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Research Paper

Trend analysis of the proportional allocation of funding by gender in Spanish National Research Projects: A study by disciplines and staff positions

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ABSTRACT

Given the critical role of research funding in driving knowledge production and promoting gender parity in academia, this study aimed to analyze gender differences in funding allocation over time across different disciplines or areas of knowledge and research staff categories. We analyzed data from 20,843 Spanish grants awarded between 2015 and 2022, matching these records with data on tenured research staff. Considering that in scientific systems, women represent a lower workforce, we analyzed the proportion of grants awarded relative to their presence as associate and full professors. To quantify these differences, we employed proportional gender funding and the women/men ratio. This approach was used to analyze whether the amount of grants awarded was proportional to their presence as tenured staff members. Our findings reveal significant disparities in grant allocation and tenured staff, with women receiving approximately 33% of the grants and representing 43% and 38% of associate and full professors, respectively. This difference was higher in terms of areas of knowledge, with *Engineering and Architecture* having the lowest women/men ratio and *Arts and Humanities* having the highest ratio. This pattern was repeated among associate and full professors with pronounced differences in *Engineering and Architecture*. Despite this, the longitudinal analysis showed that the differences decreased over time, showing a positive trend for both staff categories and across different areas of knowledge. Regarding proportionality, we observed that the proportion of grants awarded to women agreed with their representation as tenured staff, reaching its highest value by 2022. In areas where women received fewer grants and were fewer associate and full professors, such as *Engineering and Architecture*, the proportion of grants awarded to women was similar to that of men. Although our findings indicate a positive trend favoring women, more action needs to be taken. Future research could explore how grant allocations, productivity, and collaborative roles interact to deepen the understanding of gender dynamics in research funding.

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1. Introduction

Gender inequality is a significant social issue that requires worldwide attention. Although it has been widely debated, it has gained increasing relevance in academia. Numerous studies have qualitatively and quantitatively analyzed gender disparities, providing a theoretical basis and context for how these inequalities manifest and persist in science (Sugimoto & Larivière, 2023). The significance of this issue is reflected in international policy initiatives such as the United Nations' inclusion of 'Gender Equality' as one of the 17 Sustainable Development Goals (SDG), which aims to create a more equitable and sustainable future by 2030 (United Nations, 2015). Similarly, the European Union has incorporated this goal into its Horizon 2030 program, committing to address it to improve societal well-being (Bichisao et al., 2019; European Commission, 2021). Despite this, progress remains slow, and projections have reported that it may take 140 years on average for women to be equally represented in power and leadership roles (United Nations, Department of Economic and Social Affairs, 2023).

In scientific scenarios, gender differences remain evident in many aspects, detected in levels of productivity and performance (Lariviere et al., 2013; Boekhout et al., 2021; Zhang et al., 2021), collaboration rates, patenting (Liu et al., 2022; Caviggioli et al., 2021; Kwiek & Roszka, 2021), representation in prestigious universities (Cattaneo et al., 2016; Spoon et al., 2023), and a disproportional presence in STEM fields (Ceci et al., 2014; Cheryan et al., 2017; Huang et al., 2020; Haghani et al., 2022; Boekhout et al., 2021). Furthermore, when analyzing a specific field of knowledge, women often concentrate on topics traditionally associated with caregiving, education, and social welfare, such as the health sciences and humanities (Choji et al., 2024). These factors, individually and collectively, contribute to the cumulative disadvantages of women's academic careers.

Given the critical role of research funding in knowledge production and career advancement, understanding its dynamics is fundamental. Funding allocation can significantly influence the development of various fields of knowledge. On the one hand, funding can be equally distributed or disproportionately allocated to specific areas, fields of knowledge, and/or projects, potentially leading to imbalances in scientific progress (Morillo, 2019). On the other hand, awarding a grant could be an important part of a researcher's career, and it could represent a boost to reach higher academic positions (Cruz Castro & Sanz Menéndez, 2020).

Previous studies have explored gender disparities in research funding from different perspectives and discovered various findings. In line with previous research Cruz Castro and Sanz Menéndez (2020); Cruz-Castro and Sanz-Menéndez (2023); Traag and Waltman (2024), we used the term "gender disparity/disparities" to refer to observed differences in funding allocation across groups, without implying a direct causal or inherent bias. In terms of applications, some studies have found that men apply for grants at higher rates and receive more grants and greater amounts of funding than do women (Tamblyn et al., 2016; Waisbren et al., 2008). However, neither traditional studies nor meta-analyses have found conclusive evidence of gender disparities in grant awards (Bornmann et al., 2007; Marsh et al., 2009). When controlling for faculty rank, no significant differences were observed in the success rate or funding amount awarded, although the application rates for women were notably lower at lower faculty ranks (Waisbren et al., 2008). Regarding the peer review process, the findings showed that the productivity of the principal investigator (PI) is a stronger determinant of grant success than gender (Tamblyn et al., 2018). A randomized experiment did not reveal any significant differences in grant scores between men and women (Cruz-Castro & Sanz-Menéndez, 2023). A recent meta-analysis of 55 studies supported these findings, indicating no significant differences in peer-reviewed grants. Despite this, women are less likely to re-apply for grants and often receive smaller amounts of funding than men (Schmaling & Gallo, 2023). This lower re-application amount may be partly attributed to socio-structural factors, such as self-selection, where women and minority groups may perceive themselves as less qualified to apply for a grant (Adamecz-Völgyi & Shure, 2022), and the tendency to re-apply could be influenced by previous negative responses (Cruz-Castro et al., 2023). Additionally, Larregue and Nielsen (2024) analyzed grant applications in the Social Sciences, considering disciplinary approaches, research topics, and methodological aspects. They found a 20% gender disparity in grant allocation, which they linked to differences in methodological preferences, with men favoring quantitative methods and women mixing quantitative and qualitative methods. This perspective is particularly valuable because it highlights the need to examine how other structural or epistemic trends in academia shape gender differences in funding allocations.

