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Assessing gender balance among journal authors and editorial board members

Elva Mauleón[1],
[1] University of Bologna, Department of Management, Bologna, Italy

Laura Hillán[2], Luz Moreno[2], Isabel Gómez[2], María Bordons[2]
[2.] Instituto de Estudios Documentales en Ciencia y Tecnología (IEDCYT), Centre for Human and Social Sciences (CCHS), Spanish National Research Council (CSIC), Madrid, Spain

Corresponding author:
María Bordons
IEDCYT
CCHS
Albasanz 26-28
28037 Madrid (Spain)
Phone: 34-91-602-23-00
Fax: 34-91-304-75-10

Abstract

The study of journal authorship and editorial board membership from a gender perspective is addressed in this paper following international recommendations about the need to obtain science and technology indicators by gender. Authorship informs us about active scientists who contribute to the production and dissemination of new knowledge through journal articles, while editorial board membership tells us about leading scientists who have obtained scientific recognition within the scientific community. This study analyses by gender the composition of the editorial boards of 131 high-quality Spanish journals in all fields of science, the presence of men and women as authors in a selection of 36 journals, and the evolution of these aspects from 1998 to 2009. Female presence is lower than male presence in authorship, editorial board membership and editorship. The presence of female authors is slightly lower than the presence of women in the Spanish Higher Education sector and doubles female presence in editorial boards, which mirrors female presence in the highest academic rank. The gender gap tends to diminish over the years in most areas, especially in authorship and very slightly in editorial board membership. Large editorial boards and having a female editor-in-chief are positively correlated with women presence in editorial boards. The situation of women in Spanish science is further assessed in an international context analysing a selection of international reference journals. The usefulness of journal-based indicators to monitor the situation of men and women in science and to assess the success of policies oriented to enhance gender equality in science is finally discussed.

Keywords: scientific journals, editorial boards, women and science, gender gap, authorship

[1] E-mail: maria.mauleon@unibo.it; elba114@hotmail.com
[2] E-mail: laura.hillan@cchs.csic.es; luz.moreno@cchs.csic.es; maria.bordons@cchs.csic.es

Introduction

Existing studies show that women are under-represented in science insofar as only 1 out of 3 scientists is a woman in most developed countries (She Figures, 2009; National Science Board, 2010). Women are very scarce in specific fields, such as Engineering, while they tend to concentrate in others, mostly in Social Sciences, Humanities and Health Sciences. Moreover, the number of women tends to decline at the highest levels of the academic career or in positions of high responsibility within the science system such as decision-making bodies. Thus, only 15% of full professors at European universities are women against a rate of 36% when total researchers are considered. Even in the fields where the proportion of women is quite high, there is an under-representation of women in senior positions. There are many arguments to advocate for a more gender-balanced structure of science, which span from the defence of women's rights to the need of using the potential of all qualified individuals, be them men or women, for the benefit of society as a whole (National Academies of Sciences, 2006; European Commission, 2010).

In the past decade, different actions have been implemented in the most advanced countries to gather and analyse data about the situation of women in science. In the European context, special mention should be made of the ETAN report (2000), which provided the first global overview of the situation of women in European science; and the She Figures reports, published every three years to provide selected EU employment statistics disaggregated by sex and supplemented by certain other complementary data (She Figures 2009). In the United States, data on the situation of women in science are also being collected in their Science & Engineering Indicators (National Science Board, 2010) as well as in specific publications (e.g., National Science Foundation, 2011).

The scarcity of women in decision-making bodies in science is currently a matter of deep concern. Accordingly, an expert group on Women In Research Decision Making (WIRDEM) was established in 2006 to provide a report on this issue covering European countries (European Commission, 2008). As stated in the report, the weak presence of women in decision-making bodies implies that their opinions are less likely to be taken into account in important issues such as recruitment, funding or priority setting in scientific research. Moreover, women are required in leading positions to serve as role models for graduate students and junior researchers and to attract and retain young women in the scientific profession.

There is a series of former studies setting forth a set of recommendations to maximise the potential of women in science (see for example, National Academies of Sciences, 2006). Furthermore, several initiatives and actions have been designed and implemented in many countries to try and attract women to all fields of science, to retain them once they enter the research system –a high level of withdrawals has been observed- and to promote their advancement in the academic career (see for example, European Commission, 2010). At the same time, the development of appropriate indicators to monitor the position of women in science and to assess the success of the different policy measures undertaken becomes an essential task.

Given the importance of scientific journals in the research system as the main channel of communication for new knowledge, the interest of obtaining journal-based indicators disaggregated by gender is obvious. Within journals, it is possible to assess the presence of men and women as authors of documents, but also their participation in the editorial boards, which are a type of decision-making body in the scientific community. While journal authors can be representative of the active scientific community in the journal field, editors are supposed to be part of the elite of leading

scientists in the field. In summary, authorship, editorial board membership and editorship by gender can be studied as a surrogate marker of gender balance/imbalance in science.

The editorial boards of scientific journals play a crucial role in science. Their members have been called the “gate-keepers” of science because they contribute to ensure the quality of scientific journals (Braun, 2004), and are selected according to their experience and prestige in their fields enjoying high visibility in the scientific community (Crane, 1967; Merton, 1977). Since editorial board composition is usually available in journals, it is possible to assess how often women are present in these bodies which play a critical role in their success. A number of studies have analysed the presence of women in the editorial boards of journals, mostly limited to a selection of journal titles within a given subject area such as Medicine (see for example, Kennedy, Li and Dickstein, 2001; Morton and Sonnad, 2007; Amrein et al., 2011; Miqueo, 2011), Psychology (Robinson et al., 1998), Management (Metz and Harzing, 2009) or Political Science (Stegmaier, Palmer and Van Assendelft, 2011). Authorship has also been addressed from a gender standpoint in specific journals (González-Alcaide, 2010; González-Alcaide et al., 2010) or disciplines (Sidhu et al., 2009; Torres Salinas, Muñoz-Muñoz and Jiménez-Contreras, 2011). In addition, some studies adopt an interesting perspective consisting in a parallel survey of the presence of women in authorship and in editorial board membership (see for example, Robinson et al., 1998; Porter, Christian and Poling, 2003; Evans, Hsieh and Robinson, 2005).

The percentage of women among authors and editorial board members varies by journal and discipline. Besides, it has been noted that within a given discipline the share of women decreases as the prestige of the activity increases, which means that female presence among authors tends to be higher than among editorial board members (see for example Dickersin et al., 1998); and even that the percentage of women reaches a maximum among authors and declines for first authors, editorial board members and editors-in-chief (McSweeney et al., 2000; Porter, Christian and Poling, 2003). This statement is consistent with the “glass ceiling” argument, which states that the participation of women in research declines as you go up the position ladder.

In parallel with the increasing numbers of women in research documented in the literature (She Figures 2009) an upward trend in female involvement as journal authors and/or editorial board members has been described over the last decades. As an example, we can mention that an increase over time in the percentage of female authors has been observed in different studies in the fields of Psychology (Robinson et al., 1998) and Medicine (Jagsi et al., 2006; Sidhu et al., 2009), although no change was reported in Oncology journals (Singh and Jatoi, 2008). Women presence among editorial board members also tends to grow over the years in Epidemiology (Dickersin et al., 1998); Psychology (Robinson et al., 1998; Evans, Hsieh and Robinson, 2005; Fong et al., 2009); and Management (Metz and Harzing, 2009).

A key issue in the revised studies on the topic is what proportion of women among authors and editorial board members should be expected. Concerning authorship, the general consensus is that the percentage of female authors in a given field should be compared with the percentage of women in the speciality, and as a proxy for the latter, the percentage of female faculty or the percentage of female members in a professional association of the speciality have been used (Fong et al., 2011; Jagsi et al., 2008). With regard to editorial boards, there is a greater discrepancy in published studies about which reference should be used. Some studies compare the percentage of female editorial board members to the percentage of female authors in the corresponding journals, assuming they are representative of the pool of women

scientists in the field (Dickersin et al., 1998). In other studies, the percentage of women editorial board members is matched against the percentage of women faculty or female members in professional associations (Kennedy, Li and Dickstein, 2001; Morton and Sonnad, 2007; Amrein et al., 2011). However, since senior scientists are more likely to serve in editorial board positions, the share of women in the highest faculty rank instead of in the total of faculty could be a more appropriate expected value for female presence in editorial boards (Stegmaier, Palmer and Van Assendelft, 2011; Miqueo et al., 2011). First and last-authorship figures have also been considered as a proxy for senior scientists in specific disciplines in which principal researchers tend to sign in one of these positions in the by-line of publications (Jagsi et al., 2006; Metz and Harzing, 2009; Sidhu et al., 2009).

