.536	2	0.613	1	0.582	0	0.343	2	0.302	5	0.475
Medical Physics	0	1.485	0	1.902	0	1.783	2	1.720	3	1.842	5	1.746
Journal of Thoracic Imaging	0	1.167	2	–	1	0.618	1	0.855	0	1.379	4	–
Academic Radiology	0	–	1	–	1	–	0	0.505	1	0.708	3	–
Surgical and Radiological Anatomy	0	0.306	1	0.163	1	0.389	0	0.288	1	0.356	3	0.300
Clinical Imaging	0	0.237	0	0.195	0	0.404	2	0.398	0	0.311	2	0.309
Journal of Vascular and Interventional Radiology	0	–	1	–	0	1.366	1	1.352	0	1.868	2	–
Canadian Association of Radiologists Journal	0	0.178	1	0.287	0	0.259	0	0.322	0	0.230	1	0.255
Journal of Magnetic Resonance	0	3.271	0	–	0	–	0	–	1	2.257	1	–
Journal of Neuroimaging	0	–	1	–	0	0.835	0	0.652	0	1.044	1	–
Magnetic Resonance Imaging	0	1.760	0	1.672	0	1.373	0	1.361	1	1.208	1	1.475
Radiologic Clinics of North America	0	1.316	1	1.208	0	1.455	0	1.727	0	1.442	1	1.429
Ultrasound in Medicine and Biology	0	1.252	0	1.254	0	1.527	0	1.533	1	1.797	1	1.472
Journal of Neuroradiology (Journal de Neuroradiologie)	0	0.426	0	0.304	1	0.377	0	0.588	0	0.368	1	0.412
Total articles and yearly IF	32	0.79	46	0.87	63	1.14	66	0.97	92	1.16	299	0.98

*IF: impact factor.

Journal Distribution: Impact Factor for Diagnostic Radiology

Of the 666 articles published by Spanish radiographers in a total of 32 Spanish and international radiology journals, 367 (55.1%) appeared in *Radiología.* The remaining 299 articles (44.9%) were published in 31 foreign radiology journals included in the JCR (Table 3). Only 25 of these 31 journals, with 246 articles in total, obtained an IF for every year of the study period. The mean IF (1994-1998) of these 25 radiology journals is shown in Table 3. Little change in IF normalized to the number of diagnostic radiology articles published was seen over the study period (Table 3). The mean IF in the period 1994-1998 for the specialty was 0.98. No significant differences were seen between cardiology and radiology on comparison of the proportions of articles published in official journals of the specialty and foreign journals with an IF (P=.184).

Article Distribution According to Impact Factor

Of the 19 foreign cardiology journals (Table 2) that obtained an IF for all years of the period 1994-1998, with an overall production of 140 articles, a total of 54 articles (38.6%) were published in the 5 journals belonging to the upper quartile of IF. In the remaining 14 journals, we found 86 articles (61.4%). In contrast, of the 25 foreign radiology journals that obtained an IF for all years of the study period (Table 3), with a total production of 238 articles, the 6 journals belonging to the upper quartile accounted for 41 articles (17.2%),

whereas 197 articles (82.8%) were published in a total of 19 journals. Therefore, a greater proportion of articles are published in cardiology journals belonging to the upper quartile of IF. The difference between cardiology and radiology was statistically significant ($P<.0001$).

Article Distribution by Diagnostic Technique

Table 4 shows the distribution of the sample of articles recovered from the official society journals (SCS and SSMR) and from the foreign cardiology and radiology journals by diagnostic technique. The total number of articles by technique does not necessarily correspond to the total number of articles because an article might discuss echocardiography and magnetic resonance imaging, and so be assigned to both categories.

From Table 4, we see that echocardiography accounts for 80.3% of the articles in REVISTA ESPAÑOLA DE CARDIOLOGÍA, whereas coronary angiography accounts for 13.3%. Magnetic resonance imaging (MRI) and computed tomography (CT) are discussed in 3.5% and 2.9% of the articles, respectively. In *Radiología,* CT accounts for 42.7% of the articles, followed by echography (31%), MRI (29.7%) and angiography (3.9% of articles). In foreign cardiology journals, echocardiography is the most discussed technique (66.6%), followed by coronary angiography (27.1%), whereas MRI and CT are rarely discussed (2.8% and 3.4%, respectively). In foreign radiology journals, MRI accounts for 33.2% of the articles and CT for 44% of the articles. Echography is discussed in 18% and angiography in 5% of the articles.