The discrepancies in previous research findings suggest that the grant allocation system is complex and influenced by multiple factors (Aagaard et al., 2021), including funding agency policies, government initiatives, institutional evaluation criteria, the unequal representation of women and men across fields of knowledge eligible for grants, and the specific time period analyzed, among others.

To the best of our knowledge, no previous study has examined funding allocation while simultaneously accounting for faculty rank and areas of knowledge differences in general or specific countries or contexts. Some studies have addressed the specific aspects of this issue. In the Netherlands, a study identified positive trends in gender representation across domains in specific calls and reported that targeted interventions can mitigate disparities (Albers et al., 2024). Other studies have analyzed the relationship between faculty rank and grant success rates, showing that gender disparities in funding may be explained by differences in academic rank (Burns et al., 2019; Waisbren et al., 2008). However, these studies did not disaggregate the data according to areas of knowledge, leaving a gap in understanding whether areas of knowledge may interact with gender and faculty rank.

Considering the mixed evidence regarding gender differences in grant allocation, our study assumes that faculty rank plays a crucial role in grant eligibility (Waisbren et al., 2008; Suarez et al., 2023; Spoon et al., 2023; Burns et al., 2019) and that women tend to concentrate on specific fields of knowledge (Ceci et al., 2014; Lariviere et al., 2013; Boekhout et al., 2021; Zhang et al., 2021; Huang et al., 2020). By integrating both dimensions, we assessed whether grant awards have remained proportional to the distribution of tenured researchers over time.

In view of this background, this study aims to address this gap by analyzing gender disparities in the allocation of research, development, and innovation (R&D&I) grants awarded by the Spanish Ministry of Universities between 2013 and 2022. Specifically, we pursue three main objectives: (1) to assess gender representation in grant allocation; (2) to examine gender representation among

tenured research staff, including associate and full professors; and (3) to evaluate the proportionality of grants awarded by gender relative to the number of associate and full professors. The three objectives are analyzed in aggregate terms, disaggregated by areas of knowledge, and trends over time. To achieve this, we conducted a statistical analysis of funding distribution. Our unit of analysis was grants awarded and the number of professors in the faculty rank.

2. Methodology

To conduct this study, we propose a methodology based on two phases described in the following subsections: *2.1 Data Acquisition and Preprocessing*, *2.2 Statistical Analysis and Visualization*, and *2.3 Workflow*.

2.1. Data acquisition and preprocessing

To analyze the grants awarded by each gender in Spanish public universities in R&D&I and their relationship with academic positions among research staff, we combined two national datasets. The first dataset, retrieved from the Ministry of Universities (Ministerio de Universidades, España, 2024), provides the number of men and women in different tenured research positions from 2015 to 2022 disaggregated by academic area. The second dataset, obtained from the Spanish State Research Agency (Agencia Estatal de Investigación, 2024), includes grants awarded under three national funding programs: *Generation of knowledge, Challenges and Knowledge generation*, and *Challenges of Society* programs (Additional information about the calls is provided in Appendix A). This dataset includes all grants awarded from 2013 to 2022, and no identifications other than gender are available for the PI.

We did not include other national calls, such as those from Instituto de Salud Carlos III, to avoid potential biases arising from differences in funding schemes. Each call may have distinct objectives and priorities, potentially affecting the comparability of funding distributions across academic areas. Additionally, because we do not have comprehensive data on the total funding allocated to each discipline across all national calls, incorporating additional programs could introduce imbalances in our comparisons. By focusing on specific calls that cover a broad range of areas, we ensured that all areas of knowledge were considered under the same criteria, enhancing the validity of our analysis.

Data were retrieved in March 2024, including 30,183 unique grants awarded between 2013 and 2022. Information such as the identification code and call for the grant, the amount of funding received, the PI's gender, the institution and its geographic location, and the field and subfield of knowledge were provided.

In addition, we retrieved publicly available data from the Spanish Ministry of Universities, which provide information on academic staff positions. These data were organized according to the number of researchers, gender, year, and area of knowledge, offering an overview of the Spanish workforce. The available data were from 2015 to 2022 and were accessed through the statistics portal of the Spanish Ministry (Ministerio de Universidades, España, 2024).