The identification of journal factors which may influence the presence of women in journals has also been explored in the literature. A higher presence of women in editorial boards has been described in academic journals when compared with commercial ones, maybe because academia is more aware of the need to provide equitable career opportunities to men and women (Metz and Harzing, 2009). However, journals associated with a professional society did not show higher female presence in Medicine (Amrein et al., 2011). Journals with a female editor-in-chief showed higher female representation in editorial boards in some studies (Metz and Harzing, 2009), while no differences were observed in others (Amrein et al., 2011). Interestingly, different studies suggest a higher proportion of women in the editorial boards of the most prestigious journals (Metz and Harzing, 2009; Miqueo et al., 2011). Different aspects such as journal commitment to gender issues or the need to meet diversity requirements in the editorial boards of the most prestigious journals were pointed out as the driving underlying factors. According to Metz and Harzing (2009), diversity in editorial boards is positive to provide wider perspectives on research and gender variety contributes to editorial board diversity.

In this context, the aim of this paper is two-fold:

1. To study editorial board membership, authorship and editorship by gender in a set of high-quality Spanish scientific journals across all fields of science; to analyse inter-field differences; and to track changes during an eleven-year period. As a benchmarking exercise, the study is extended to a set of international reference journals to compare the presence of women authors in Spanish journals to that in the international scientific community.

2. To explore the relationship between female authorship, female presence among academic staff in the journal's field, journal features (editorial board size, journal prestige and internationalisation) and female presence in editorial boards.

These variables were selected according to the following rationale. Firstly, we would expect to find a higher percentage of female editorial board members in those areas with a greater presence of female scientists assuming that the presence of women in editorial boards is partly determined by the pool of female scientists in each field (hypothesis 1). Secondly, a higher presence of women in editorial boards is expected for those fields with a higher share of women at the highest rank of the academic hierarchy, since senior scientists are more often invited to join editorial boards (hypothesis 2). Finally, in relation to journal factors, we expect a positive influence from editorial board size (hypothesis 3), female editors-in-chief presence (hypothesis 4) and journal prestige and internationalisation (hypothesis 5) on the share of female editorial board members. The last hypothesis is supported by past research (Metz and

Harzing, 2009; Miqueo et al., 2011), where a higher female presence was described for the editorial boards of the most prestigious journals. Besides, we assume that prestigious journals are more likely to receive citations and have a wider international scope.

A number of reasons may be argued to defend the interest of this paper.

Firstly, the study is of interest from a research policy perspective, since it provides journal-based indicators by gender which are useful to monitor the situation of men and women in the Spanish scientific community. It enables us to explore how women contribute to the advancement of science through the creation and dissemination of new knowledge via journals (as authors), to what extent they succeed in attaining an influential position in journals (as editorial board members), and to monitor the evolution of these features throughout an eleven-year period. It is particularly worth noting that a regular collection of sex-disaggregated S&T data, as the one undertaken in this study, is recommended by national and international agents to monitor the situation of men and women in science, to recognise potential gender imbalances and to assess whether the strategies used to promote gender balance are pertinent and effective. In addition, the study might be of interest to journal editors, who may gather information on the performance of their journals from a gender perspective and in relation to other journals in the same field (for a detailed description of indicators at journal level see Bordons et al., 2012)[3].

Secondly, exploring which are the variables with a greater influence on female authorship and editorial board membership can shed new light about factors contributing to the under-representation of women in journals and support policies oriented to enhance women contribution.

Finally, there are few studies which analyse authorship from a gender perspective in Spanish journals (see for example, Aleixandre-Benavent et al., 2007; González Alcaide, 2010; González Alcaide et al., 2010), and the composition of editorial boards has hardly been analysed. An exception to this is a recent study of Miqueo et al. (2011) which covers Spanish medicine journals. To the best of our knowledge there are no prior studies offering a combined analysis of editorial boards and authorship in Spanish journals from a gender perspective.

Methodology

This study analyses the presence of men and women in the research elite that forms part of the editorial boards of 131 Spanish scientific journals covered by the Web of Science database (WoS) throughout the 1998-2008 period. The breakdown of the total number of journals under survey is as follows: 36 journals in Social Sciences, 31 in Humanities and 65 in Experimental and Life Sciences (table 1). The quality and international dissemination of these journals is supported by their inclusion in the WoS database. In order to be included in the WoS, journals must pass an evaluation of their scientific quality and a series of editorial and formal aspects (http://thomsonreuters.com/products_services/science/free/essays/journal_selection_process/).

The study of authorship was limited to only 36 of the 131 journals distributed among the different areas under analysis: 14 in Social Sciences, 10 in Humanities and 12 in Experimental and Life Sciences (Annex 1). These journals were selected according to

[3] Preliminary results presented at the "IX Congreso Iberoamericano de Ciencia, Tecnología y Género", held in Seville (Spain), January 31st-February 3rd, 2012.

several criteria which include: research area, WoS coverage during the whole 1998-2008 period, inclusion of the full name of authors (not only first name initials), and journal accessibility. Only articles and reviews (citable items) have been considered (hereinafter referred to as “articles”).

To place the data of the Spanish journals in an international context, a total of 12 international journals were selected on the basis of their subject area and high international visibility and impact (citations and impact factor in WoS). Among different potential international reference journals: (a) the one more cited by Spanish journals was selected to ensure the relatedness of the journals subject to comparison, and (b) Spain being a European country, European journals were preferred. This has allowed us to carry out a benchmarking exercise, since the involvement of female authors in the Spanish journals is compared against the same in a set of international reference journals which are considered representative of the international scientific community.

Table 1. Number of Spanish journals analysed by subject area and type of analysis

Subject area	Number of journals analysed	
	Editorial Board	Authorship
Agric./Biol./Environment	13	2
Biomedicine	13	2
Chemistry	2	2
Clinical Medicine	24	2
Engineering/Technology	9	3
Humanities	31	10
Mathematics	10	2
Social Sciences	35	14
TOTAL	131	36

Note: the sum is higher than the total number of journals due to journal multi-assignation.

Articles were downloaded from the WoS database in the case of journals in Experimental and Life Sciences and from the Spanish Index in Social Sciences and Humanities (ISOC) for the remaining areas. ISOC was used because some of the Social Sciences and Humanities journals were only partially covered by the WoS. The information about the composition of the editorial boards was generally obtained from the official journal website or from the print edition of the journals when available at CSIC’s libraries network. Failing both these options, we have requested the journal by electronic mail or by phone to provide this information.

Different procedures were followed for sex identification purposes: (a) sex was inferred from the name of the authors when they had well-known names whose sex assignation was clear; (b) through the automatic sending of electronic mail to authors asking for their sex as well as that of their co-authors in the selected documents; or (c) through a search of web pages, either personal or institutional. The sex of authors has been identified in 97% of the articles from Spanish journals and in 88% of the articles from international reference journals. The remaining articles were excluded from the study.

1. Journal-based indicators by sex

A number of indicators were calculated for the study of the involvement of women as authors and members of editorial boards.

(a) Editorial boards

- Percentage of women and percentage of men in editorial boards.
- Percentage of journals with a female editor-in-chief.
- Woman/Man ratio (W/M ratio): percentage of women divided by the percentage of men in a given editorial board. This ratio is below 1 when the percentage of women is lower than that of men, and above 1 in the opposite situation. A ratio of 1 indicates gender parity. This indicator enables us to measure the "gender gap".

These indicators were calculated for the 131 Spanish journals in two different years (1998 and 2009) with the aim of identifying time trends and monitor the evolution of the "gender gap". Data obtained at journal level were aggregated into disciplines and areas (area level is shown in this paper) to obtain a global view of the situation.

(b) Authorship in articles

- Female presence in articles: share of women in the total number of authors who sign articles in a given journal. Male presence refers to the share of men among authors in a journal. These indicators are calculated taking into account the total number of author occurrences (authorships) (and not unique authors), since a given author may appear under different variant names which were not normalised in this study. The Woman/Man ratio was calculated as described above as the percentage of women divided by the percentage of men.
- Participation: percentage distribution of articles in three different types: (a) articles authored only by women, (b) articles authored only by men; and (c) articles authored by cross-gender teams including at least one man and one woman.

These indicators were calculated for the 36 selected Spanish journals for the 1998-2008 period to identify time trends and for the 12 reference journals in 2008. Data obtained at journal level were aggregated into areas.

2. Journal features

An analysis of the relationship between female presence in journals and the following journal features was conducted:

- Size of journal editorial board. It is measured by the number of members in the editorial board of the journal in 2009.
- Scimago Journal Rank (SJR): indicator of journal prestige (http://www.scimagojr.com/). It takes into account both the number of citations received by a journal and the importance or prestige of the journals where such citations come from. We have used the SJR for 2009. A strong correlation between SJR and the Thomson impact factor has been described in the literature (González-Pereira et al., 2010). SJR was considered to be a better choice than the Thomson impact factor because the latter is not calculated for journals in Humanities. To allow comparisons between different subfields, the Normalised Journal Position (Pos_SJR) is calculated, which considers the position of each journal in the ranking of journals in descending order of SJR by subfields. This indicator was previously described to normalise impact factor values (Bordons and Barrigón, 1992). It ranges from 0 (low SJR values) to 1 (high SJR values).

  $$Pos\_SJR = 1 - \frac{\text{Ordinal position of journal in subfield X}}{\text{Total number of journals in subfield X}}$$

- Internationalisation: percentage of papers from foreign countries during the period 1998-2008. The indicator was obtained for the whole period rather than for the year 2008 to avoid annual fluctuations of data.

