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SOCIAL SCIENCES

Androcentrism in the scientific field: Brazilian systems of graduate studies, science and technology as a case study

ROBERTA ARÊAS, ALICE ABREU, CARLOS NOBRE, MARCIA C. BARBOSA & ADEMIR E. SANTANA

Abstract: This article performs an analysis of female participation in science, in the Brazilian system of graduate studies and scientific research as a case study. This is relevant because science is a central supporting structure for modern societies and, therefore, a detailed analysis of the scientific power structure behind academic policy creation can reveal aspects of androcentrism in scientific activity. The main goal of this work is to identify the process of misogyny in science by describing its reproductive pattern. Our results show that women are around 50% of the undergraduate and graduate students when all fields are taken into consideration, but only 37% of the researchers in the CNPq system. We also observe a significant increase in female percentage within scientific activities at the initial and intermediary levels, except for the most prestigious areas as hard science. However, a scissor effect is identified between the initial level and the more prominent positions. This unbalanced participation reveals that female occupations in science are mostly as lower workforce since women are quite far from the social decision-making circles in this career

Key words: Gender, women in science, misogyny, Brazilian case study.

INTRODUCTION

Symbolic violence in the scientific field is a remarkable social phenomenon that is studied from different perspectives. Nonetheless, specifically regarding gender, this violence often falls upon women[1] in the form of ubiquitous moral and cultural coercion through a process of naturalization of social patterns. Unfortunately, these aspects have not been fully explored and determined (Santana 2014). Symbolic oppression is characterized by the principle of denial of differences (Young 1990). This principle is the describing factor of the naturalization process dynamics resulting in moral violence. Under this situation, there is an unbalanced accumulation

1 In this article the terms sex and gender are used according to the accepted academic distinctions, sex as referring to biological characteristics and gender as referring to cultural attitudes and behaviors. As well described by Tannenbaum et al. (2019) "[...]Sex refers to the biological attributes that distinguish organisms as male, female, intersex (ranging from 1:100 to 1:4,500 in humans, depending on the criteria used) and hermaphrodite (over 30% of no insect nonhuman animals). (...) Gender refers to psychological, social and cultural factors that shape attitudes, behaviors, stereotypes, technologies and knowledge. Gender includes three related dimensions. Gender norms refer to spoken and unspoken rules in the family, workplace, institution or global culture that influence individuals. Gender identity refers to how individuals and groups perceive and present themselves within specific cultures. Gender relations refer to power relations between individuals with different gender roles and identities. [...]". Another careful description of the distinction can be found at http://genderedinnovations.stanford.edu/terms.html. In this text, the dynamic structure of misogyny in science is analyzed from a gender perspective while the statistics used to create indicators are disaggregated by sex.

of symbolic capital supporting social structures of production based on a praxis of cultural and economic imperialism (Heinich 1997). This is present in the perspective of disputes in different realms, as much in inter-classes as in intra-classes, but also in geopolitical contexts (Elias 1990, Bourdieu 2012).

According to Bourdieu, discrimination is a phenomenon that takes place in the process of dispute for capital appropriation in the social realm. This leads to the naturalization of the dominating actions of a group regarding another. In other words, naturalization is a procedure developed toward ensuring the dominant *status quo*. It leads to the pervasive symbolic violence in scientific communities, particularly in the context of gender issues, with a direct impact on the *intelligentsia* of contemporary societies (Bourdieu 2003).

For the occupation of socio-spatial positions, the accumulation and importance of symbolic-cultural capital by scholars (university professors, researchers and doctoral students, among others) is only equivalent, in terms of social power, to the economic capital of businesspeople, industry CEOs and some liberal positions. In the case of academic culture such positions are intimately linked to political-state capital, which is, in turn, the measure and guide for economic activities, developments in knowledge and innovation, as well as cultural activities that include education and arts (Jourdain & Naulim 2017). Regarding these aspects, modern universities, and research centers play an important role as a construct supporting and guaranteeing the perpetuation of hegemonic industrial and post-industrial societies.

The scientific field, with its disputes and mediation, has been analyzed under different aspects due to its importance, including on the issue of gender. Nevertheless, the symbolic violence and elements of an intra-field of androcentric discrimination in social *intelligentsia* formation are phenomena demanding further investigations.