To create the final dataset for this analysis, we followed three steps:

- **Focus on Spanish public universities:** To guarantee that our observations were as accurate as possible and to allow fair comparisons between institutions, our study focused on Spanish public universities, considering that these institutions are engaged in similar scopes of work and activities. To identify Spanish public universities, a list of universities recognized by Spanish authorities was used (Ministerio de Educación, Cultura y Deporte, España, 2008).
- **Matching fields of knowledge:** While grant data is categorized at the field level, research staff data is aggregated into five broader areas of knowledge. As a result, our analysis considers five main areas: Arts and Humanities, Sciences, Health Sciences, Social and Legal Sciences, and Engineering and Architecture. To ensure consistency, we aligned these categories following the classifications provided by the Official State Gazette (Boletín Oficial del Estado, 2007). Our analysis covers five main areas: *Arts and Humanities, Sciences, Health Sciences, Social and Legal Sciences*, and *Engineering and Architecture*. In cases where a field could belong to more than one area of knowledge, such as Biomedicine, Biosciences, and Biotechnology (which could be classified under both *Sciences* and *Health Sciences*) we standardized our classification by grouping them under *Health Sciences*. A full list of field-to-area assignments is available in Appendix B.
- **Selection of research staff categories:** The Spanish university system divides academic staff into two primary categories: tenured and non-tenured positions (Pekkola & Siekkinen, 2024). For our analysis, we focused solely on tenured positions, particularly associate and full professors. We selected these categories because they represent a more stable workforce, providing continuity and a clearer view of long-term trends in academic careers, as detailed in the Appendix C. Additionally, tenured positions typically exhibit a higher career age and level of expertise, which enhance their competitiveness in grant applications. The decision to exclude prior positions is based on the fact that the attrition rate is higher among early career researchers, particularly women (Cech & Blair-Loy, 2019; Spoon et al., 2023; Burns et al., 2019). Furthermore, these prior positions are usually considered mid-career stages and do not compete on an equal footing in national funding grant applications. By concentrating on tenured positions, we aimed to improve the accuracy of our analysis and offer a deeper understanding of the progression over the years (Additional information about the calls is provided in Appendix C).

It is important to note that, in this analysis, gender was considered binary for both grants and research staff, with gender assignment provided by the Spanish State Research Agency.

The final dataset used in the analysis included 20,483 grants (67.9% of the initial dataset). The remaining 32.1% were excluded to remove grants awarded to private institutions. Grants, professor, and full professor dataset are available at Choji et al. (2025).

2.2. Statistical analysis and visualization

Our analysis involved two different quantitative approaches. First, to determine the distribution and tendency of grants awarded and research staff by gender, segregated into five areas of knowledge, the unit of analysis was grants awarded from 2013 to 2022. Second, to add the perspective of women's presence in different statuses of research staff, our analysis was based on the grants awarded and in two groups of research staff positions in different areas from 2015 to 2022, one representing senior researchers and the other encompassing all professors. By combining both sets of data, we were able to evaluate and compare the proportion of grants awarded by women and men, based on their presence in each group of research staff. Considering that the distribution of men outnumbers women in science itself and in different areas, fields, and subfields (Holman et al., 2018; Huang et al., 2020; Lariviere et al., 2013; UNESCO Institute for Statistics (UIS), 2019). This step was crucial for assessing and normalizing grants awarded and their presence as research staff.

On the one hand, in the first approach, the distribution of grants by gender and areas of knowledge was assessed using the odds ratio between women and men (W/M) for each case. This step was performed to allow for only one variable to be used. On the other hand, to the second approach, the relative gender contribution rate (RGCR) (Choji et al., 2024) was adapted to calculate the proportion of grants to each gender and research staff group. In the current analysis, we named this adaptation the proportional gender funding ratio (PGFR), which was calculated using the following criteria:

$$PGFR = \frac{\left(\frac{X_a}{Y_a}\right)}{\left(\frac{X_b}{Y_b}\right)} \quad (1)$$

Where X is the percentage of grants awarded, and Y is the percentage of research staff for both women (a) and men (b). PGFR values may be higher or lower than 1. When the PGFR was higher than 1, the proportion of women who were awarded a grant was higher than their presence in the researcher staff. Values equal to or very close to 1 indicate cases in which the grants awarded and the presence of staff were proportional, suggesting a gender balance. Values lower than 1 indicate that the proportion of grants awarded by women was lower than their presence in the research staff. This adaptation allowed us to discover when and where (i.e., in which year and/or area of knowledge) the allocation of funding to women was proportional to their presence in the research staff.

Finally, descriptive and statistical trend analyses were conducted for each research status. First, the Kolmogorov-Smirnov test was used to determine whether gender distribution was normal. If the distribution was normal, the t-student test was used to compare the means. Otherwise, the Mann-Whitney (Wilcoxon) test was used to evaluate medians. For the trend analysis, we used the Mann-Kendall test to identify whether there was an increasing trend in the presence of women in different areas of knowledge, both in the grants awarded and among research staff. The results are displayed as a set of tables and heat maps.

2.3. Workflow

To facilitate the reproducibility of our study, we created a workflow, Fig. 1, that outlined the entire process. First, we collected grant data, followed by filtering for public universities. Next, we collected research staff data, followed by filtering for associate and full professors. Then, we matched the fields and areas of knowledge. Using both datasets, we conducted a general analysis of grants and tenured research staff, followed by a trend analysis, and calculated the proportionality of grants awarded relative to their presence as associate and full professors. Finally, we generated visualizations.

3. Results

After conducting the methodology, we analyzed 20,483 grants from 2013 to 2022. Among them, 6,628 grants (32.4%) were awarded to women PIs, while 13,855 grants (67.6%) were awarded to men PIs, as shown in Table 1. When considering the overall grants awarded, women PI were awarded a statistically lower number of grants than their male counterparts. This statistical difference was also observed in five areas of knowledge, in which women's presence was higher in *Arts and Humanities* and lower in *Engineering and Architecture*. These two areas of knowledge had higher (0.725) and lower (0.234) W/M ratios, respectively.