- Female editor-in-chief: assuming that female editors have an enduring effect (Metz and Harzing, 2009), it was coded 1 if the journal had a female editor either in 1998 or 2009, and 0 if not.

These indicators were calculated for the 36 selected Spanish journals.

3. Female presence among scientists in Spain

The percentage of women among academics in the Spanish Higher Education sector (HE)[4] was used as a proxy for female presence among scientists in Spain. The percentage of women in the highest academic rank *("catedráticos")* at the Spanish HE sector was used as a proxy for female presence among senior scientists in the country. We would have liked to have this data for all institutional sectors, but it was not available by areas for the period analysed in our study. However, we consider it an appropriate reference, since, in Spain, more than 60% of scientific publications originate from the higher education sector (Gómez et al., 2011).

The distribution by sex of academic staff in Spanish Higher Education is provided periodically for five broad areas (Experimental Sciences, Humanities, Health Sciences, Social Sciences, Technology) and also disaggregated into almost 200 fields of knowledge. For the purposes of our study, every journal was assigned to a field of knowledge according to its scope of research, and female presence in each journal was compared to female presence in the academic staff of the corresponding field.

Journal-based indicators in 2008 (authorship) or 2009 (editorial boards) were compared with HE staff statistics for the 2008-2009 academic year. It should be noted that for this year, women accounted for 37% of the academic staff and 15% of those in the highest rank *("catedráticos")*, although there are some inter-field differences (INE). A positive correlation was found between the percentage of women in overall academic staff in the Spanish HE sector and the percentage of women among those in the highest rank by field of knowledge (R^2=0.532) (own elaboration). The same trend was observed when the subset of fields with any of the 36 analysed journals was considered (R^2=0.745).

4. Multivariate analysis of data

The relationship between journal-based indicators by sex, journal features and female presence in academic staff was studied through Spearman correlations, principal component analysis for categorical data and categorical regression analysis.

Categorical principal components analysis (CATPCA) was used to identify and summarise relationships between the different variables. It reduces the original set of variables to a smaller set of non-correlated components that represent most of the information. The benefit of using this technique rather than the standard principal component analysis is that it allows for the treatment of different types of variables (numeric, ordinal or nominal) -which are transformed into optimally scaled variables- and that it does not require assumptions such as the normality of variables or a linear relationship between them. This technique provides an interesting graphical representation of the relationship between variables.

Categorical regression (CATREG) was used to identify which are the most influential variables on the share of female editorial board members. This technique was preferred to traditional regression because it enables us to use nominal variables which

[4] It includes all academic staff at the Higher Education Sector, either permanent or temporary.

are transformed into interval variables using the optimal scaling method. Multiple regression analysis is then applied to these transformed variables.

Statistical analyses were performed with SPSS (version 17) for Windows. Descriptive statistics are given as the average ± standard deviation. Differences were considered significant when $p<0.05$.

Results

This study analyses the editorial boards of 131 Spanish journals comprising a total of 5,127 members in 1998 (average size=39) and 6,757 members in 2009 (average size=52).

As regards authorship, the study of 36 Spanish journals covers 1,495 articles in 1998 and 1,450 in 2008 totalling, respectively, 4,341 and 4,884 authorships. The analysis of the 12 international reference journals deals with 5,801 articles in 2008 including 20,257 authorships.

1. Editorial boards

The presence of women in the editorial boards of the 131 Spanish journals varies by area but it stands below 30% in every case. The lowest female presence rate is observed in Mathematics (6%), both for 1998 and 2009, and the highest in Humanities (around 26% of women in 2009) (table 2). In 6 out of the 8 areas the presence of women shows a rising trend throughout the period, especially in Agr./Biol./Envir., where the percentage of women grows from 15% in 1998 to 23% in 2009. No increase is observed in Engineering and Mathematics, which show similar values of female presence in both years.

Table 2. Gender gap evolution in the editorial board composition of the 131 Spanish journals by areas (in decreasing order of women percentage in 2009)

	1998				2009				Change in gap
	Tot. no. of Members	% Women	% Men	Ratio W/M	Tot. no. of Members	% Women	% Men	Ratio W/M	
Humanities	672	23.81	76.19	0.313	970	26.49	73.51	0.360	0.048
Social Sci.	1234	19.61	80.39	0.244	1763	24.39	75.61	0.323	0.079
Agr./Biol./Envir.	435	15.17	84.83	0.179	584	23.12	76.88	0.301	0.122
Chemistry	38	15.79	84.21	0.188	44	22.73	77.27	0.294	0.107
Biomedicine	698	13.18	86.82	0.152	827	18.02	81.98	0.220	0.068
Clinical Med.	1485	10.51	89.49	0.117	1905	14.75	85.25	0.173	0.056
Engineering	219	12.79	87.21	0.147	303	12.54	87.46	0.143	-0.003
Mathematics	346	5.78	94.22	0.061	361	5.54	94.46	0.059	-0.003
Average		14.58	85.42	0.175		18.45	81.55	0.234	0.059

Note: The last column shows the gender gap change, that is, the difference between the W/M ratio in 2008 and 1998.

With respect to the presence of women in leading positions within editorial boards, only 8% of journals in 1998 and 24% in 2009 had at least a woman as editor-in-chief, although substantial differences by area have been found. The case of Humanities is worth noting, since more than 30% of the journals analysed had at least one woman as editor-in-chief both in 1998 and in 2009. Over the whole period the number of female

editors-in-chief follows an upward trend to the extent that no journal had a female editor in-chief in 1998 in the areas of Biomedicine, Mathematics, Clinical Medicine and Chemistry, whilst in 2009 there is at least one woman-led journal within each area (table 3). Overall, 8% of editors-in-chief were women in 1998 vs. 21% in 2009 (some journals have more than one editor-in-chief).

Table 3. Evolution in the percentage of journals with women as editors-in-chief by areas (131 journals)

	% Journals with a female editor-in-chief		Total no. of journals
	1998	2009	
Agr./Biol./Envir.	7.69	23.08	13
Biomedicine	0	23.08	13
Chemistry	0	50	2
Clinical Medicine	0	4.17	24
Engineering	11.11	22.22	9
Humanities	32.26	35.48	31
Mathematics	0	10	10
Social Sciences	11.43	22.86	35
Average	7.81	23.86	

2. Authorship of articles

The study of the authors of the articles published in the 36 Spanish journals reveals that the presence of women ranges from 15% in Mathematics to 40% in Biomedicine for the whole 1998-2008 period.

Female presence gains ground across all areas except in Agr./Biol./Envir., where it remains at around 37% throughout the period. The highest increase corresponds to Engineering, where the percentage of women goes up from 24% in 1998 to 40% in 2008 (+16 percentage points), whilst the lowest is observed in Mathematics, where female presence only grows from 12% to 14% (+2 percentage points). It is worth mentioning that by the end of the period four of the areas have a female presence above 40% and a W/M ratio above 0.7 (table 4).

Table 4. Gender gap evolution in authorship for the 36 Spanish journals by area (in decreasing order of women percentage for 2008).

	1998				2008				Change In gap
	Total Authors	% Women	% Men	W/M	Total Authors	% Women	% Men	W/M	
Biomedicine	475	36.80	63.20	0.582	545	44.20	55.80	0.792	0.210
Humanities	277	29.20	70.80	0.412	171	43.30	56.70	0.764	0.351
Chemistry	285	31.90	68.10	0.468	397	42.80	57.20	0.748	0.280
Social Sciences	577	29.50	70.50	0.418	1151	41.30	58.70	0.704	0.285
Engineering	145	24.10	75.90	0.318	309	40.10	59.90	0.669	0.352
Agr./Biol./Envir.	263	37.60	62.40	0.603	428	36.90	63.10	0.585	-0.018
Clinical Med.	2237	26.20	73.80	0.355	1703	33.59	66.41	0.506	0.151
Mathematics	82	12.20	87.80	0.139	180	14.40	85.60	0.168	0.029
Average		28.44	71.56	0.412		37.07	62.93	0.617	0.210

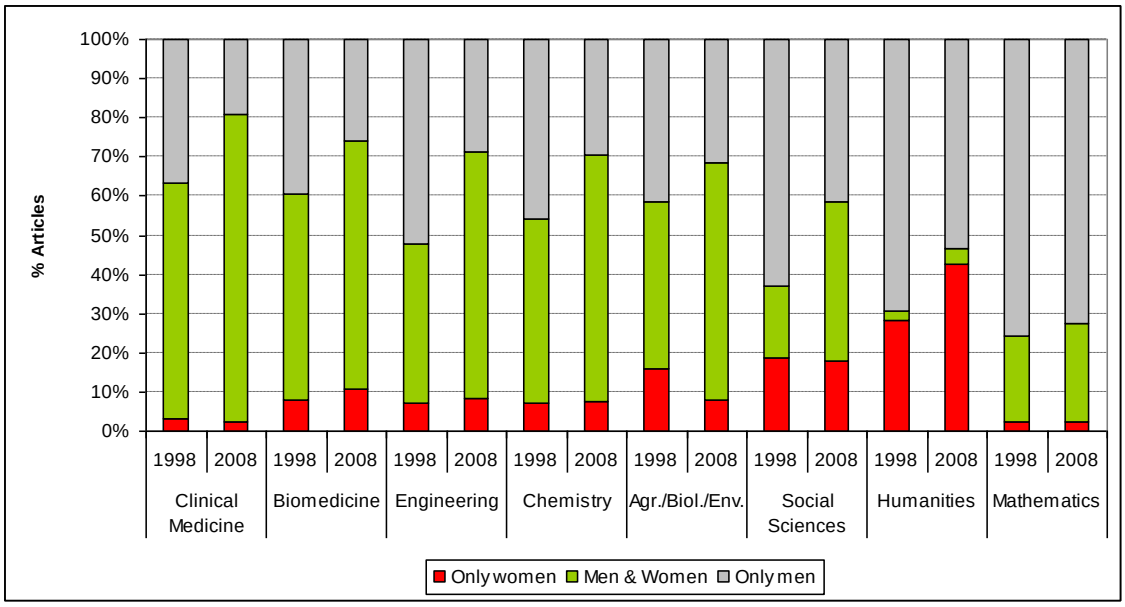
Note: The last column shows the gender gap change, that is, the difference between the W/M ratio in 2008 and 1998.