DISCUSSION

Importance of Diagnostic Imaging in Cardiovascular Research

Currently, publications on diagnostic imaging reflect a substantial multidisciplinary element,[1] with a growing importance for scientific research on cardiovascular imaging diagnostics, as discussed in a recent article in REVISTA ESPAÑOLA DE CARDIOLOGÍA entitled "*Técnicas de imagen en la medicina cardiovascular moderna*" [Imaging Techniques in Modern Cardiovascular Medicine]. According to this study, over the 3-year period between 2000 and 2002, more than 8000 articles were published on "echocardiography," almost 3000 on "magnetic resonance imaging," and more than 2000 on "computed tomography." The article also affirms that "analysis of references in the Medline database shows that diagnostic imaging, in any of its modalities, comprises approximately 20% to 25% of the scientific articles on the circulatory system."[13]

Importance of the Impact Factor in Publication Tendencies

Studies[1,18] have shown a tendency of Spanish authors to publish in journals included in international indexes and databases in order to reach a wider readership. Journals with the highest IF within each specialty are usually the most prestigious and well known internationally, that is, the most widely read by researchers, and the journals that researchers look to most for publication of their work.[18] An editorial published in REVISTA ESPAÑOLA DE CARDIOLOGÍA[19] highlighted the increase of more than 50% in manuscripts received by this journal between 2000 and 2002. This has forced the editors to limit the number of articles accepted per month, with the subsequent increase in rate of rejections.[20] Part of this success can be attributed to the inclusion of the journal in the JCR from 1999 onwards[21] (with an IF of 0.94 in 2002[22]), in addition to less changeable aspects related to the scientific quality of the journal.

Despite the fact that the JCR is the only index which assigns an IF, the overall Spanish production in REVISTA ESPAÑOLA DE CARDIOLOGÍA is slightly greater than in foreign journals on cardiology included in the JCR. The Spanish production in *Radiología* was greater than that in foreign radiology journals. There were differences in the 2 groups of journals, both in

TABLE 4. **Distribution of Articles by Diagnostic Technique in Official Society Journals and Foreign Journals Included in Journal Citation Reports**

	1994				1995				1996				1997				1998			
Journals	**US[a]**	**MRI[b]**	**CT[c]**	**A[d]**	**US[a]**	**MRIb**	**CT[c]**	**A[d]**	**US[a]**	**MRI[b]**	**CT[c]**	**A[d]**	**US[a]**	**MRI[b]**	**CT[c]**	**A[d]**	**US[a]**	**MRI[b]**	**CT[c]**	**A[d]**
REVISTA ESPAÑOLA DE CARDIOLOGÍA	27	2	1	3	26	1	0	4	26	1	0	8	31	1	2	1	29	1	2	7
Radiología	31	22	31	6	15	17	31	3	32	23	35	1	26	22	35	2	32	32	36	5
Foreign cardiology journals	22	1	2	8	20	1	2	5	20	0	2	11	25	0	0	9	31	3	0	15
Foreign radiology journals	9	8	14	1	7	18	20	2	13	24	30	2	16	27	34	5	15	31	47	7

[a]Number of articles on echography (including Doppler techniques). [b]Number of articles on magnetic resonance imaging. [c]Number of articles on computed tomography. [d]Number of articles on angiography.

the annual change in production and in the publication trend over time.

In the case of *Radiología,* the trend in Spanish production over time is somewhat erratic, with most papers appearing in 1997 (86 articles) and fewest in 1995 (50 articles). Moreover, although the overall production in *Radiología* was greater than in all foreign radiology journals combined, there are differences from year to year. Thus, Spanish production in *Radiología* was greater than that in foreign radiology journals in the first 4 years of the 5-year period but in 1998, foreign journals showed greater production. There was also a progressive increase in the number of publications in foreign radiology journals over the whole of the period analyzed, with production in 1998 three times higher than in 1994.

Reasons that may justify the tendency of radiologists to publish in *Radiología* include giving priority to diffusing knowledge among their fellow Spanish authors and a desire to become known at the SSMR, given that *Radiología* is the main voice of this society. Furthermore, publications on diagnostic radiology in Spanish are limited by the fact that no other Spanish journals are dedicated exclusively to radiology. The Spanish radiologist must therefore choose between nonradiological Spanish journals or foreign radiology journals. Cardiology, in contrast, has other Spanish journals dedicated to the specialty. Thus articles by Spanish groups on cardiovascular diagnostic imaging were found in the *Revista Latina de Cardiología, Clínica Cardiovascular,* and *Hipertensión.* However, we decided not to include these 3 journals in the analysis because they are not official society journals or included in the JCR, and production by Spanish groups in them is low (15 articles in the *Revista Latina de Cardiología,* 2 articles in *Clínica Cardiovascular,* and 1 in *Hipertensión* on cardiovascular diagnostic imaging).