Analyzing the W/M ratio over the years (Fig. 2), an improvement in the presence of women was observed in the overall grants and areas of knowledge. *Health Sciences* and *Social and Legal Sciences* were highlighted to present the largestargest improvement of the last 10 years, increasing from 0.50 to 0.81 and 0.54 to 0.88, respectively. Meanwhile, *Arts and Humanities* showed the highest ratio in 2019, although variance in women's presence was observed over the years. When examining trends (Fig. 2), a statistically significant trend favoring women was observed for overall grants awarded, but also across *Sciences, Health Sciences, Social and Legal Sciences* and *Engineering and Architecture*, suggesting that the W/M ratio will continue to increase over the next few years.

In terms of research staff, by 2022, there were 103,459 tenured professors in the Spanish public education system (Table 2), of which 41,564 (40.2% of the overall) were full professors (Table 3). In both cases, a statistically significant favoring of men was detected. Moreover, the odds ratio revealed that women had a higher presence as associate professors than in senior positions. However, in the areas of knowledge, the scenario was different. On the one hand, statistical differences were detected in all areas and positions, except for associate professors of *Health Sciences*. To associate professors, women were at a similar rate to men in *Arts and Humanities* (1.021), *Health Sciences* (1.096), and *Social and Legal Sciences* (0.938). As full professors, women were lower in all areas, including *Arts and Humanities, Health Sciences*, in which the W/M ratio to associate professors was nearly 1. Interestingly, *Engineering and Architecture* had the lowest rate of women for both associate professors and full professors.

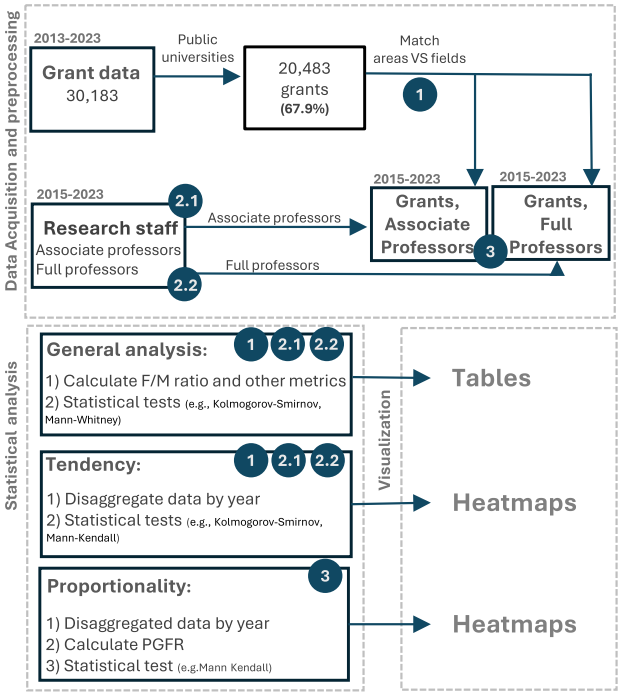

Fig. 1. Workflow for data acquisition, preprocessing, and statistical analysis of grant and research staff data. The analysis includes general metrics, trend analysis, and proportionality tests, and the results are visualized in tables and heatmaps.

Table 1
Number of grants disaggregated by areas of knowledge, gender, percentage of each gender, W/M odds ratio.

	N Grants	%Grants	Women	Men	%W	%M	W/M	p-value
Total	20483	-	6628	13855	32.4%	67.6%	0.478	**0.0002**[a]
Arts and Humanities	2883	14.1%	1212	1671	42%	58%	0.725	**0.0006**[a]
Sciences	7077	34.6%	2012	5065	28.4%	71.6%	0.397	**0.0002**[a]
Health Sciences	3118	15.2%	1258	1860	40.3%	59.7%	0.676	**0.001**[a]
Social and Legal Sciences	3462	16.9%	1398	2064	40.4%	59.6%	0.677	**0.0002**[a]
Engineering and Architecture	3943	19.3%	748	3195	19%	81%	0.234	**0.0002**[a]

[a] Mann-Whitney test and p-values from Mann-Kendall trend test.

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	p-value
Grants	0,38	0,42	0,43	0,48	0,42	0,47	0,55	0,52	0,51	0,58	**0,0042** [a]
Arts and Humanities	0,79	0,55	0,64	0,86	0,61	0,64	0,98	0,71	0,70	0,83	0,3710 [a]
Sciences	0,34	0,40	0,31	0,39	0,35	0,42	0,46	0,44	0,42	0,46	**0,0153** [a]
Health Sciences	0,50	0,55	0,59	0,65	0,61	0,67	0,70	0,83	0,80	0,81	**0,0007** [a]
Social and Legal Sciences	0,54	0,58	0,69	0,66	0,58	0,64	0,84	0,71	0,70	0,88	**0,0122** [a]
Engineering and Architecture	0,17	0,25	0,16	0,23	0,22	0,26	0,22	0,25	0,28	0,31	**0,0318** [a]

a: Mann-kendal test

MIN. MAX.

Fig. 2. Comparison of W/M in grants in different areas of knowledge from 2013 to 2022, and p-values from Mann-Kendall trend tests. Shades of yellow and green represent lower and higher values, respectively.