Considering the *intelligentsia* organization in contemporary industrial or post-industrial societies, dominant groups express their specific discrimination regarding the former through a false naturalization of the discourse on scientific achievements. The notion of "scientific competence" in scientific research, for example, is naturalized in a way to favor androcentric viewpoints (Bourdieu 2003). Even today, one can easily observe that men are a majority in higher levels of research and academic institutions in all scientific areas (Abreu et al. 2016, GenderInSite 2018). Bourdieu associates this context with the notion of "*racism*[2] *of the intelligentsia*" that, in the case of gender, is forged initially at home and school. Indeed, "(The) *School classification is a euphemized social classification, therefore, naturalized, absolutized, a social classification that has already been censored, thus, an alchemy, a transmutation tending to transform class differences into the differences of "intelligence"," gift", that is to say, differences in nature*" (Bourdieu 2003).

The discrimination arising from school rank-classification is quite often sanctioned by science itself. However, "intellectual capacity" and "gifts" are developed by an accumulation process of cultural capital developed since

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It is essential to highlight that the term racism is extensive and, in some interpretations, may be related to the skin color of individuals. Bourdieu argues in his original article "racism of intelligentsia" (2003) that there are various types of racism and that this term can be applied whenever there is a discriminatory process, regardless of its nature. In the present paper, the term racism is inseparable from the term intelligentsia – as the matter of fact, the proposal is even more specific: to use the term Discrimination of Intelligentsia to designate the marginalization process that women suffer in the scientific field.

childhood. In this scenario, the aforementioned "racism of the *intelligentsia*" takes place not only in the context of inter-social class disputes as the concept was originally introduced, but also intra-class, within social groups. One instance is the family, a social superstructure that starts to impose a process of segregation regarding particular preferences such as colors, clothes, body postures, toys, and dreams of professional activities upon young girls. Those girls that proceed in the opposite direction during their lives will inevitably face hindrances construed by naturalized discrimination. This process, with all types of implicit symbolic violence, is not exotic to intellectual-academic institutions.

Though many aspects of the explicit (physical) violence against women have been explored and discussed under different perspectives (Heinich 1997, Brasil 2004, Fontenele-Mourão 2006), those of implicit nature, marked by symbolic violence (Swim et al. 2010, Swain 2017, Hooks 2019), gained much less attention; certainly, due to the intrinsic difficulties of this issue. Indeed, from a theoretical perspective, much more research is required toward developing an acceptable narrative about the naturalization and perpetuation mechanisms of androcentrism in areas such as science (Santana 2014). Gender symbolic violence can be seen in science in a still preliminary approach by looking at the participation of women in a typical male area such as physics. The percentage of Ph.D. women in physics in some geopolitical regions are: 10% in North America; 12% in Latin America; 7% in Anglo-Saxon Europe; and 22% in Latin Europe and East Europe (Saitovitch et al. 2015).

These data compared with the aforementioned ones of graduate students seem somewhat contradictory. The undergraduate level is the first step in science but is primarily dedicated to provide people to participate in the productive network system. In some cases, female participation diminishes drastically when proceeding to further levels in science training as the doctoral or postdoctoral levels. The usual explanation for this is a highly naturalized argument: "a lack of genuine interest for science in women!" From this disguised narrative, which is but a naturalistic fallacy, the racism of *intelligentsia* emerges, and as such it demands careful investigation. Considering science, it is acceptable and convenient to denominate such a type of racism as *discrimination of intelligentsia* for emphasizing that it t occurs not only within inter-social but also intra-social class contexts.

Given that science is a supporting construct for modern societies (Jourdain & Naulin 2017), a detailed analysis of its power structure where academic policies are defined, can reveal aspects of androcentrism in scientific activity. Indeed, by focusing on the productive pattern of the *discrimination of intelligentsia*, the process of misogyny becomes evident. In this work we analyze how the participation of women at all levels of the academic carrier decreases as its progresses and how this situation changed over the years in different fields. Therefore, we consider academic androcentrism as a case study through the available data from two central research funding agencies of the Brazilian federal government. Our study identifies the positions where women are minority which in principle are connected with a more political network.

Our analysis employs theoretical elements of Bourdieu and Thompson hermeneutics (Thompson 1981, Demo 2001, Thompson 2011). The initial hypothesis is the understanding that, although female participation has been increasing in different areas – including technical activities associated to science –, androcentrism is hegemonic in the higher spheres of power and at the decision-making level of the scientific field.

The presentation is organized in the following manner: in the next section the women participation in the academic and scientific workforce is reviewed. Afterward, the methodology utilized is presented in the Materials and Methods section, Results section presents an exposition regarding women participation in higher education and science is performed with data from CNPq and CAPES, two Brazilian federal government agencies. Discussion section considers the theoretical background to analyze the results presented in the previous section. Conclusions and recommendations section finishes this manuscript.