Radiología is the only Spanish journal dedicated to diagnostic imaging. All articles published in this journal deal with this field of medicine, unlike REVISTA ESPAÑOLA DE CARDIOLOGÍA, which publishes mainly articles in other fields of its specialty. To minimize bias in the techniques, 603 articles published in *Radiología* during the study period were excluded and only the 367 articles that discussed the techniques selected for this study were included. Likewise, articles on the application of techniques relating to the application of nuclear medicine in the field of cardiology were excluded.

The only 2 doctoral theses[1,3] to have carried out a literature survey of Spanish scientific output in the field of diagnostic imaging investigate 2 different periods with no overlap, namely, 1984-1993[3] and 1994-1998.[1] Both theses conclude that *Radiología* publishes approximately 20% of all Spanish studies on diagnostic imaging (20.1% in the period 1984-1993 and 20.2% in the 5-year period 1994-1998) and both agree that *Radiología* is the only core journal (according to the Bradford law). Unfortunately, *Radiología* is not included in the JCR or in the *Index Medicus*/MEDLINE database despite being the most representative journal in terms of volume of scientific activity published in Spain on diagnostic imaging.

In contrast, REVISTA ESPAÑOLA DE CARDIOLOGÍA has been included in MEDLINE since 1966, and in the JCR since 1999.[21] The official journal of the SCS has been shown to publish most Spanish studies on cardiovascular diagnostic imaging (50.5%), with little change over time (the year with most articles published was 1997, with 33 articles, whereas the year with least articles published was 1995, with 27). This contrasts with the irregular change in Spanish production in foreign cardiology journals, although production tended to settle down in the last 2 years of the study period. Differences were found on comparison of the annual production in REVISTA ESPAÑOLA DE CARDIOLOGÍA with that in foreign cardiology journals. Production in cardiovascular imaging showed greater differences in 1995 and, above all, in 1996, when production in the official journal of the SCS exceeded total Spanish production in foreign journals. The opposite tendency was found in the remaining years, in which the total production in the foreign cardiology journals slightly exceeded that in REVISTA ESPAÑOLA DE CARDIOLOGÍA. Spanish cardiovascular imaging production in the official journal of the SCS also easily exceeded that in other Spanish journals, such as the *Revista Latina de Cardiología,* whose diagnostic imaging production was concentrated in the first 3 years of the study period.

The percentage of Spanish studies in foreign journals belonging to the upper quartile—a normalized indicator of IF—was greater in the foreign cardiology journals than in the radiology journals. Caution is required when comparing IF for different disciplines because of possible differences in their characteristics (basic/clinical research, size of the field, publication and citation patterns). Nevertheless, we have seen that Spanish cardiologists published in journals with a higher IF than Spanish radiologists. This can be partly explained by the higher IF of cardiology journals, something that we found in a recent study[1] and have been able to confirm in the present study (Tables 2 and 3 show that 42% of cardiology journals have a mean IF above 1.5 in the period studied compared to 16% of radiology journals). Furthermore, in articles recovered from foreign journals, the IF for the cardiology journal with highest impact (*Circulation*) was twice that of the radiology journal with highest impact (*Radiology*). Despite these findings, we emphasize that it is desirable to use normalized indicators for a more accurate comparison between different disciplines.

With regard to the methodology used, a possible limitation of the study lies in the strategy used to consult MEDLINE. A more open search strategy, using truncated terms (radiol*, cardiol,* and radiodiag*), may have avoided possible bias due to loss of articles because some Spanish groups might have published their work under institutional names other than "service" or "department" (for example "Cardiology unit" or "Cardiology group").

According to the distribution of articles by diagnostic technique, echocardiography and angiography are found to be techniques most used by Spanish cardiologists, both in articles published in REVISTA ESPAÑOLA DE CARDIOLOGÍA and in the foreign journals on the subject included in the JCR. Both techniques clearly predominated over MRI and CT during the study period, though we think this might change if later periods are analyzed because of more widespread application of techniques such as cardiac MRI or coronary artery CT in diagnostic imaging in cardiology. It would be interesting to analyze possible changes in future studies. We also note that an analysis stratified by imaging technique is limited by a lack of statistical power.

Angiography appears little in radiology publications (for example, coronary angiography is widely used in cardiology but not in diagnostic radiology). This is because the two disciplines explore different medical areas, with few radiology publications on heart disease and the great vessels. This therefore constitutes a further limitation in the analysis performed. Nevertheless, both fields have a similar social-scientific structure, with prestigious Spanish societies who use official journals as a means of communication. Both disciplines also share a common interest in diagnostic tools such as echography, MRI, CT, and angiography, in both clinical practice and research. Quantitative comparison has therefore only been made between articles published by Spanish cardiologists in research journals on the cardiovascular system and those published by radiologists on other organs and body systems.