Expanding the analysis over the years, Fig. 3 shows that the W/M ratio increased for associate and full professors both overall and across areas of knowledge. From 2015 to 2022, *Health Sciences* showed the highest increase for both associate professors (0.239) and full professors (0.091). *Social and Legal Sciences* showed growth in both categories (0.106 and 0.130). In contrast, *Sciences* and *Engineering and Architecture* showed a slight increase, particularly for full professors (0.038 and 0.047, respectively). Analyzing trends in associate professors and full professors, the analysis showed statistically significant trends favoring women for both overall associate professors and full professors, as well as for each of the analyzed areas.

In summary, statistical differences were detected in grants awarded to associate and full professors, in general and across areas of knowledge. Moreover, statistical differences in trends favoring women were observed. Only *Arts and Humanities* did not present

Table 2
Number of associate professors disaggregated by areas of knowledge, gender, percentage of each gender, W/M odds ratio.

	N Research Staff	%Research Staff	Women	Men	%W	%M	W/M	p-value
Total	103459	-	44716	58743	43.2%	56.8%	0.761	**0.0009**[a]
Arts and Humanities	12380	12.0%	6254	6126	50.5%	49.5%	1.021	**0,029**[b]
Sciences	14705	14.2%	5670	9035	38.6%	61.4%	0.628	**0.0009**[a]
Health Sciences	21213	20.5%	11092	10121	52.3%	47.7%	1.096	0,14[b]
Social and Legal Sciences	34549	33.4%	16720	17829	48.4%	51.6%	0.938	**0.0009**[a]
Engineering and Architecture	20612	19.9%	4980	15632	24.2%	75.8%	0.319	**0.0009**[a]

[a] Mann-Kendall test.
[b] t-student test.

Table 3
Number of full professors disaggregated by areas of knowledge, gender, percentage of each gender, W/M odds ratio.

	N Research Staff	%ResearchStaff	Women	Men	%W	%M	W/M	p-value
Total	41564	-	15825	25739	38,1%	61,9%	0,615	**0.0009**[a]
Arts and Humanities	5474	13,2%	2510	2964	45,9%	54,1%	0,847	**0.0009**[a]
Sciences	9147	22,0%	3300	5847	36,1%	63,9%	0,564	**0.0009**[a]
Health Sciences	4095	9,9%	1781	2314	43,5%	56,5%	0,770	**0.0009**[a]
Social and Legal Sciences	12659	30,5%	5841	6818	46,1%	53,9%	0,857	**0.0009**[a]
Engineering and Architecture	10189	24,5%	2393	7796	23,5%	76,5%	0,307	**0.0009**[a]

[a] Mann-Whitney test.

	2015	2016	2017	2018	2019	2020	2021	2022	p-value
Associate Profesor	0,664	0,677	0,691	0,708	0,724	0,737	0,747	0,761	**0,00005** a
Full Profesor	0,552	0,555	0,561	0,570	0,582	0,591	0,599	0,615	**0,00005** a
Arts and Humanities									
Associate Profesor	0,918	0,937	0,941	0,972	0,990	1,010	1,018	1,021	**0,00005** a
Full Profesor	0,782	0,792	0,781	0,797	0,821	0,840	0,846	0,847	**0,00174** a
Sciences									
Associate Profesor	0,593	0,601	0,603	0,608	0,612	0,617	0,620	0,628	**0,00005** a
Full Profesor	0,526	0,530	0,531	0,535	0,542	0,548	0,552	0,564	**0,00005** a
Health Sciences									
Associate Profesor	0,857	0,885	0,913	0,949	0,987	1,022	1,051	1,096	**0,00005** a
Full Profesor	0,678	0,678	0,682	0,687	0,713	0,728	0,735	0,770	**0,00038** a
Social and Legal Sciences									
Associate Profesor	0,832	0,843	0,859	0,880	0,896	0,913	0,927	0,938	**0,00005** a
Full Profesor	0,727	0,737	0,757	0,774	0,795	0,807	0,825	0,857	**0,00005** a
Engineering and Architecture									
Associate Profesor	0,291	0,296	0,306	0,306	0,313	0,314	0,315	0,319	**0,00005** a
Full Profesor	0,260	0,262	0,271	0,279	0,285	0,292	0,300	0,307	**0,00005** a

a: Mann-kendal test

MIN. MAX.

Fig. 3. Comparison of W/M between associate and full professors by areas of knowledge from 2015 to 2022, and p-values from Mann-Kendall trend tests. Shades of yellow and green represent lower and higher values, respectively.

a statistical tendency of growth. To associate and full professors, statistical trends were detected in general and across areas of knowledge.

Considering PGFR, Fig. 4, the proportion of grants awarded to associate professors and full professors varied significantly across areas of knowledge between 2015 and 2022. *Arts and Humanities* and *Social and Legal Sciences* presented the most variable behavior among both associate professors and full professors. Their PGFR values ranged between 0.65 and 1.08 over the years and did not show significant trends in either group. Similarly, the PFGR behavior of *Health Sciences* and *Engineering and Architecture* associate professors showed a slight decrease in some years, with no significant trends for either. In contrast, the scenario for full professors was positive for both, presenting a positive statistical trend. Despite *Sciences* being the area with a statistical trend for both associate professors and full professors, it was the one that presented the lowest values of PGFR. In terms of full professors, the PGFR was close to or equal to 1 across all areas, except for *Sciences*.