A review of the panoramic view on work and gender

Women and work: tendencies in modern societies

The role played by women in modern societies has been systematically analyzed in several studies with a diversity of perspectives. Economically, for example, the World Bank has identified female empowering as a key element for poverty reduction (Malhotra et al. 2002). The role of women as providers has also been observed l. In monoparental families, where women are responsible for the family budget, the family group seems to be in a better situation when compared with those in which the economic family head is a male (Duflo 2012). In political activities, female presence is inversely proportional to corruption levels, i.e., a greater presence of women in parliament reduces the level of corruption (Dollar et al. 2001, Swamy et al. 2001). Women researchers also introduce more novelty in science than their male counterpart (Hofstra et al. 2020).

There is a significant number of research and evidence demonstrating that female presence in professional activities induces greater efficiency, social egalitarianism, and a sustainable environment (United Nations Women [UN Women] 2015). The United Nations has been an important advocate of gender equity since the Millennium Development Goals, agreed in 2000, where one of the 8 goals were to “promote gender equality and empower women.” More recently, with the Sustainable Development Goals, this position was strengthened, as one of the 17 new goals for the 2030 agenda is precisely “gender equity” and “gender” itself is explicitly mentioned in the other 16 goals.

In the last decades in Brazil, it is possible to find many initiatives toward increasing gender equity as the creation of the National Council for Woman Rights (1980) and the creation of specialized police stations to handle the rights of women’(1985). Nevertheless, these actions are very far from being enough, since Brazil is at the 92nd position in the ranking of 159 countries analyzed regarding gender in 2015 by the UN. Some weak indicators explain Brazil’s position in this list: high levels of teenage pregnancy; a strong gap in wages of women compared with those of men in the same type of activity and a very low representation in government. This last issue, present in the Brazilian Congress, can be measured by a comparison with other countries with a lower HDI (Human Development Index). The Central Africa Republic, for instance, the country with the lowest HDI in the world, has 12.5% of women in parliament, while in Brazil this index is 10.8% (United Nations Development Program [UNDP] 2015, Cancian 2017).

The academic scene in science: “A Boys´ Club”

The gender problem in science, in spite of recent advances, remains very unbalanced in favor of men. At the undergraduate level, the first step in a scientific career, female participation increased along the 20th century. In the higher levels of scientific careers, however, there is a strong prevalence of male positions, a result of historically naturalized preconceived ideas about women (Abreu et al. 2016). Many stereotypes have been prevalent for many years, such as the one positing that the “weaker sex” lacks the necessary characteristics of high intelligence and brightness, both considered necessary conditions for performing competent and competitive science. These concepts give rise to an invisible barrier, sometimes called the glass ceiling, preventing women from reaching the higher levels of a scientific career (Leslie et al. 2015, Bian et al. 2017). These barriers are the result of the discrimination of *intelligentsia* that aims to keep the direction and control of science as an “old boys´ club” with its praxis. Some recent studies analyzing those stereotypes against women deserve to be mentioned here.

Studying the concept of what is considered “a brilliant person,” Bian et al. (2017) have demonstrated that boys and girls up to 5-year-old, when asked to choose an intelligent person, tend to select persons of the same gender. Nonetheless, a turning point happens at the age of 6 to 7 years old, when there is a tendency to select predominantly male figures. In short, Bian and his co-authors demonstrate that the stereotyped idea that males are “more intelligent or capable, or better” starts at home during an earlier age, engendering since then the discrimination of the *intelligentsia* in a soft and invisible process.

Although rooted in historical prejudices, the iconic picture of a scientist as a bald male with eyeglasses has been systematically deconstructed in recent research. For instance, Leslie et al. (2015) investigated the existence of an innate talent to become a brilliant person. The research measured attributes for extended and exhausting working hours, and capability for systematic thoughts and empathic behavior – ubiquitous characteristics in main arguments used in social stereotypes formation. Analyzing 1820 students in 30 courses of American universities, males and females were evaluated according to hours of study, grades in standardized tests, and interviews regarding behavior patterns. The results showed no significant difference to support the naturalized (common sense) argument that males have a natural tendency to be more brilliant, or capable, than females in those academic activities.

These types of studies provide a compelling understanding that gender inequity in science is the result not of a biological or innate capacity, but a biased social construction. This process is marked by naturalistic fallacies, leading to “glass ceilings”, i.e., difficulties forbidding equalitarian access of women to all strata of scientific activity.