CONCLUSIONS

The production of Spanish cardiologists in REVISTA ESPAÑOLA DE CARDIOLOGÍA and overall production in selected foreign cardiology journals are similar, with slight variations from year to year. In the case of radiologists, the progressive annual increase in the number of articles published in foreign journals (the production in 1998 was 3 times that of 1994) would support a trend towards publication in international journals, although *Radiología* remains the journal with greatest Spanish production. Probably, Spanish radiologists started to participate in the international scientific community later than Spanish cardiologists, whose production over the period 1994 to 1998 in international specialist journals listed in the JCR was more stable. A higher proportion of articles are published by Spanish cardiologists in journals in the upper quartile of IF for their discipline compared to radiologists (38.6% vs 17.2%).

ACKNOWLEDGEMENTS

We thank Dr Alicia Maceira for her helpful collaboration in this study.

REFERENCES

1. Miguel A. Estudio bibliométrico de las publicaciones españolas sobre diagnóstico por la imagen (1994-1998) [tesis doctoral]. Valencia: Universitat de València, 2003.
2. Pérez V. Análisis bibliométrico de la revista *Radiología.* Radiología 1983;3:195-200.
3. Martínez M. Análisis bibliométrico de la producción científica española sobre radiodiagnóstico a través de la revista *Radiología* (1984-1993) [tesis doctoral]. Murcia: Universidad de Murcia, 1996.
4. Martínez M, Sáez JM, García Medina V. Importancia de *Radiología* en el conjunto de las publicaciones médicas relacionadas con el radiodiagnóstico. Análisis bibliométrico de su producción entre 1984 y 1993. Radiología 1997;39:195-9.
5. Martínez M, Sáez JM, García Medina V. Productividad de los autores españoles en radiodiagnóstico. Análisis bibliométrico a través de la revista *Radiología* (1984-1993). Radiología 1997;39: 417-21.
6. Miguel A, Martí-Bonmatí L. La autocitación en la revista *Radiología:* un parámetro de calidad. Radiología 2000;42:545-52.
7. Miguel A, Martí-Bonmatí L. Self-citation: comparison between Radiology, European Radiology and Radiology for 1997-98. Eur Radiol 2002;12:248-52.
8. Valderrama Zurián JC, Gisbert Tío A, Terrada Ferrandis ML. Bibliografía Española e internacional de estudios bibliométricos. Valencia: Instituto de Estudios Documentales e Históricos sobre la Ciencia, 1996.
9. Haba Ejarque J. Análisis bibliométrico de las publicaciones españolas sobre cardiología 1979-1983 [tesis doctoral]. Valencia: Universitat de València, 1990.
10. Marqués Defez JL. Análisis bibliométrico de las publicaciones sobre angina vasoespástica (1977-1981) [tesis doctoral]. Valencia: Universitat de València, 1984.
11. Martínez Azucena MA. La aportación española a las publicaciones sobre patología cardiovascular circulantes en la comunidad médica internacional hasta 1925. Inventario y estudio bibliométrico [tesis de licenciatura]. Valencia: Universitat de València, 1983.
12. Instituto de Historia de la Ciencia y Documentación López Piñero. Directorio de revistas del Índice Médico Español. Valencia: Universitat de València-CSIC, 2000; p. 38-40.
13. Bermejo J, Alfonso F, Bosch X. Técnicas de imagen en la medicina cardiovascular moderna. Rev Esp Cardiol 2003;56:193-4.
14. Ramos, L. Qué hacemos y cómo nos llamamos: reflexiones sobre nuestro trabajo y nuestra denominación profesional. Radiología 1997;39:671-5.
15. National Library of Medicine. List of journals indexed in Index Medicus. Bethesda: National Institute of Health, 1996; p. 189,191-2, 207-8 y 211.
16. Institute for Scientific Information [consultado 30/9/2003]. Disponible en: http://isi3.webofscience.com/CIW.cgi

17. Institute for Scientific Information. Science Citation Index-Journal Citation Reports. A Bibliometric Analysis of Science Journals in the ISI Database. Filadelfia, 1994.
18. Bordons M, Felipe A, Gómez I. Revistas científicas españolas con factor de impacto en el año 2000. Rev Esp Doc Cient 2002;25:49-71.
19. Bosch X, Alfonso F, Bermejo J. Calidad, interés e internacionalización. Rev Esp Cardiol 2002;55:1337-40.
20. Bosch X, Alfonso F, Bermejo J. ¿Por qué se ha rechazado nuestro artículo? Rev Esp Cardiol 2002;55:782-3.
21. Bosch X, Villacastín JP, Alonso J. Revista Española de Cardiología en Journal Citation Reports. Rev Esp Cardiol 2000;53: 1421-4.
22. Alfonso F, Bermejo J. Revista Española de Cardiología: en camino. Rev Esp Cardiol 2004;57:1-3.