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Evolution of Spanish scientific production in international obstetrics and gynecology journals during the period 1986–2002

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Abstract

Objective: The present bibliometric study analyzes Spanish scientific work published in the field of obstetrics and gynecology in the most important journals during the period 1986–2002.
Study design: The material studied (779 original documents) was selected in accordance with the *science citation index* (SCI) of 2001, *obstetrics and gynecology* section, using the *EMBASE*: *Obstetrics and Gynecology* database. We applied the customary rules of bibliometrics: Price's Law of increase in scientific literature, Bradford's Law of scattering of scientific literature and Lotka's Law of author productivity. Furthermore, we analyzed participation index (PaI), the collaboration index and the superior (%SUP).
Results: The material studied is closer to an exponential adjustment ($r = 0.958$) than to a linear adjustment ($r = 0.856$). The journal with the largest number of originals is *Human Reproduction* (Bradford's first area), with 217 articles and that with the highest PaI is *Menopause* (4.07). The total number of authors is 1829, who are responsible for 3938 authorships (2.79% of the authors have a productivity index (PI) ≥ 1 and 70.09% have a PI = 0). The majority of the studies were carried out in hospitals (47.62%) and universities (23.36%).
Conclusion: Spanish productivity in the field of obstetrics and gynecology increased considerably in the period 1986–2002.

Keywords: Bibliometry; Gynecology; Obstetrics; Spain

1. Introduction

Bibliometric studies constitute useful tools for evaluating the social and scientific importance of a specific discipline during a given period of time [1–4]. These studies constitute an effective complement to the opinions and judgments of the experts in each field, providing useful and objective instruments for assessing the results of scientific activity and offering a more realistic view of this activity and its possible evolution and trends [4,5].

Within the biomedical disciplines, bibliometrics is becoming increasingly relevant [3,6–8], in the wake of technical progress and in view of its diverse areas of application [5,9] and it has made it possible to confirm a significant increase in Spanish publication in journals of international scope and prestige [2,3,10–15].

In order to asses the prestige of a journal or the quality of a publication, researchers are using an indicator called impact factor (IF), which is published in the *journal citation reports* (JCR) section of the *science citation index* (SCI) and calculated by the Institute for Scientific Information (Philadelphia, USA), for the cataloging of scientific journals. The JCR categorizes journals by specific areas, ascribing to each one its corresponding IF, thus establishing a prestige ranking [16].

The use of bibliometric indicators for studying the research activity of a country is based on the premise that scientific publications are an essential result of that activity [5]. Since the introduction of bibliometrics in Spain, by

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professor López-Piñero in the 1970s, several bibliometric studies have been published here, allowing in-depth analysis of the international diffusion of Spanish science in general and of the biomedical disciplines in particular [2–5,7,13,14,17]. On consulting the MEDLINE database, crossing the terms ''bibliometr*'' and ''Spain'', there appear, from the year 1980 to date, 180 documents, on a variety of topics, such us oncology, neurology, psychiatry, pharmacology, respiratory diseases and so on. Moreover, various authors have already carried out studies providing an outline of the characteristics of Spanish scientific production in the general area of health and life sciences [4,7]. However, up to now there have been no studies analyzing Spanish scientific production in the field of gynecology and obstetrics. It is this fact that has motivated the present bibliometric study, which aims to analyze Spanish scientific work in international journals in the area of obstetrics and gynecology, covering the period between 1986 and 2002.

2. Materials and methods

2.1. Data source

In order to make a selection to carry out this bibliometric analysis, all journals included in the area of *obstetrics and gynecology* from JCR (2001) have been considered; which were considered priority journals by Excerpta Medica, in the database *EMBASE*: *Obstetrics and Gynecology* (Elsevier Science B.V., Amsterdam, Holland) available on CD-ROM (Silver Platter International N.V., MD, USA). This database includes references from 4000 journals all over published in more than 70 countries. The condition ''priority journal'' means that it is index-linked, being analyzed cover to cover, that is to say, all articles, conference paper, review, letter, note, etc., are collected. With this double selection the international quality of papers is assured, with the certainty that absolutely everything published in the above mentioned journals is collected.