The participation of women as authors of articles varies notably by area. The lowest female involvement is observed in Mathematics, where 26% of the articles had at least one woman among authors, while the highest female participation was reached in Clinical Medicine or Biomedicine, where 71% of articles were authored by at least one woman.

We can see in Figure 1 that articles authored only by men predominate in Mathematics (74%) and Humanities (63%), while those authored by cross-gender teams (men and women) are the prevailing case in the remaining areas, except for Social Sciences. It is interesting to highlight the fact that Humanities and Social Sciences show the greatest values for articles authored only by women (32% y 21% respectively), a fact that may be due to the important weight of single-authorship in these areas. The greatest share of single-authored articles was found in Humanities (90%), followed by Social Sciences (48%) and Mathematics (33%), while the rate of single-authored articles for the rest of the areas stood below 15%.

Female participation grew across all areas from 1998 to 2008. The highest growth rate is observed in Engineering (+23 percentage points, 48% of articles with at least one woman in 1998 vs. 71% in 2008) and Social Sciences (+22 percentage points, 37% of the articles with at least one woman in 1998 vs. 59% in 2008). Mathematics is the area with the lowest female participation for both years, and it is also the area with the lowest growth rate (+3 percentage points, 24% of the articles with at least one woman in 1998 vs. 27% in 2008). It should be noted that in all areas, except for Humanities, higher female participation is mainly due to a rise in the number of articles authored by cross-gender teams. The fact that the highest increase is found for articles authored only by women in Humanities can be due to the predominance of single-authored papers in this area (Figure 1).

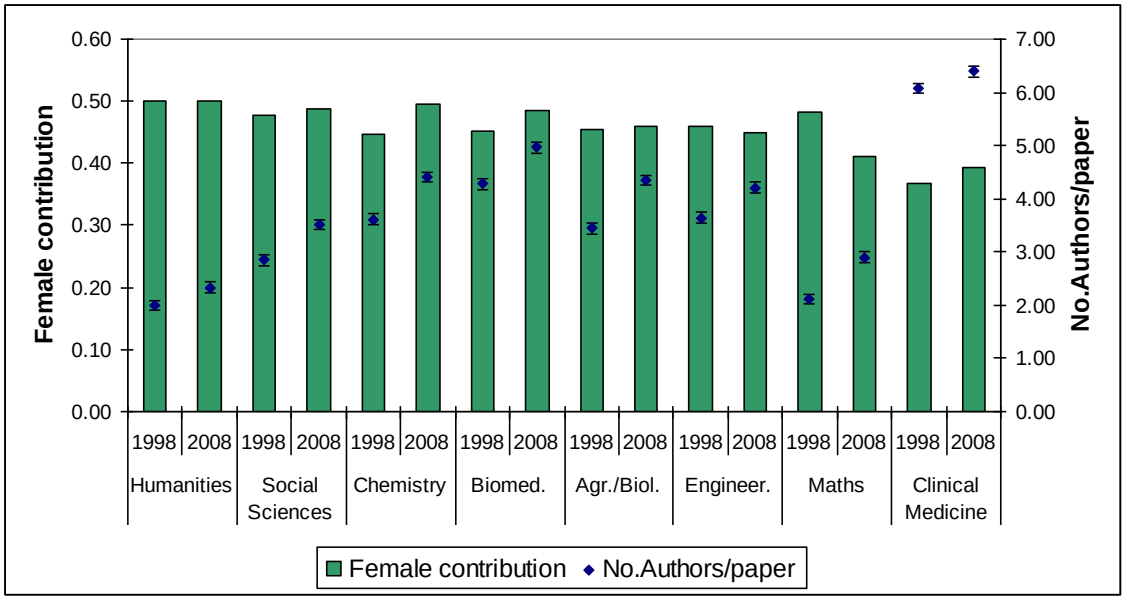
Figure 1. Time trends by area in the distribution of articles according to the participation of authors by sex (36 journals)



The extent of the involvement of women in cross-gender papers may vary depending on the subject field, since more collaborative fields may have larger teams but with only an occasional participation of women in them. To explore this issue, female contribution (fractional count of female authors) in cross-gender papers by field is

shown in Figure 2, where the average size of cross-gender teams is also presented. It clearly appears that there are not large differences by fields in average female contribution, which ranges from values below 40% in Clinical Medicine to around 50% in Humanities. Although in Figure1 Clinical Medicine presents the highest share of cross-gender papers, it shows the lowest female contribution; this being explained by the large size of their teams (where roughly 40% of members are women). It is interesting to observe that the size of teams tends to increase over the years in all areas. However, in some cases, female contribution remains more or less stable[5] (Humanities, Social Sciences, Agr./Biol./Envir., Engineering), which means that the numbers of both men and women grow at the same rate; in other areas there is an increase in female contribution[6] (Chemistry, Biomedicine and Clinical Medicine), which means that the number of women grows faster than that of men; and, finally, in one single area [7] (Mathematics) a decline in female contribution is observed.

Figure 2. Female contribution (fractional count) and average number of authors for cross-gender papers (areas in descending order of female contribution in 2008) (36 journals)



3. Comparison with international reference journals

To place Spanish data in an international context, women involvement in Spanish journals is compared to the corresponding values in a selection of international reference journals. This study is limited to 12 journals distributed across different subfields. Each Spanish journal is compared with a leading international journal in its subfield. Figure 3 presents the Women/Men ratio in authorship (year 2008) for the Spanish and the reference journal for each subfield. The list of benchmark journals is included in Annex 2 (most of them are from EU countries, only two from the US).

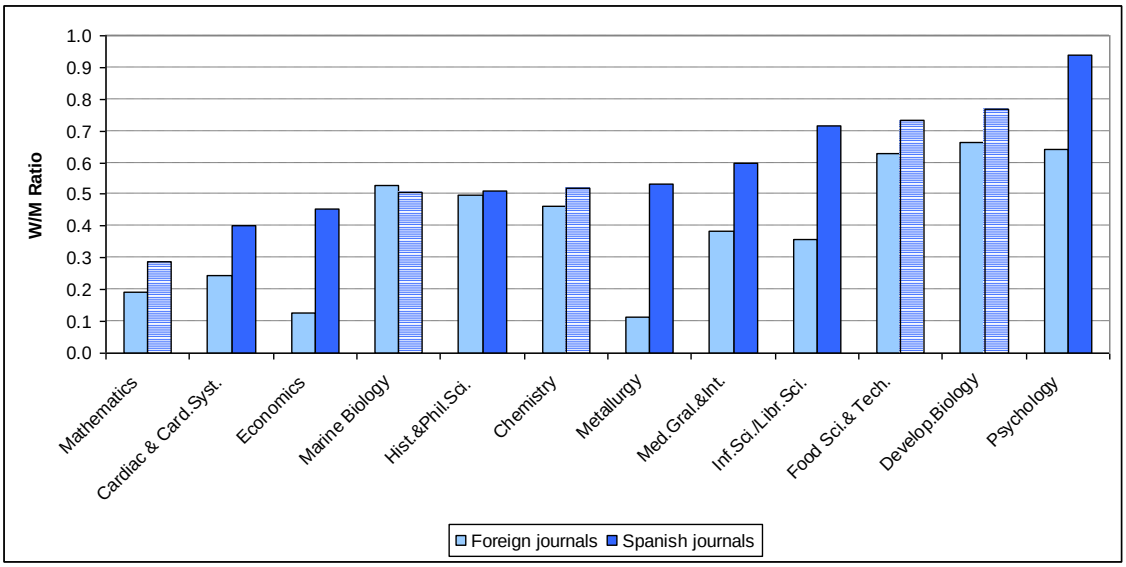
Female presence as authors is lower than male presence both in Spanish and in international journals (W/M ratio below 1) in all subfields. Interestingly, the gender gap

[5] Change over time of female contribution below 3%
[6] Increase of female contribution above 5%
[7] Decline of female contribution above 5%

tends to be wider in international journals (lower W/M ratios). The greatest differences between Spanish and international journals are observed in Metallurgy and in Economics, where the percentage of women in Spanish journals is three times higher than in benchmark publications.