	2015	2016	2017	2018	2019	2020	2021	2022	p-value
Arts and Humanities									
Associate Profesor	0,71	0,91	0,65	0,66	0,99	0,71	0,68	0,81	0,904 [a]
Full Profesor	0,76	0,98	0,71	0,72	1,08	0,78	0,74	0,98	0,720 [a]
Sciences									
Associate Profesor	0,56	0,65	0,56	0,69	0,75	0,70	0,67	0,74	**0,032** [a]
Full Profesor	0,58	0,68	0,59	0,72	0,78	0,74	0,70	0,82	**0,032** [a]
Health Sciences									
Associate Profesor	0,71	0,74	0,67	0,70	0,71	0,82	0,76	0,74	0,720 [a]
Full Profesor	0,78	0,84	0,76	0,81	0,83	0,96	0,90	1,05	**0,032** [a]
Social and Legal Sciences									
Associate Profesor	0,83	0,80	0,68	0,73	0,94	0,78	0,75	0,94	0,276 [a]
Full Profesor	0,95	0,92	0,77	0,83	1,06	0,88	0,84	1,03	0,904 [a]
Engineering and Architecture									
Associate Profesor	0,55	0,77	0,71	0,84	0,70	0,81	0,89	0,97	0,062 [a]
Full Profesor	0,56	0,79	0,73	0,86	0,72	0,82	0,90	1,00	**0,032** [a]

a: Mann-kendal test

MIN. MAX.

Fig. 4. Comparison of PGFR between associate professor and full professor by areas of knowledge from 2015 to 2022, and p-values from Mann-Kendall trend tests. Shades of yellow and green represent lower and higher values, respectively.

4. Discussion

This study conducts a comprehensive analysis of 20,483 grants awarded from 2013 to 2022, focusing on different gender participation as PI in R&D&I projects and their distribution across areas of knowledge and tenured research staff. The novelty of our approach was to merge data for both grants and research staff to analyze the trends as well as the proportion of grants awarded by each gender with respect to their presence as associate and full professors across the areas of knowledge. Our findings underscore a positive shift towards a greater gender-equitable landscape and reveal significant differences not only in the distribution of grants by gender, in associate professors and full professors across areas of knowledge, but also in the relative proportion of grants awarded by women in these positions. Nevertheless, disparities persist, with women underrepresented as full professors and in the areas of *Sciences* and *Engineering and Architecture*. Although our findings indicate a positive trend towards a more equitable distribution of grants, determining whether these changes are the result of policy changes, generational shifts, or broader external factors were not within the scope of our study. As an observational study, we analyzed evolutionary data to characterize funding allocation over the last 10 years.

Despite these positive results, notable disparities remained at higher career levels. In our findings, we observed that 43% of associate professors, 38% of full professors, and only 32% of PI were women, as shown in Tables 2, 3 and 1, respectively. These findings are consistent with previous studies showing that as career specialization and seniority increase, female representation declines (Gill et al., 2022; Fagan & Teasdale, 2021).

This pattern can be understood in terms of global, national, and socio-structural factors. Globally, the underrepresentation of women in senior positions is partly due to their later entrance into the workforce (Goldin & Katz, 2002). In the Spanish context, while women gained access to universities in the early 20th century, their rights, and consequently their academic careers, were restricted during the Francoist dictatorship (1939–1975) (Moraga García, 2008). After 1975, women gradually reintegrated into the academic workforce, but the effects of historical exclusion may partly explain their lower representation in senior academic roles. Additionally, socio-structural barriers, especially those linked to maternity and caregiving, significantly affect career trajectories. Many women leave academia due to toxic work environments (Spoon et al., 2023) and the negative impact of parenthood on their career progression (Derrick et al., 2022; Burns et al., 2019), further limiting their access to leadership roles. These factors create cumulative disadvantages and may help explain the underrepresentation of women in senior positions.

In terms of areas of knowledge, the percentage of women as associate and full professors, and PIs did not follow a specific pattern. Some areas, such as *Arts and Humanities*, have shown near-equal gender representation for years, while others, such as *Engineering and Architecture*, remain male-dominated. In the Spanish context, *Engineering and Architecture* presented almost 24% of women full professors and only 19% of grants awarded. This finding is consistent with previous studies that show that women are underrepresented in STEM-related fields (Ceci et al., 2014; Huang et al., 2020; Cheryan et al., 2017; Lariviere et al., 2013; Haghani et al., 2022).

Women also exhibit higher attrition rates throughout their careers (Spoon et al., 2023; Waisbren et al., 2008; Madariaga et al., 2011), and our results showed that this pattern also extends to the Spanish context. These disparities can be reinforced by sociocultural and structural factors, including gender stereotypes, which influence perceptions of scientific ability from an early age (Miner et al., 2018). Textbooks often depict scientists as white men (Corsbie-Massay & Wheatly, 2022; Mitchell & McKinnon, 2019), and by the age of 13 or 14, girls tend to exhibit lower confidence in STEM subjects because of stereotypes associated with scientific and technical skills with men (Nosek et al., 2009). In adulthood, stereotypes about scientists remain more closely aligned with those about men than with those about women, although this perception changes as women's representation in the scientific field increases (Carli et al., 2016).

These patterns help to explain the lower participation of women in fields such as *Engineering and Architecture*, where traditional gender roles and stereotypes persist. However, it also provides an optimistic perspective that by increasing the representation of women, these stereotypes can be adapted to both genders.