Through teledischarge techniques, we selected documents that contained in the title (TI) section, the descriptors *Spain*, and always restricting ourselves to documents published between 1986 and 2002.

2.2. Bibliometrics indicators

As a methodological basis in developing the analysis of the results, we applied a series of bibliometric models and indicators considered as referential. For bibliometrics indicators of production we applied Price's Law [18]. This law, undoubtedly the indicator most commonly used when the aim is to analyze productivity in a specific discipline or a given country, reflects an essential fact of scientific production, which is it exponential growth. This phenomenon supposes a faster pace of growth for science production than for the rest of human activities, so that its size would duplicate every 10–15 years. To assess whether the increase in data conforms to Price's Law of exponential growth, we carried out a linear adjustment of the values ($y = 39{,}485x + 10{,}287$) and another adjustment to an exponential curve ($y = 13{,}869e^{01{,}312x}$).

With respect to the productivity of researchers, Lotka's Law [19] aims to calculate the number of authors expected for a given number of works produced. This law is expressed as: $A_n = K_n^{-b}$, $n = 1, 2, 3, \ldots$, where A_n represents the probability that an author produces n publications on a given topic, whereas K and b are parameters to be estimated according to the data. Following this law, as long as the time studied is sufficiently long and the bibliographical search as complete as possible, ''the number of authors that publish n works is inversely proportional to n^2.'' With regard to this aspect, we calculated the productivity index (PI) of the authors. The PI (logarithm of the values of n for each author) allows us to establish three levels of productivity: PI = 0 (transcience index: authors with a single publication—that is, occasional authors), $0 < \mathrm{PI} < 1$ (authors that have published between two and nine articles) and $\mathrm{PI} \geq 1$ (highly productive authors, with $\geq$10 articles).

As a bibliometric indicator of dispersion of scientific information we used Bradford's Law [20]. To know the distribution of the scientific literature of a given discipline, Bradford proposed a model of concentric zones of productivity (Bradford's zones) with decreasing density of information. Thus, each zone would contain a similar number of articles, but the number of journals in which these were published would increase on moving from one zone to another. This model thus permits us to determine which journals are most used or have a greater specific weight in a given area or in scientific production. Thus, the number of journals in the different Bradford's zones would be: 1, n, n^2, ...

Among the indicators of the repercussion of the publications, we used the impact factor. This index, developed by the Institute for Scientific Information, is published annually in the section *journal citation reports* of the *scientific citation index*. The IF of a journal is calculated on the basis of the number of times this journals is cited in the source journals of the SCI during the 2 previous years and the total number of articles published by the journal in question in these 2 years. The JCR list scientific journals by specific areas, ascribing to each of them their corresponding IF and establishing a ranking of prestige. The %SUP [3] has also been used, as an indicator of the excellent or quality of the work studied. This indicator shows the percentage of our documents included in the 15% world production of the best quality (estimated from IF of the selection journals).

Other indicators included in the present analysis were the participation index (PaI) and the index of collaboration between authors (signatures/document or authors/paper index). The PaI shows the quotient between the number of papers generated in a country or institution and the total number of documents collected in this repertoire.

2.3. Document allocation

At the end, through teledischarge techniques, we selected documents that contained, in the document type (DT) section of *EMBASE*: *Obstetrics and Gynecology* database. This section permits us to classify the papers of different types: article, conference paper, editorial, letter, note, short survey, review. Regrettably, this classification was not used until 1998, for what; for this present study, the document allocation has been limited to the period 1998–2002.

3. Results

After a study of the journals analyzed, during the period 1986–2002, we obtained 779 articles originated from Spain, dealing with various aspects of research in the field of gynecology and obstetrics. The general contribution of Spanish science, within this thematic area, represents a global PaI of 1.28% with respect to world production.