Lerback & Hanson (2017) concluded that the difficulties for women to attain higher ranks in scientific careers are related to the fact that women do not participate as equal partners in fundamental activities of science production as, for instance, in refereeing committees for academic journals. The study analyzed publications between 2012 and 2015 in 20 journals of the American Geophysical Union (AGU). The result was that only 20% of referees were women. This amount is much less than expected, since, for instance, 28% of AGU affiliations are women; 23% of the articles were written by women; and considering the first author in an article, this number reaches 27% (Lerback & Hanson 2017).

Regarding the matter of funding research projects, it is interesting to mention the work by van der Lee & Ellemers (2015). Their study shows financial support in favor of male scientists, in general, by investigating its unbalanced distributions in different areas. Some contradictions are observed in projects analysis, reinforcing an action based on discrimination of *intelligentsia*. For instance, women are ranked on a lesser degree considering the researcher quality r. However, there is no difference in rank degree for research quality and scientific background skill (Van der Lee & Ellemers 2015).

Similar results were found by Wessel (2016), analyzing data from Wisconsin University from 2010 to 2014. The initial distribution of financial support for research projects had been equal between men and women. Nevertheless, projects headed by men were renewed in larger numbers, even though projects headed by women had been assigned a better rank. For Wessel, the androcentric paradigm is the key to understanding this paradox, as men occupy 80% of the high-level positions in this career.

Bailey (2016) obtained results in the same direction by looking at the numbers of female and male Professors in the Medical Faculty of Harvard University since 1980. Although s there are more women than men at the initial stages of this career since 2016, women represent only 17% of the Full Professor level. Bailey (2016) also shows that female participation in high-level management committees and as deans is about 16% in the USA.

Considering similar studies that confirm explicit and implicit bias, Moss-Racusin et al. (2014) had proposed a framework of strategies to implement a group of interventions at research universities to bring diversity. The authors stated that the fair treatment of other scientists is an essential aspect of scientific quality and progress.

Brazilian women in science

In Brazil, following a global trend, the participation of women in science has been growing over the decades. In the webpage for CNPq - Conselho Nacional de Desenvolvimento Científico e Tecnológico (the Brazilian National Research Council, a federal Government agency) a brief history of pioneer Brazilian women in science can be found. Berta Lutz is mentioned as a typical example of women working in Brazilian science at the beginning of the 20th Century. Bertha Lutz, daughter of the scientist Adolfo Lutz, graduated in sciences in Sorbonne, France. Returning to Brazil with 24 years old, she started working as a biologist at the National Museum of Rio de Janeiro. Bertha has been reputed as one of the first woman scientists in Brazil and the first woman working as a civil servant. An activist for women's rights, she started a parallel career as a politician, being elected for the federal parliament as deputy. In this capacity, she represented the country in many international meetings as in the UN. She also provided important scientific contribution, discovered new species, organized her father's first herbaria and published many scientific articles that gave her a high international reputation in zoology. Her remarkable political and scientific careers paved a road for many others (Melo & Rodrigues 2018).

Since the 1960s, with the increase in female education, the number of women in science working in diverse areas raised significantly over the decades. Several indicators show the advances in this field. Primary education is almost universal: 90% of female and male children receives primary education. In 2008, 55% of undergraduate students in Brazilian universities were women and 60% of those completing the course were women. However, when analyzing the percentage of working men and women four years later, in 2012, 89% of men were working/employed while women configured only 80%. This distortion is larger when you look at global numbers: 72.6% of men in working age a occupy academic positions, while only 50.1% of women do so. The most dramatic situation is concerning wages. Even if Brazilian women have, in average, more years of education than men, men still receive 28.9% higher wages (Abreu et al. 2016).

Women represent about 50% of lecturers and researchers in public universities in Brazil. Nevertheless, this percentage changes according to the considered scientific area (Areas et al. 2019). Following a trend found in other countries, women are present in greater numbers in humanities, biology, and health sciences. This changes for the so-called hard sciences physics, mathematics, and computing. (Abreu et al. 2016). In physics, for example, according to Barbosa & Lima (2013), one of the causes for this low representation is that women entered undergraduate studies in physics much later than men.

A new report by the Elsevier Foundation in 2017 presented some interesting data. Using a new methodology allowing to distinguish author gender in a large database of peer-reviewed articles from 12 countries for the last 20 years, the report looked at important indicators, such as publication number, citations, mobility, and co-authorship as a collaboration index. The results are very favorable to Brazil, since Brazilian women scientists publish as much as men (total number of papers for the period divided by the total number of researchers for the period) in a five-year period (Elsevier 2017). Nonetheless, other databases demonstrate, as will be analyzed in the following session, that Brazilian women scientists still face many challenges.