While this gender disparity remains a concern, our analysis of data over time revealed a positive trend favoring women across nearly all areas of knowledge. The only exception is *Arts and Humanities*, where women's representation has been relatively equal to that of men and has remained stable over the years.

Nevertheless, it is crucial to carefully interpret comparisons between the percentage of each gender in grants awarded, associate and full professors. Globally, women researchers represent only 26% of the global academic workforce (UNESCO Institute for Statistics (UIS), 2019), indicating that achieving a perfect 50/50 gender balance is highly unlikely. This observation was also reflected in our analysis of women/men (W/M) ratio. Here, men outnumbered women as research staff across almost all analyzed areas and years. To address disparities in grant distribution and enable fair comparisons across areas of knowledge and research roles, we calculated the PGFR to access the proportion of grants awarded to each gender based on their representation as associate and full professors. When analyzing these proportions over the years, we observed a consistent increase favoring women in both roles. The only exception was in *Health Sciences*, where the PGFR variation from 2015 to 2022 was minimal (0.03).

Interestingly, the proportionality of grants appears to be higher for full professors than for associate professors, with similar numbers of grants awarded to men and women in the *Sciences*, *Social and Legal Sciences*, and *Engineering and Architecture* research areas by 2022. Significant trends in PGFR were noted in the field of *Sciences* for both associate and full professors. However, in *Health Sciences* and *Engineering and Architecture*, these trends were evident only among full professors. A closer examination of the PFGR in *Engineering and Architecture* reveals that, despite the lower number of women among both associate professor and full professor roles, the relative proportion of grants awarded to women has steadily increased over the years. In 2022, grants awarded to women were proportional to their presence in both roles. This observation is consistent with the selection criteria described by Sugimoto et al. (Sugimoto & Larivière, 2023), suggesting that women engaged in this field and at these career stages are able to achieve similar levels of performance to their men colleagues.

As stated in the Introduction, the complexity of the funding system is influenced by socio-structural factors and individual characteristics, which shape both the system itself and how it is experienced by different individuals in various contexts. Funding allocation is a multifactorial process, and our study examined the temporal evolution of grants awarded as well as the representation of each gender among associate and full professors, both overall and across different areas of knowledge. Our findings reveal that although women were in lower numbers as full professors, they achieved a proportional rate of grants awarded compared to men. This suggests that career stage had a greater impact on grant allocation than the PI's gender. Regarding trends over time, while the proportion of grants awarded to women as associate professors and full professors remained lower than that of men, it increased overall. A recent comprehensive study on authorship also observed an increase in women's participation and trends towards more equitable participation in science (Sánchez-Jiménez et al., 2024), further supporting our findings.

However, our results also highlight the lower representation of women among full professors and in certain fields, such as *Engineering and Architecture*. This pattern, in which men outnumber women in advanced career stages, has been observed in previous studies both in academia (Adamecz-Völgyi & Shure, 2022; Petrongolo, 2019) and the global workforce (Forum, 2023; European Commission. Directorate General for Research and Innovation, 2021). In both cases, gender disparity was particularly pronounced in the male-dominated disciplines.

Given these findings, we emphasize that our study does not seek to question the fairness of the funding process or suggest that Spanish funding agencies apply biased evaluations. We advocate the importance of continuing research on funding allocation from different perspectives, incorporating diverse factors, and, where possible, fostering multidisciplinary collaboration with experts in sociology, political science, public policy, and related fields. Finally, efforts regarding gender equality must continue to understand why and how these disparities arise and persist in both academia and society. To foster a more gender-equitable academic environment, it is crucial to implement policies that promote awareness, mentorship programs, and more inclusive and sustainable workspaces that support work-life balance. We offer suggestions for funding agencies that could help promote gender equity. Although Cruz-Castro and Sanz-Menéndez (2023) found no evidence of differences in evaluations in Spain, it would be interesting to consider the implementation of a blinded review process to avoid any potential gender bias or undue influence based on the PI's identity. Additionally, it would be interesting to define and incorporate a parity metric for research teams, allowing the assessment of gender diversity among team members. Including this factor in the evaluation process could encourage the formation of more balanced and collaborative groups, enriching scientific perspectives, and problem-solving approaches. This criterion could also be expanded to assess diversity in other aspects such as geographic representation. The last suggestion would be funding calls specifically addressed to women working in male-dominated fields. These initiatives could provide women researchers with valuable career opportunities, helping to strengthen their positions within the science itself and the research community.

Although our findings contribute to a better understanding of gender dynamics in grant distribution, some limitations need to be reported. We acknowledge that our analysis was constrained by the availability of aggregated research staff data, which implies the classification of grants into broader areas of knowledge. Our classification followed an official document (Boletín Oficial del Estado, 2007), however, if this classification does not accurately reflect the actual distribution of research activities, our findings may not fully capture the reality of grant allocation across areas of knowledge. One key factor to consider is the structure of academic careers and institutional structures, which still enforce disciplinary boundaries, despite increasing multidisciplinary research. In Spain, tenured positions are structured around specific certifications within the areas of knowledge (Agencia Nacional de Evaluación de la Calidad y Acreditación, 2022), which can limit multidisciplinarity. For example, a researcher with an academic degree in the field of Arts and Humanities cannot apply for a tenured professorship in Computer Engineering. However, we recognize that some fields are more

permeable and we have taken some considerations to mitigate these limitations. For instance, Biology can be classified under both *Sciences* and *Health Sciences* according to the official classification (Boletín Oficial del Estado, 2007). To address this, we grouped all biology-related fields in the *Health Sciences* to maintain coherence. This methodological decision reduces classification ambiguity while preserving the broader structure necessary to analyze the grant distribution. Additionally, we acknowledge that research teams are often multidisciplinary, meaning that while individual researchers may have expertise in multiple fields, PI is typically the one whose expertise aligns most closely with the project's main field. Thus, even in multidisciplinary projects, PI's background often dictates grant classification, reinforcing the validity of our methodological approach. With these considerations, we aimed to acknowledge the complexities of research classification, while demonstrating that our study provides a structured and relevant approach.