Table 1 shows documents' distribution on obstetrics and gynecology, in some of the most productive countries in the world on biomedicine and health science, during the period 1994–2000. Spain occupies the 11th place in the world.

As Fig. 1 shows, there was a notable increase, in the period under study, in the number of publications generated in Spain in the field of Gynecology. The mathematical adjustment to an exponential curve (see Fig. 1) allows us to obtain a correlation coefficient r of 0.958, indicating 9.42% of variability not explained by this adjustment. On the other hand, the linear adjustment of the measured values gives an r of 0.856 and therefore a percentage of unexplained variability of 14.37%. These data confirm that the material analyzed is closer to an exponential adjustment than a linear adjustment, as predicted by Price's Law.

The growth in scientific production in gynecology and obstetrics, as can be seen in Fig. 2, is progressive up to 1998, when there is stagnation. On analyzing the last 12 years, it can be seen that the accumulative growth in total scientific production of each 4-year block over the preceding one is considerable for the periods 1991–1994 (74.4%) and 1995–1998 (61.1%), but that growth stabilizes in the period 1999–2002 (3.1%).

As can be seen in Table 2, the support journals most commonly used in the diffusion of work on gynecology and obstetrics show high IFs (of the 25 journals including documents originating in Spain, 8 have an IF > 2), largely coinciding with the highest-ranking journals of the JCR, in its *obstetrics and gynecology* section. Within this group of most frequently used journals, the majority, as we would

Table 1
Documents' distribution on obstetrics and gynecology, in some of the most productive countries in the world on biomedicine and health sciences, during the period 1994–2002

Biomedicine and health sciences[a]		Obstetrics and gynecology[b]	
Country	Document (%)	Document (%)	Country
United States	41.37	33.05	United States
United Kingdom	10.68	10.44	United Kingdom
Japan	8.73	6.27	Japan
Germany	8.03	5.93	Germany
France	5.85	5.50	France
Canada	4.95	4.04	Italy
Italy	4.41	3.36	Canada
Netherlands	3.21	2.71	Australia
Australia	2.89	2.71	Austria
Sweden	2.60	2.45	Netherlands
Spain	2.41	2.22	Spain
Switzerland	2.00	1.76	Israel
Belgium	1.48	1.61	Sweden
Israel	1.33	1.27	Belgium
Finland	1.26	1.16	India
Denmark	1.26	1.11	Switzerland
China	1.07	1.01	Finland
Austria	1.05	0.99	Denmark
India	0.93	0.64	Brazil
Brazil	0.87	0.47	China
European Union	39.09	36.85	European Union

[a] The 12 most productive countries in the world on biomedicine and health sciences (extracted from ref. [25]).
[b] Results from our study.

Table 2
Journals analyzed and impact factor (IF), by the *science citation index—Journal Citation Reports* (2001)

	Journal	JCR ranking	Number of articles	IF	PaI
1	*Menopause*	1	11	3.505	4.07
2	*Hum Reprod*	2	217	2.987	3.13
3	*Hum Reprod Update*	3	15	2.969	3.69
4	*Fertil Steril*	4	133	2.960	1.77
5	*Am J Obstet Gynecol*	5	42	2.871	0.39
6	*Semin Perinatol*	6	0	2.864	0.00
7	*J Soc Gynecol Invest*	7	0	2.830	0.00
8	*Placenta*	8	6	2.521	0.57
9	*Gynecol Oncol*	11	34	2.200	0.74
10	*Obstet Gynecol*	12	23	2.196	0.30
11	*Contraception*	15	17	1.758	0.88
12	*Clin Perinatol*	16	0	1.755	0.00
13	*Maturitas*	17	36	1.640	3.70
14	*Int J Obstet Pathol*	18	24	1.454	2.82
15	*J Perinat Med*	20	29	1.221	2.56
16	*Hypertens Pregnancy*	21	6	1.217	2.45
17	*Int J Obstet Anesth*	24	3	1.187	0.48
18	*Early Hum Dev*	25	16	1.151	1.27
19	*Fetal Diagn Ther*	26	7	1.142	0.87
20	*Gynecol Endocrinol*	33	23	0.878	4.09
21	*J Reprod Med*	36	20	0.777	0.56
22	*Int J Gynecol Cancer*	37	4	0.709	0.49
23	*Int J Gynecol Obstet*	40	47	0.635	1.52
24	*Gynaecol Endosc*	41	4	0.625	0.64
25	*Eur J Gynaecol Oncol*	44	52	0.562	3.73
26	*Breast*	45	7	0.538	1.32
27	*Ann Chir Gynaecol*	48	2	0.435	0.40
28	*Gynakologe*	50	1	0.215	0.08
29	*Semin Reprod Med*	51	0	0.205	0.00