Are these differences due to the higher presence of women in the Spanish scientific community as compared to other countries? If that was the case we would expect to find less differences between national and benchmark journals for Spanish journals with a wider international scope. Since one possible measure of the international nature of journals is the publication of papers from different countries and not only from the journal's country of publication[8], those Spanish journals with at least half of their articles from countries other than Spain were marked as internationally oriented (striped line in Figure 3). The difference between the W/M ratio of Spanish and benchmark journals was significantly lower for Spanish internationally-oriented journals as compared with the rest of them (0.07 ± 0.5 vs. 0.25 ± 0.13; Z=-2.196, p<0.05, Mann-Whitney test), which points to the higher female presence in the most nationally-oriented journals.

Figure 3. Gender gap in the authorship of articles published in Spanish and international reference journals (presence) (2008)



Note: striped bars represent Spanish journals with at least half of their articles written by authors from countries other than Spain.

4. Global analysis of data

This part of the study is limited to the set of 36 journals for which an in-depth analysis of authorship has been conducted. Moreover, journals are grouped into five different areas (Social Sciences, Humanities, Technology, Health Sciences and Experimental Sciences[9]) instead of the eight shown in the sections above for data comparison purposes on female presence among academics in the Spanish Higher Education sector (INE).

[8] As stated by Uzun (2004), the contribution of authors from different countries and the international composition of the editorial boards are strongly related factors which contribute to the internationalisation of journals.

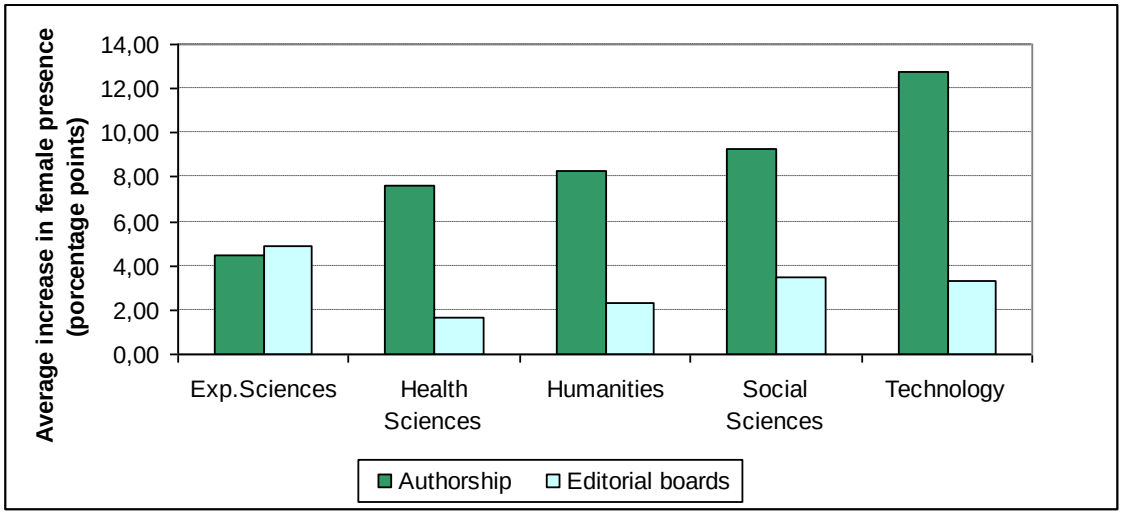
[9] To match our subject areas with those described in the statistics of the Spanish Higher Education Sector produced by the Spanish National Institute for Statistics (INE), the journals included in Biomedicine, Chemistry, Agr.Biol.Envir. and Mathematics were all grouped under the heading "Experimental Sciences".

To begin with, it is worth noting that the percentages of female authors and editorial board members show an upward trend over the years, being both significantly higher in the most recent year (Wilcoxon test; Z=-3.833 for authors, p<0.000; and Z=-3.077 for editorial board members, p<0.01).

Moreover, the percentage of female authors was significantly higher than the percentage of female editorial board members in both periods (Wilcoxon text; Z=-3.650, p<0.000 in the first year; Z=-3.94, p<0.000 in the most recent year).

The presence of female authors increased over time in 29 out of 36 journals, while the presence of female editorial board members grew in 24 journals. Overall, the average increase in female presence was higher for authors (around 8 percentage points) than for editorial board members (around 3 percentage points) (average growth rates: 8.27± 11.88 for authors, 3.32 ± 7.74 for editorial board members; p<0.05). As shown in Figure 4, the growth in female authors was higher than that in female editorial board members for all areas except in Experimental Sciences, where both rates were similar (results are not significantly different, although we have to remain aware of the small size of the samples).

Figure 4. Average increase in female presence in 36 journals by broad area



Which are the factors that may have an influence on the presence of women in journals? We have explored the relationship between three types of variables: (a) female presence in journals, as measured by the share of female authors and female editorial board members; (b) journal features, which include the size of the editorial board, SJR position and journal internationalisation; and (c) female presence among scientists in Spain. Three different and complementary approaches were used to gain new insights into the data: bivariate correlations among variables to measure the existing association between pairs of variables; principal components analysis which provides us with a graphical representation of data; and categorical regression analysis, to explore the effect of different variables on the share of female editorial board members.

4.1. Correlation between variables

The correlation between the variables analysed is shown in table 5. The percentage of women in editorial boards is positively correlated with the percentage of women in the Higher Education sector (either for the total number of scientists or for those in the highest rank), the percentage of female authors and the presence of a woman as editor-in-chief. This means that women are better represented in the editorial board of journals led by women as well as in fields with a higher share of women academics.

No relationship between female presence in journals (either as authors or as editorial board members) and the prestige (as measured by the SJR) and internationalisation of journals (as measured by the percentage of foreign articles published in a given journal) was found. However, journal prestige tends to rise with internationalisation. This could be partly explained by the fact that the higher visibility and potential readership of international journals may increase the likelihood of their articles receiving citations, which are on the basis of the SJR calculation.

Table 5. Correlation between journal-based indicators of female presence, journal features and female presence among academic staff in the HE sector (Years: 2008, 2009)

		1	2	3	4	5	6	7	8
1	% Women in editorial boards	1.000 .	.405*	.109	-.107	.498*	.490**	.645**	.024
2	% Women authors		1.000	.012	-.189	.095	.479**	.443**	-.182
3	Size of editorial board			1.000	.182	.131	.179	.151	.239
4	Pos_SJR				1.000	.089	-.065	-.189	.436**
5	Woman editor-in-chief					1.000	.189	.262	.264
6	% Women in total acad. staff						1.000	.896**	-.069
7	% Women in highest acad. rank							1.000	-.028
8	% Foreign papers								1.000 .

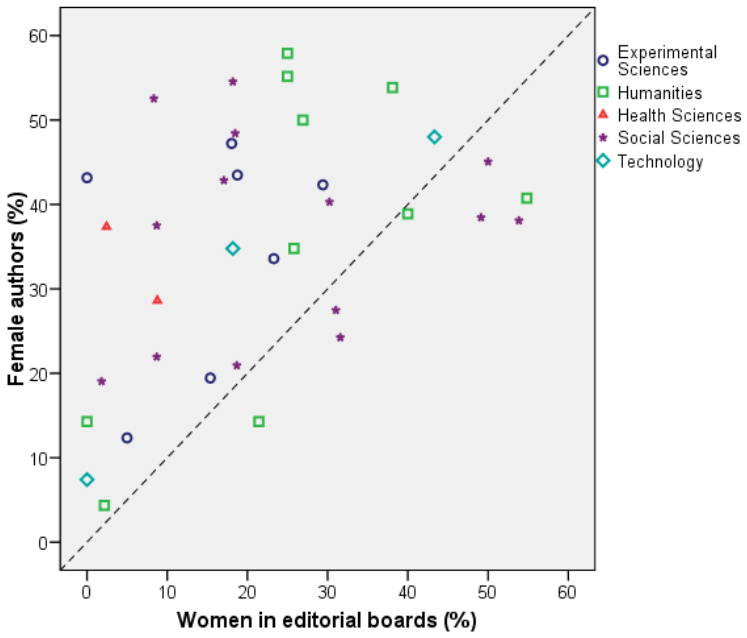
Spearman correlation. * p<0.05; **p<0.01
36 journals
Note: Data on academic staff refer to the 2008-2009 academic year. Editorial board data for 2009. Authorship data for 2008.

Interestingly, the share of women in editorial boards shows a stronger correlation with the share of women in the highest academic rank than with the share of women among the total scientist population, which suggest that the former is a better proxy for the pool of potential editorial board members.

The relationship between the percentage of women authors of articles and the percentage of women in editorial boards is shown in Figure 5, revealing a positive correlation between both variables. We observe that while a wide range of female authorship levels is observed for low values of female editorial board membership, high

levels of female authorship seem to be needed to obtain high values of female editorial board membership. In other words, a high percentage of female authors is required to obtain a high percentage of women in editorial boards, and yet provides no assurance in that respect. Only seven journals show higher female presence in editorial boards than in authorship (points under the diagonal line in Figure 5), 4 specialise in Humanities and 3 in Social Sciences.