In addition, our analysis did not consider grant applications because of a lack of available data. Including this information would provide a more comprehensive understanding of funding allocation in the Spanish context and allow for an evaluation of women's success in securing grants. The timeframe analyzed was shaped by data availability. Additionally, we focused on broader areas of knowledge given that the research staff data were only available in this aggregated form. These factors limited to do an analysis at the level of specific in fields of knowledge and for earlier years.

In future research, we aim to deepen the analysis in terms of productivity, performance, and collaboration to better understand how these variables influence gender dynamics in research funding. Another interesting research that could serve as a complement would study which and how different factors can explain these trends, deepening the understanding of which attitudes would be more efficient in terms of gender parity.

5. Conclusions

Despite the complexity of analyzing the various factors that influence the funding allocation system, our longitudinal analysis is based on the premise that areas of knowledge and academic rank play important roles in the funding system. Our study aimed to analyze the distribution and trends of grants awarded to women and men across various areas of knowledge, tenured research staff categories, and the proportion of grants relative to their presence as associate and full professors from 2015 to 2022. We analyzed 20,843 grants, disaggregating the data by year, and used statistical analysis to evaluate the significance of our findings. Our results revealed significant differences in the grants awarded and the representation of associate and full professors, with women being more present in lower faculty positions. Despite the differences in grants awarded, there was a positive trend toward gender parity, with an increasing number of grants awarded to women over time. This pattern was more pronounced in the *Sciences, Health Sciences, Social and Legal Sciences* and *Engineering and Architecture*. Regarding the research staff, our results were in accordance with those of previous studies, showing significant differences between women and men in associate and full professors across all analyzed areas, except for associate professors in *Health Sciences*. However, a positive trend for women was detected across all areas of knowledge in both categories. To address the gender imbalance in terms of the scientific workforce, our PGFR analysis reveals that in recent years, women grants have been awarded proportionally to their presence as full professors overall. In terms of areas of knowledge, this proportionality was observed in *Health Sciences, Social, and Legal Sciences* and *Engineering and Architecture*. Despite these positive findings, we emphasize the need for attention and discussion on the implications of women's underrepresentation in senior research staff positions and specific areas of knowledge, such as STEM. Our findings are helpful for understanding the evolving landscape of grant allocation in the Spanish context across areas of knowledge and faculty rank.

CRediT authorship contribution statement

Thamyres T. Choji: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Jose A. Moral-Munoz:** Writing – review & editing, Validation, Supervision, Funding acquisition, Conceptualization. **Manuel J. Cobo:** Writing – review & editing, Validation, Supervision, Methodology, Funding acquisition, Conceptualization.

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Appendix A. Calls to grants

To replicate this study, the categories used to filter the grants are described below:

- **Challenges and Knowledge generation**: Proyectos de I+D+I (Generación de Conocimiento y Retos Investigación), in Spanish.
- **Generation of knowledge**: Proyectos de I+D (Excelencia / Generación de Conocimiento), in Spanish.
- **Challenges of Society**: Proyectos de I+D+I (Retos Investigación), in Spanish.

Appendix B. Areas of knowledge standardization

Table B.4 shows how we matched the areas of knowledge and fields of knowledge.

Table B.4
Match between Areas and Fields of Knowledge.

Area of Knowledge	Fields of Knowledge
Arts and Humanities	Culture: philology, literature and art Mind, language and thought
Sciences	Agricultural and agro-food sciences Physical sciences Mathematical sciences Materials sciences and technologies Environmental sciences and technologies Chemical sciences and technologies
Health Sciences	Biosciences and biotechnology Biomedicine Psychology
Social and Legal Sciences	Educational sciences Social sciences Law Economics Feminist, women's and gender studies
Engineering and Architecture	Energy and transport Industrial production, civil engineering and engineering for society Information and communication technologies

Appendix C. Categories of research staff

The Teaching and Research Staff (*Personal Docente e Investigador*, in Spanish) in Spanish universities are divided into tenured and non-tenured positions, with responsibilities in both teaching and research tasks at higher education institutions (Pekkola & Siekkinen, 2024). Our analysis focuses on tenured positions as follows:

- **Associate professors**: Tenured positions requiring a PhD, typically held by mid-career academics. Associate professors are expected to demonstrate significant progress in their field but generally have fewer leadership roles. They may hold either temporary or permanent contracts and may or may not have civil servant status.
- **Full Professors**: Tenured positions requiring a PhD, held by senior academics with a well-established reputation for excellence. Full professors have greater leadership responsibilities and influence their institutions and fields. They hold permanent contracts and job stability with or without civil servant status.

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