It included the number of papers to write in Spain for each journal and their participation index (PaI). IF, impact factor; PaI, participation index.

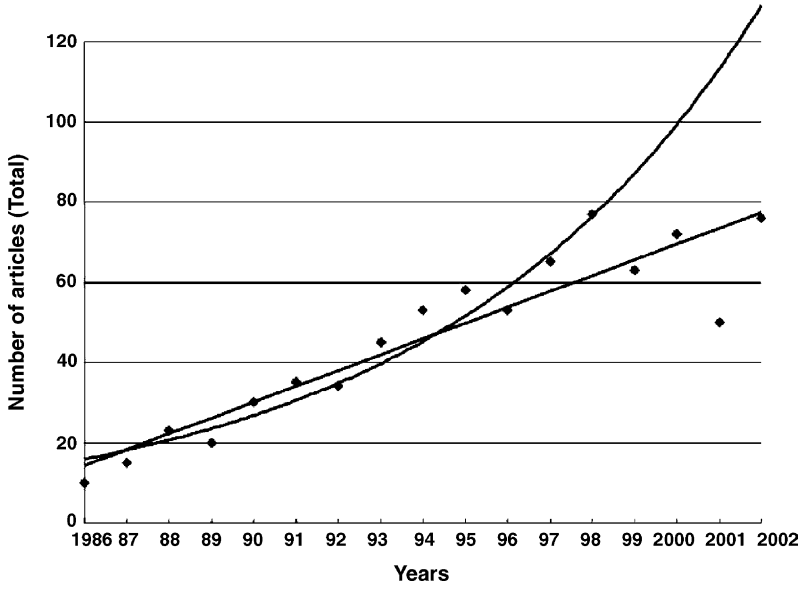

Fig. 1. Increase in number of international biomedical publications on obstetrics and gynecology in our documental repertory (*EMBASE*: *Obstetrics and Gynecology*). Linear adjustment of data and another adjustment to an exponential curve were performed to verify whether the analyzed production adjustments Price's Law.

expect, are sub-specialization publications, in the fields of the menopause, fertility, endocrinology or gynecological oncology. It is notable, as can be seen in Table 3, that more than half of the scientific documents analyzed (481) are published in journals with an IF higher than 2 (61.78% of the total sample). Furthermore, the mean impact factor (MIF) is 2.154, which gives an indication of the scientific quality level of Spanish work in the field of Gynecology. On the other hand, the %SUP, considered, in the particular case of this analysis, as the percentage of Spanish production included in the 15% of world production of the highest quality, is extremely high, attaining a figure of 29.27%.

In the analysis of type of document published in the journals analyzed, during the period 1998–2002, the most common, as we would expect, is the original article (78.93%), followed, at a considerable distance, by the short survey (6.82%), conference paper (6.23%) and reviews (3.86%).