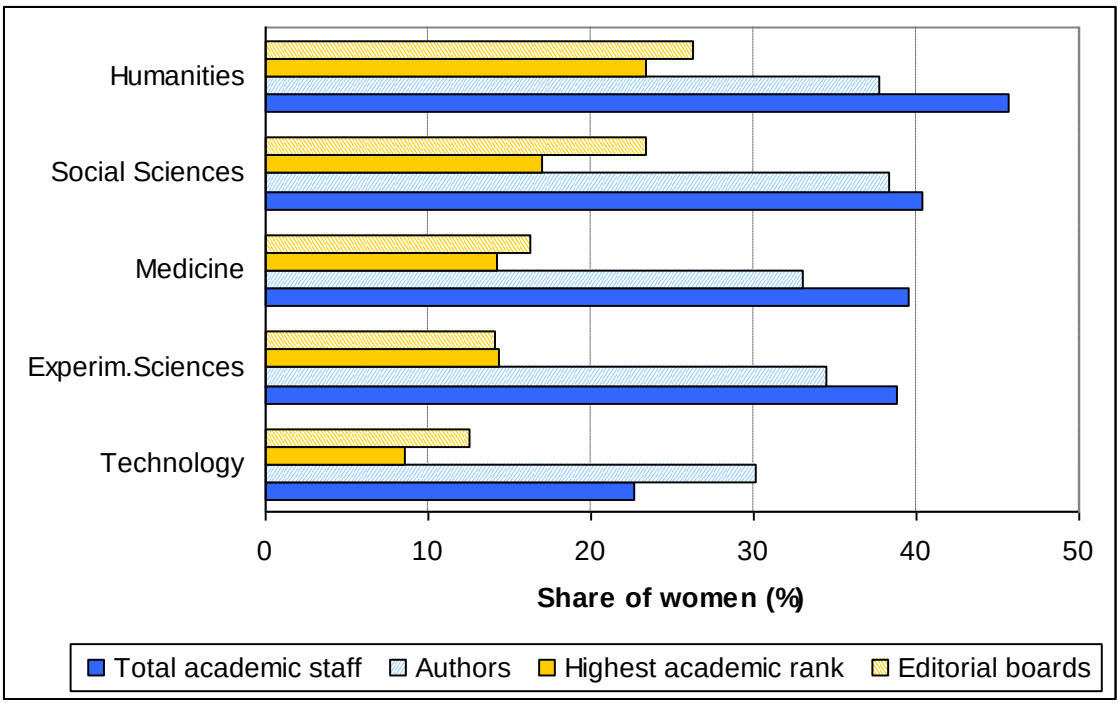
Figure 5. Relationship between the percentage of female authors and the percentage of women in editorial boards (Years 2008, 2009) (36 journals)



A comparative study of the presence of women among HE academic staff and among journal authors and in editorial board members has been conducted. At journal level, the share of female authors is significant higher than the share of women serving as academic staff ($Z=-2.074$, $p<0.05$) whilst no significant differences between the share of female editorial board members and the share of women at the highest academic rank have been identified.

Similar trends are observed at area level (Figure 6). The presence of women among authors is slightly lower than among academic staff in four out of the five areas under analysis while women's presence in editorial boards seems to be slightly higher than women's presence in the highest academic rank. Particular emphasis should be placed on the fact that the share of female authors is above their share as staff members only in Technology, which could be related with the characteristics of the journals analysed in this area (see the discussion section). We did not search out for significant differences at area level because of the small number of journals in some of the fields.

Figure 6. Comparison of women presence in journals (female presence in authorship and in editorial board membership) and women presence in academic staff in the Spanish Higher Education sector (total and highest ranked academics) by area



Note
Indicators shown: Share of female authors in 36 journals (2008), share of women in the editorial boards of 131 journals (2009); share of women in the academic staff of the Spanish Higher Education (HE) system, and share of women in the highest academic rank within the Spanish HE system by broad areas (Source: Spanish Higher Education Statistics, academic year 2008-2009.)

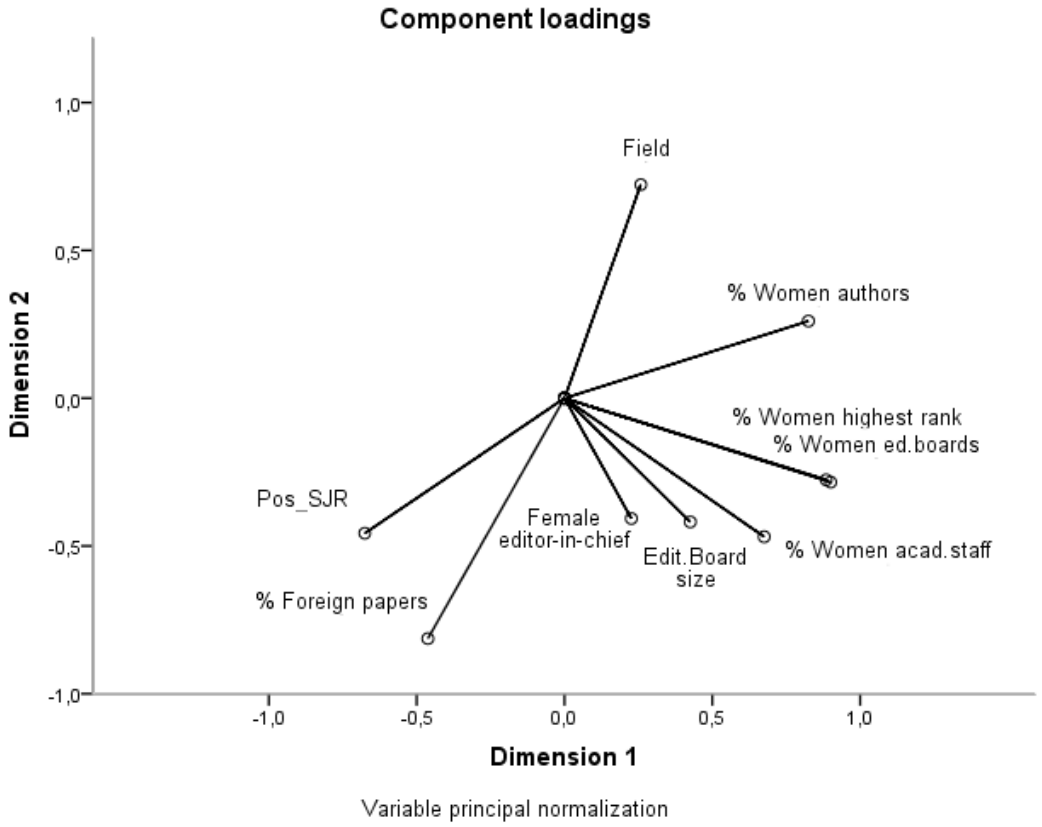
4.2. Principal components analysis

Categorical principal components analysis is used to explore the relationships among the variables. The original set of variables is reduced to a smaller set of non-correlated dimensions. A two-dimensional solution is presented which accounts for 65.30% of the variance.

Figure 7 shows the plot of component loadings. The relationships between variables represented by their correlations with the principal components are displayed by vectors pointing towards the category with the highest score. The longer the vectors (lines), the better the two dimensions account for most of the variance of all quantified variables. The angle between two vectors reflects the correlations between the variables they represent: the more orthogonal the vectors, the less correlated the variables are. The first dimension is correlated mainly with the variables measuring female presence. A positive correlation between female presence among authors, among editorial board members and among academic staff (both total and highest ranked) is observed. Furthermore, female presence in editorial boards is positively correlated with the size of the editorial board and the presence of a woman editor-in-chief. In the second dimension, the field is negatively correlated with the share of foreign papers. The values assigned to the variable field (quantification) are shown in Figure 7 (bottom) and display an upward trend from Technology (the lowest value) to Health Sciences (the highest value). Accordingly, the share of foreign papers declines from Technology to Health Sciences. A positive correlation between journal prestige and the share of foreign papers is also identified implying that journals with a higher

Pos-SJR are also more likely to include a higher share of foreign papers. The share of women authors points in opposite direction to Pos-SJR and the share of foreign papers implying that the most prestigious and internationalised journals tend to show a smaller proportion of female authors. This relationship is strongly influenced by the variable field since there are significant differences between Pos-SJR and the share of foreign papers by field ($p<0.05$) and the highest presence of women authors is observed in Social Sciences and Humanities, which show the lowest average values for Pos-SJR and the share of foreign papers. Finally, the vector representing the share of women authors is perpendicular to the vector representing female editors-in-chief thereby indicating that these variables are uncorrelated.

Figure 7. Relationship between female presence in journals, female presence among academic staff and journal features drawn from a categorical principal components analysis



Quantification of the "field" variable

Category	Quantification
Health Sciences	1.533
Social Sciences	.644
Humanities	.315
Experimental Sciences	-1.213
Technology	-2.176

4.3. Categorical regression analysis

A categorical regression analysis was run to explore the influence of different variables on the percentage of women in journal editorial boards (dependent variable). As shown in table 6, two different models were obtained. In the first model, the more influential variables on the percentage of women in editorial boards are the percentage of women in the highest rank of the HE system and the size of the editorial board. The remaining variables were removed from the model because they were not significant (model 1).