Table 4 shows the division into Bradford's areas of the material under study. Mean number of articles by area is 194.75, though if we eliminate the last area, whose accuracy is clearly inferior, the mean would be 226.67. The central nucleus or first area would be made up, exclusively, of *Human Reproduction*, with 217 documents and the second area by *Fertility and Sterility*, *The International Journal of*

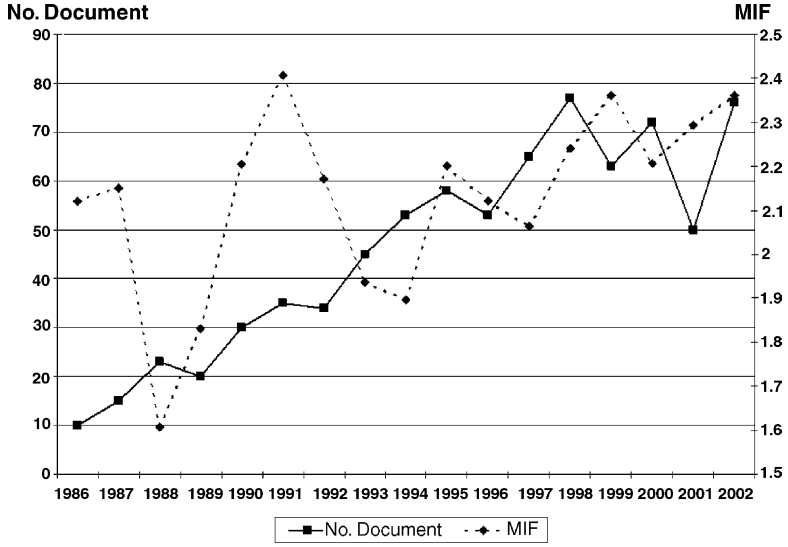

Fig. 2. Relationship between the number of articles in our documental repertory and the mean impact factor (MIF) for the period analyzed.

Table 3
Distribution of the articles by impact factor (IF) of the journals analyzed and participation index (PaI) of each group

Impact factor (IF)	Number of articles[a]	Total articles[b]	Participation index (PaI)
>3	11	270	4.07
2–3	470	39,663	1.18
1–2	138	8531	1.62
<1	160	13,987	1.14

Mean impact factor (MIF) = 2.154.
[a] Papers produced in Spain.
[b] Total articles published in the journals of each group.

Gynecology and Obstetrics and *The European Journal of Gynaecological Oncology*. The remaining journals analyzed fall into areas 3 and 4. In total, 25 different journals were used in the publication of the material analyzed, and it is notable that 44.93% of the documents considered were published in just two journals. Table 2 shows the journals most commonly used for the diffusion of scientific work on obstetrics and gynecology, along with their corresponding IFs, according to the JCR of 2001.

Another commonly used bibliometric indicator is that of scientists' productivity, which is governed by Lotka's Law. In general, this law would be fulfilled when less than one-tenth of the authors are responsible for a third of the works. In our study, 105 authors (5.74% of the total), signatories to at least 6 articles, produced 37.1 of the documents analyzed, so that the observed distribution fulfils the mentioned law. The 779 articles included in the present study correspond to a total of 1829 authors, responsible, in turn, for 3938 authorships.

The productivity indexes (logarithm of the *n* values for each author) permit us to establish three classic levels of productivity, shown in Table 5. Fifty-one authors have a PI $\geq$ 1 and can be considered as large producers, that is, they have published 10 articles or more. This small percentage of authors (just 2.79% of the total) generated 27.60% of the documents in our sample. On the other hand, 1282 signatories (70.09% of the total) produced just 1 article (PI = 0), which gives us a value for the transience index (percentage of publications corresponding to occasional authors) of 32.55.

The collaboration index, indicative of the cooperation of authors in the production of documents, is quite high (4.86), having increased during the years studied by 66% (3.44 in 1986 and 5.71 in 2002).

Table 4
Distribution of the journals in Bradford's zones

Zone	Number of journals	Number of articles	Bradford's constants
1	1	217	
2	3	232	3
3	8	231	2.7
4	13	99	1.6

Mean number of articles excluding the last Bradford zone = 226.67.

Table 6 shows the most productive institutions in relation to the material under study. As it can be seen, 47.62% of total production was generated in the clinical context and 23.36% in universities, while 22.34% was generated within private associations and institutions. Regarding the autonomous communities, the most productive concerning works in gynecology and obstetrics are Catalonia whose PaI is 38.64, followed by Valencia (PaI = 22.21), Madrid (PaI = 11.81) and Andalusia (PaI = 10.4).

4. Discussion

First of all, it should be pointed out that the present study has an important methodological limitation: selection of the documents repertoire [2,3,12,21]. In this regard, we should stress that the material selected for carrying out our study is merely a small sample of international production in this field and that the scientific literature on gynecology and obstetrics is considerably more extensive; however, the restrictions deriving from the sources of data themselves (*JCR* and *EMBASE*: *Obstetrics and Gynecology*) condition the subsequent development of the material. In this analysis we have not considered work carried out in collaboration with foreign institutions in which there is no Spanish researcher as first author. Likewise, we should point out that special care was taken to ensure that the term ''Spain'' referred to our country and not to the name of any Latin-American institution. Finally, we must also consider the possibility that some Spanish scientific studies in the gynecological field were published in journals of a multidisciplinary nature or with additional specialties (*Cancer*, *Journal of Clinical Endocrinology and Metabolism*, *Bone*, *The New England Journal of Medicine*, *The Lancet* and so on) and have therefore not being included in

Table 5
Productivity index of authors

Productivity index	Number of authors	Authors (%)	Number of articles	Articles (%)
PI = 0 (1 article)	1282	70.09	1282	32.55
0 < PI < 1 (2–9 articles)	496	27.12	1569	39.85
PI $\geq$ 1 (10 or more articles)	51	2.79	1087	27.60
Total	1829		3938	

PI, productivity index. The PI led to the establishment of three accepted levels of productivity: PI = 0 (transience index; fortuitous authors), 0 < PI < 1 (authors of intermediate productivity), PI $\geq$ 1 (large producers).

Table 6
Contribution of different institutions

Type of centre	Participation index (%)
Hospital	47.62
University	23.36
Faculty of Medicine	17.07
Faculty of Sciences	5.65
Faculty of Psychology	0.13
Faculty of Pharmacy	0.26
Faculty of Veterinary	0.13
Various	0.13
Private associations and institutions	22.34
CSIC	0.64
Other public institutions	1.15
Various	4.89

CSIC, Consejo Superior de Investigaciones Científicas (Spanish Council for Scientific Research).

the present sample, even though this aspect would not modify our conclusions.

Another point to bear in mind is that we have not considered publications in national journals, since none of the journals published in Spain is included in the *Obstetrics and Gynecology* of the *JCR*. In this regard, we should point out the tendency of researchers in this field to publish in national journals, so that, in principle, scientific production would not be accurately reflected. Nevertheless, the acknowledged quality of the publications included in the database employed and its scope mean that the documents selected are a more than representative sample of international research in the field considered. Moreover, the exhaustiveness of the bibliographical search and the extent of the period analyzed have allowed us to apply the bibliometric methods and indexes correctly, reducing as far as possible the relativity of the data [1,3,22].

The scientific literature on gynecology and obstetrics, as shown by our study material, has seen considerable growth in the last 20 years. On carrying out the mathematic adjustment of the curve in Fig. 1 it was found that the number of Spanish publications grew exponentially and not until the end of the studied period did we observe the saturation process described by Price in his theory of the expansion of scientific literature [18]. This trend, coupled with the absence of the saturation point, points to good future perspectives, especially if we take into account that Spain's presence in this area has been quite low up to now. Indeed, while the results of our study show that the general Spanish contribution in this field represents 1.28% of total world production, the data provided by Camí et al. [4] situate Spanish production in the biomedical and health sciences, for the period 1990–1993, at 1.8% of the world total. Recently, this group has published data that shows a relationship among the 20 most productive countries in the world on biomedicine and health sciences [23]. The ranking of these countries is quite similar with the results from our study. Spain occupies the 11th place in the world.