However, if the percentage of women at the highest rank is excluded from the analysis, the percentage of women authors becomes a significant factor together with the size of the editorial board and the field (model 2). To explain this finding we argue that the percentage of women at the highest rank varies among fields more than the percentage of women authors. As a result, if the former is removed, both the female authors and field variables are needed to explain the percentage of female editorial board members. The "field" variable has been quantified so that it scales up from Health Sciences (lowest value) through Social Sciences, Experimental Sciences, Technology to Humanities (highest value) (table 6).

Table 6. Categorical regression analysis. Dependent variable: percentage of women in editorial boards in 2009

	Model 1[a]		Model 2[b]	
	Standardised coefficients		Standardised coefficients	
	Beta	Bootstrap (1000) Estimate of Std. error	Beta	Bootstrap (1000) Estimate of Std. error
% Women acad. staff	-	-	-	-
% Women highest rank	.888***	.150	-	-
Edit. Board size	.480*	.258	.693**	.293
% Women authors	-	-	.712***	.158
Field	-	-	.603**	.264
Woman editor-in-chief	-	-	-	-
Pos-SJR	-	-	-	-
% Foreign papers	-	-	-	-

*p<0.05; **p<0.01, ***p<0.001

[a]Model 1: F=17.298; p<0.001; corrected R^2= 0.807

[b]Model 2: F=59.944; p<0.001; corrected R^2= 0.894

Quantification of the "field" variable

Category	Quantification
Humanities	.446
Technology	.393
Experimental Sciences	.307
Social Sciences	.023
Health Sciences	-4.055

Discussion

This paper follows international recommendations concerning the need to include the gender dimension in studies of scientific activity in order to increase our knowledge on the situation of men and women in research (ETAN, 2000; She Figures, 2009). In particular, our study focuses on a selection of high-quality Spanish journals which we assume reflect the Spanish scientific community in the different fields under analysis.

Methodological considerations

We would like to point out some methodological considerations that should be taken into account for the interpretation of results. Firstly, our assumption that Spanish journals represent the national scientific community applies in particular to Social Sciences, Humanities and Clinical Medicine, where the journals analysed are clearly locally-oriented and most articles are authored by Spanish researchers; whilst in more internationally-oriented fields, such as Experimental Sciences, our results may be biased by the contribution of foreign authors. Anyway, very few journals show a large share of articles by authors from countries other than Spain (only 6 out of 36 journals had more than 60% of foreign papers).

Results are shown at area level for analytical purposes as well as to highlight differences amongst areas. However, the study of authorship is limited to a small number of journals which do not cover all the different disciplines existing in a given area, but we assume they can be representative of an area's average behaviour. A list including all the journals retained for analysis is attached as an appendix to enable readers to identify in each case what specific disciplines are under study and contribute to a correct interpretation of results.

Obtaining journal-based indicators to analyse the presence of men and women in editorial boards and as authors of articles is a laborious task because many journals do not include the full name of scientists, but only the initial of their first names. This limitation has been pointed out in previous studies dealing with the development of scientific indicators by gender based on the analysis of the composition of editorial boards (Miqueo et al., 2011), scientific publications or patents (Naldi et al., 2004; Mauleón et al., 2008; Mauleón and Bordons, 2010). It should be noted that the inclusion of the full name of authors is not only required to facilitate the development of studies by gender, but also for the correct identification of authors in other type of studies. Fortunately, the most prestigious international databases are currently improving their products in this respect to include the full name of authors and allow for the correct identification of scientists (i.e. Scopus, Web of Science). Thus, the need to foster the inclusion of the full name of scientists in journal editorial boards as well as in the by-line of publications is one of the recommendations resulting from this study as a useful measure for the correct identification of authors and for the development of sex-disaggregated indicators.

The glass ceiling in the context of journals

The average share of women in the editorial boards of Spanish journals is half the percentage of women as authors of papers (18% vs. 37% for the most recent year under analysis), although some differences by field have been found. The fact that very few women hold editorship positions relative to their share in their field of research confirms the existence of a "vertical segregation" in the context of scientific journals, i. e., the downward trend of women figures as we move up job responsibility levels (ETAN, 2000). Vertical segregation is known in the literature as the "glass ceiling" phenomenon, which points to the existence of invisible obstacles that hinder women

advancement to power and decision-making positions. The smaller presence of women as editorial board members than as authors of papers has become patent in our study for the different areas of knowledge under survey, although less "vertical" differences have been observed in Humanities and Social Sciences than in the other areas. This vertical segregation has also been described in prior studies with a particular focus on Medicine (Dickersin et al.,1998; Porter, Christian and Poling, 2003), and has been found to be less evident in other disciplines such as Psychology (Evans, Hsieh and Robinson, 2005).

Curiously, the average percentage of female editors-in-chief, which is the most prestigious and powerful position within journals, is quite close to the percentage of female editorial board members in the most recent year of our study. This result may be interpreted as a sign of the increasing scientific recognition attained by women in the Spanish scientific community. A similar presence of women among editors-in-chief and editorial board members has also been described in Educational Psychology (Evans, Hsieh and Robinson, 2005), where gender parity was almost achieved in authorship and editorial board membership. On the contrary, the share of women editors-in-chief was below the share of female editorial board members in other disciplines such as Epidemiology (Dickersin et al., 1998) or Political Science (Stegmaier, Palmer and Van Assendelft, 2011), even though women were reasonably well represented in editorial positions in proportion to the ranks they hold in the profession in the study mentioned last. It seems that the existence of a large pool of female scientists and authors may enhance female presence in the highest position of editorial boards but journal-related factors and journal awareness towards gender issues in science also play a relevant role (Evans, Hsieh and Robinson, 2005; Miqueo et al., 2011).

Are women under-represented in journals?

Our results show differences in the percentage of female authors and editorial board members by area, and, thus, are consistent with the described tendency of female scientists to concentrate on specific fields ("horizontal segregation") (ETAN, 2000). Among the five broad areas considered in our study, the highest female presence in journals is observed in Humanities and Social Sciences, while the lowest has been found in Technology.

To explore whether women are under-represented in journals, their presence as authors and editorial board members is compared with the share of female scientists in the Spanish HE system in the subject-field of the journal in question. In our study, average values of female authorship are slightly below our expectations drawn on the basis of the presence of women in the academic staff of the Spanish HE System. This could be due to a higher share of non-publishing female authors or to lower female productivity. Technology is the only area where female presence among authors is higher than their share in academic staff, probably because of the limited number (3) of technological journals studied and the special nature of two of them pertaining to Materials Science and edited by the Spanish National Research Council, where the women presence rate is higher than at university (38% vs. 29% of women in Materials Science, respectively). On the other hand, both journals were led by female editors-in-chief in 2009, a factor which emerged in our study as a positive influence on female presence in journals.

Average values of female editorial board membership are substantially lower than those of female presence among academics, but not significantly different from those of women in the highest academic rank of the HE system. This suggests that senior female scientists are well represented in editorial boards. However, given the extremely

low shares of female senior scientists existing in some disciplines, an increase of women in editorial boards could be a strategic measure aimed at stepping up gender diversity in boards, facilitating women integration in networks and giving them a sign of professional recognition that could contribute to support promotion in academic rank in the long term.

There is a series of different reasons that may be argued to explain the higher presence of female authors in Spanish journals as compared to the international reference journals used as a benchmark. Firstly, it can be partially explained by the higher presence of women scientists in our country as compared to other advanced countries (37% vs. 30% in the EU-27 in 2006, She Figures 2009) (Sánchez de Madariaga et al.)(37% vs. 33% in the US, National Science Board, 2010). The fact that female presence in the set of Spanish journals with the highest rate of internationalisation (where the pool of national academics is likely to exert lesser influence) was closer to international reference figures favours this reasoning. Secondly, it could be due to women showing a stronger propensity to publish in national journals as supported by some studies (Webster, 2001), although not observed in others (Bordons and Mauleón, 2006). Thirdly, it can be a field-dependent feature implying that female presence is higher in the most nationally-oriented fields. And finally, a weaker propensity of women to publish in the most prestigious international journals (as the ones selected as reference for our study) may also be a possible explanation, as described for Quebec professors in Health Sciences (Larivière et al., 2011) but not confirmed by other studies, such as the one conducted on researchers in Iceland (Lewison, 2001). Note should be taken that the three last reasons may have negative implications on the citation records of women.

Influential factors on female presence in editorial boards

Our study confirms the expected positive relationship between female presence in editorial boards and female presence among scientists at university (hypothesis 1). Furthermore, a higher presence of women in editorial boards is observed for fields with a higher share of women at the highest rank of the academic hierarchy (hypothesis 2). The fact that the share of women at the highest academic rank is the most influential variable on the share of women in editorial boards (categorical regression) confirms that the probability of women entering editorial boards is strongly determined by the existing pool of senior female scientists. Female presence as authors has also been found to be another significant factor since the presence of women in editorial boards tends to grow with the presence of women as authors. However, in some journals with a high relative presence of female authors female share in editorial boards is low, suggesting that a high presence of women in the field is no access guarantee to editorial boards. In other words, a high presence of female authors is necessary but does not suffice to ensure a high presence of women in editorial boards.