However, not only it is important to consider this increase in scientific production, it is also necessary to determine whether it is accompanied by an increase in quality. For this purpose we have used IF, the tool most frequently used by the international community, despite its limitations, which include discrimination against original articles in favor of reviews, high scores for reviews published in English and a tendency to disregard thematic areas dealt with by few researchers [3,12,24,25]. In this regard, it is important to stress that in the material studied here we have been able to confirm, especially after 1995, a progressive increase in the MIF of publications in the area of interest (Fig. 2). While Camí [12] obtain an MIF of 1.210 for the area of obstetrics/gynecology during the period 1990–1993 (including all the journals considered in the SCI database), the MIF of our study is practically double (2.154). This circumstance could be explained, at least in part, by the design of our study, which includes only those journals indexed in the JCR, that is, which have an IF > 0, discarding all those lacking IF, and in which the publication of Spanish documents causes the MIF to decrease. Moreover, this could be correlated with the fact that the journals most frequently used by Spanish authors have, within the wide area of Gynecology, a ''sub-specialization'' character, which would give them higher IFs. Thus, by way of example, among the journals with highest PaI are three specializing in fertility (*Human Reproduction*, IF = 2.987; *Human Reproduction Update*, IF = 2.969; *Fertility and Sterility*, IF = 2.960) and another two specializing in the menopause (*Menopause*, IF = 3.505; *Maturitas*, IF = 1.640). In this regard, on considering the three main areas of gynecology/obstetrics, which are perinatology, gynecological oncology and reproductive medicine, with our data we should conclude that it is in this field where Spanish scientific production shows most penetration and therefore in which our authors and research teams enjoy the greatest international recognition.

The transience and productivity indexes of the authors provide interesting data. The fact that only 2.79% of the authors (signatories to more than 10 studies) are responsible for 27.6% of the articles indicates that a large part of the quality scientific production included in our material originates from a small number of research teams, though some authors [2,26] consider that productivity is not necessarily an indicator of scientific quality. On the other hand, a transience index of 32.78% may indicate the presence of researchers from other related scientific areas, who have published sporadically in a journal from the specialty, or, perhaps more likely, the passing collaboration of resident physicians during their training period.

Collaboration between authors, an indicator of the importance of teamwork, is reflected in the signatories/study index. The mean value obtained in our study is 4.86 authors per article, a figure slightly higher than that indicated by other Spanish authors in other medical–scientific disciplines [3,7,8,12].

Given the eminently clinical nature of the discipline under study, the principal institution in the production of the documents is the hospital, with 47.62%, followed by the university, with 23.36% and within this category, as we would expect, it is the Faculty of Medicine that presents the highest percentage. Nevertheless, it should be pointed out that the majority of the hospitals have agreements with universities for forming research groups, so that separating these two types of institution is difficult. In fact in the majority of studies whose principle signatory belongs to a hospital, he or she is usually also linked to a university in some way, even though we have categorized such works in the hospital section. The same occurs with other disciplines, in which the majority of university departments carry out their clinical activity in university (or associated) hospitals [2,7,12].

As regards the PaI of the different autonomous communities, it should be stressed that the data obtained in this study do not seem to coincide with the percentages of participation of the biomedical disciplines in general as indicated by other authors [3,7,12], for whom the most productive communities are Madrid and Catalonia. In our case, the participation ranking is led by Catalonia and Valencia, which contribute 60.85% of total production, followed by the regions of Madrid and Andalusia. It is indeed these four regions that are also the most relevant in the field of obstetrics/gynecology in the study by Camí [12]. The fact that some autonomous communities, such us Valencia, occupy such prominent positions, may be due to the location there of some of the most relevant institutions for gynecological research, particularly in the field of fertility.

To conclude this bibliometric analysis and despite the limitations of this type of study, it can be stated that the material studied fulfils Price's Law of the growth scientific literature and that Spanish productivity in the field of obstetrics and gynecology experienced a significant increase during the period 1986–2002, both in total number of documents and in the relative participation in the international context. The contribution of reproductive medicine was a determining factor to this regard.

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