Some journal-related factors also play a role, such as the size of the editorial board and the sex of the editor-in-chief. Our results show a positive correlation between editorial boards size and female presence (hypothesis 3) which confirms recent research by Metz and Harzing (2009). Larger editorial boards may have a higher proportion of women because the representation of women grows as management pools in editorial boards become larger (Blum, 1994). Interestingly, having a woman editor-in-chief is also positively associated with the share of women in editorial boards (hypothesis 4), which contradicts the results of Amrein in Medicine (2011), but is consistent with the results obtained by Metz and Harzing in Management (2009). The fact that journal editors are more likely to appoint same-sex scientists which probably are part of their social and professional networks has been pointed out as an explanatory reason.

Although a higher share of women in the editorial boards of the most prestigious journals has been described in prior articles (Miqueo et al., 2011, Metz and Harzing, 2009), this has not been confirmed by our study (hypothesis 5 is discarded). The most prestigious journals are more international as measured by the percentage of papers from foreign authors published in the journals, but both prestige and internationalisation are highly dependent on the field in question. Journals in Experimental Sciences and Technology show high SJR values and the highest internationalisation rate. Therefore, further studies by field are required to unravel the relationship between female presence and journal prestige.

Cross-gender collaboration

The study of the participation indicator enables us to observe the importance of collaboration in research among authors of different sex. In all experimental fields, except in Mathematics, articles written in collaboration between men and women predominate over those written by same-sex authors. Moreover, the upward trend in female participation observed throughout the period is mainly due to the activity of cross-gender teams. These results boost interest in this type of collaboration for the advancement of science. In spite of the growing size of teams observed, female contribution tends to remain stable or grow in almost all areas implying that women numbers increase at the same or a faster rate than male ones in most areas. The only exception is Mathematics since the share of papers with cross-gender collaboration increases very slightly in this discipline and female contribution tends to decline. Fostering cross-gender collaboration could be particularly beneficial for women in this field where women are a minority and collaboration with men might contribute to foster their integration in networks.

A limitation of our study is that we are well aware that women are increasing their contribution to research, but we do not know how often they act as leaders or assume responsibility positions in the conduct of research. In some areas where the position of authors in the by-line is clearly connected to their role in research, the evolution of the presence of women in the two key positions, as first and last authors of publications, has been explored in the literature. Accordingly, an increase in first and last authorship of women has been described in international journals in Medicine (Jagsi et al., 2006; Sidhu et al., 2009) and Psychology (Evans, Hsieh and Robinson, 2005), although the presence of women as last author –which, for Medicine, is related to a senior position- tends to grow at a slower rate than as first author. The issue of the signing order in publications was not addressed in our study because signing habits change from one area to another and in some of them alphabetical order is the norm (i.e., Mathematics (AMS, 2009) or Economics (Frandsen and Nicolaisen, 2010)).

Narrowing the gender gap

Throughout the period, the gender gap in authorship tends to narrow in most journals and areas and even in a few journals –mostly in Humanities or Social Sciences- parity is achieved. However, it should be noted that achieving gender parity was not a real expectation in areas where women do not account for at least half of the total pool of scientists since the expected figures of female presence in journals depend on the size of the female workforce in each case. Concerning board membership, the gender gap also tends to diminish in the most recent year under analysis across all areas, except for Mathematics and Engineering, where it remains quite stable.

The growth rate of female presence among authors or editorial board members does not seem to be related with their starting levels. Therefore, those journals showing the lowest female presence in 1998 do not show a higher increase than the rest of

journals. This is particularly evident in the case of Mathematics: it shows the lowest female presence (both among authors and editorial board members) at the beginning and it maintains such low level throughout the period. The highest surge in female authors is observed in Humanities, Social Sciences and Engineering, while female editorial board members show the most important rise in Agriculture. The growing presence of women among editors-in-chief is a positive finding suggesting greater scientific recognition of women in the most recent year under study.

On average, female presence among authors grows faster than among editorial board members, which can be explained by the still limited number of women who are senior scientists or enjoy a high level of scientific recognition. Anyway, differences by field and by journal can be identified. The positive relationship observed in our study between female authorship and female editorial board membership suggests that an increase in the share of women among authors may enhance their participation in editorial boards in the longer term.

Concluding remarks

Female presence is lower than male presence with regard to authorship, editorial board membership and editorship in Spanish journals. The presence of female authors is slightly lower than the presence of women in the Spanish HE system and doubles female presence among editorial board members, which mirrors female presence in the highest academic rank. There is a gender gap in favour of men which has been gradually narrowed throughout the 1998-2009 period, especially among authors, but also and at a slower pace, among board members. This is an indication of a higher participation and professional recognition of women in the most recent year under analysis. A large editorial board and having a female editor-in-chief favour female presence in editorial boards, while the latter is not clearly related with the prestige and internationalisation of journals.

The regular calculation of journal-based indicators by sex can be of interest from a science policy perspective to track changes over time in the situation of men and women by discipline. Moreover, journal-disaggregated data may be of interest for journal editors to identify in which journals women are under-represented compared to their presence as scientists in the journal's discipline and to make inter-journal comparisons assisting in the adoption of corrective measures when necessary. The development of this type of study and the dissemination of its results may contribute to the development of sensitivity towards gender issues and the commitment of journals with equality objectives.

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Annex I. List of Spanish journals considered in the authorship analysis

Spanish journal	Area[1]	WoS subfield
Agric./Biol./Environment	*EXP*	
Scientia Marina		Marine Biology
Grasas y Aceites		Food, Science and Technology
Biomedicine	*EXP*	
International Journal of Developmental Biology		Developmental Biology
Journal of Physiology and Biochemistry		Cellular and Molecular Biology
Chemistry	*EXP*	
Afinidad		Chemistry, Multidisciplinary
Grasas y Aceites		Chemistry, Applied
Clinical Medicine	*HEALTH*	
Medicina Clínica (Barc)		Medicine, General and Internal
Revista Española de Cardiología		Cardiac and Cardiovascular System
Engineering/Technology	*TEC*	
Archives of Computational Methods in Engineering		Engineering, Multidisciplinary
Materiales de Construcción		Materials Science
Revista de Metalurgia (Madrid)		Metallurgy
Humanities	*HUM*	
Archivo Español de Arte		Art
Asclepio		History and Philosophy of Science
Dynamis		History and Philosophy of Science
Goya		Art
Hispania		History
Pensamiento		Philosophy
Revista de Filología Española		Language and Linguistics
Revista de Indias		History
Revista de Literatura		Literature
Theoria-Spain		History and Philosophy of Science
Mathematics	*EXP*	
Test		Statistics and Probability
Revista Matemática Iberoamericana		Mathematics
Social Sciences	*SOC*	
Boletín de la Asociación de Geógrafos Españoles		Geography
Cultura y Educación		Education and Educational Research
Hacienda Pública Española		Economics
Infancia y Aprendizaje		Psychology, development
Profesional de la Información		Information Science & Library Science
Psicothema		Psychology, multidisciplinary
Revista de Derecho Comunitario		Law
Revista de Economía Aplicada-Spain		Economics
Revista Española de Derecho Constitucional		Law
Revista Española de Documentación Científica		Information Science & Library Science
Revista Española de Investigaciones Sociológicas		Sociology
Revista Española de Pedagogía		Education and Educational Research
Revista Internacional de Sociología		Sociology
Scripta Nova		Geography

Note: [1]Areas included in the Statistics of Higher Education Sector in Spain. EXP= Experimental Sciences; HUM= Humanities; HEALTH=Health Sciences; SOC= Social Sciences; TEC= Technology

Annex II. List of Spanish and international benchmark journals

Spanish journal	International reference journal	WoS Subfield	Area[1]
Afinidad	Journal of the American Oil Chemists' Society (US)	Chemistry	EXP
Asclepio	Medical History (GB)	History & Philosophy of Science.	HUM
Grasas y Aceites	Journal of the Science of Food and Agriculture (GB)	Food, Science & Technology.	TEC
International Journal of Development Biology	Development (GB)	Developmental Biology	EXP
Medicina Clínica-Barcelona	Lancet (GB)	Medicine, General & Internal	HEALTH
Psicothema	Personality and Individual Differences (GB)	Psychology	SOC
Revista de Economía Aplicada-Spain	European Economic Review (NL)	Economics	SOC
Revista Española de Cardiología	European Heart Journal (GB)	Cardiac & Cardiovascular System	HEALTH
Revista Española de Documentación Científica	Scientometrics (NL)	Information Science/Library Science	SOC
Revista de Metalurgia - Madrid	Metallurgical and Materials Transactions A (US)	Metallurgy	TEC
Scientia Marina	Marine Biology (DE)	Marine Biology	EXP
Test	Biometrika (GB)	Mathematics	EXP

Note: [1]Areas included in Spanish Higher Education Sector statistics. Exp= Experimental Sciences; Hum=Humanities; Health= Health Sciences; Soc= Social Sciences; Tec= Technology.
ISO Abbreviations for publication countries: DE= Germany; GB= United Kingdom; NL= the Netherlands; US= United States.