MATERIALS AND METHODS

As a starting point we investigated two databases which are essential for the research: the first one from CAPES - Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Coordination for the Improvement of Higher Education Personnel), linked to the Ministry of Education and with the mission of training the teaching staff of public universities, and the second from CNPq (the Brazilian National Research Council), linked to the Ministry of Science and Technology and funding research. We also acquired data from the ABC – Academia Brasileira de Ciências (Brazilian Academy of Sciences), IBGE (the Brazilian Institute of Geography and Statistics or Instituto Brasileiro de Geografia e Estatística in Brazilian Portuguese), World Bank, and INEP (the Anísio Teixeira National Institute for Education Research or Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira in Brazilian Portuguese). The data from CAPES were gathered directly from the agency, while the other databases were collected from their webpages or were requested through the Electronic System of Information to the Citizen (e-SIC, in Portuguese) accordingly to the Law for Access to Information.

CAPES is responsible for evaluating graduate programs in Brazil. As such, u it used a database called Coleta up to 2021, which collected data sent to CAPES by all Graduate Programs coordinators around the country every three years. From 2013 until now, the database was significantly modified and improved, receiving the name Plataforma Sucupira. The new platform collected data annually. To merge information from both databases is complex and many indicators had to be recalculated.

The other database, from CNPq, was consulted in two different ways. On the one hand, we used data from its electronic (public) website.

The data from the Advisory Committees, on the other hand, were collected through an official request using the e-SIC system under the protocol numbers 01390000915201798 and 01390001071201701. It is important to emphasize that the level of data disaggregation available from the CNPq is different from data available from CAPES. The classification of scientific areas is also slightly different in the two agencies. It was not always possible, therefore, to aggregate data from both agencies.

Other socio-demographics and general data were gathered in other webpages of relevant organizations. This was the case for the data from INEP, the World Bank, and the Brazilian Academy of Sciences. Information about the number of ministers and presidents of CAPES and CNPq were collected in their respective webpages or in the Journal of the Union (DOU in Portuguese), which publishes all governmental acts of the Brazilian Federal Government. Using this methodology, we use statistics that refer to more than 5 million observations.

RESULTS

Brazilian higher education and sex

This section presents a profile of Brazilian institutions associated with science and higher education. Disaggregated by sex the data reflect the unbalanced participation of women in those activities.

Brazilian population disaggregated by sex

Today, the Brazilian population has a majority of women. In 2010, the demographic census IBGE detected that the Brazilian population is composed of 93.406.990 men and 97.358.809 women; this is equivalent to 49% of males and 51% of females (IBGE 2010). This proportion is similar to the results in the Brazilian National Household Sample Survey (PNAD in Brazilian Portuguese) which demonstrates that women were 51.3% in 2005; 51% in 2010 and 51,6% in 2015 (IBGE 2015).

The Brazilian system of science and technology is organized by both already mentioned agencies: CAPES and CNPq. Therefore, the data below refers to CAPES and CNPq.

Students in Brazilian universities

In Brazil, the percentage of men and women in different levels of education is very different according to grade, and in the case of higher education, the area of knowledge. At the elementary school level, the percentage is almost the same for males and females. From high school to universities the percentage of women is higher. In 2010, considering young people from 18 to 24 years old, 15.1% of women were enrolled at the undergraduate level, while for men this number was 11.3%. (IBGE 2010). The proportion of women students enrolled in undergraduate university courses is 57%, corresponding to 4.588.668 students, while men represent 43%, i.e. 3.438.629 students (INEP 2015).

At the graduate level, this pattern is similar. Looking at a historical series, it is possible to observe that this is the result of changes developed over the last two decades. According to Figure 1(a), in 2018, 54% (210.163) of graduate students (Master and PhD) were women, while men represented 46% (180.258).

Considering only the Master's degree, in Figure 1(b), the number of women finishing a Msc program is larger than men since 1998. Similar numbers can be found for women finishing a Ph.D. program in 2004, according to Figure 1(c). Some of these results were known until 2009 (Centro de Gestão e Estudos Estratégicos [CGEE] 2010). After our updating, going over 10 more years, the results show a strong trend for maintaining the majority of women, both in MSc. and PhD. However, these results are not reflected at the professional level when men and women enter a scientific career, especially if we look at the different disciplinary areas.

Regarding the influence of areas of knowledge, there is no general pattern in the

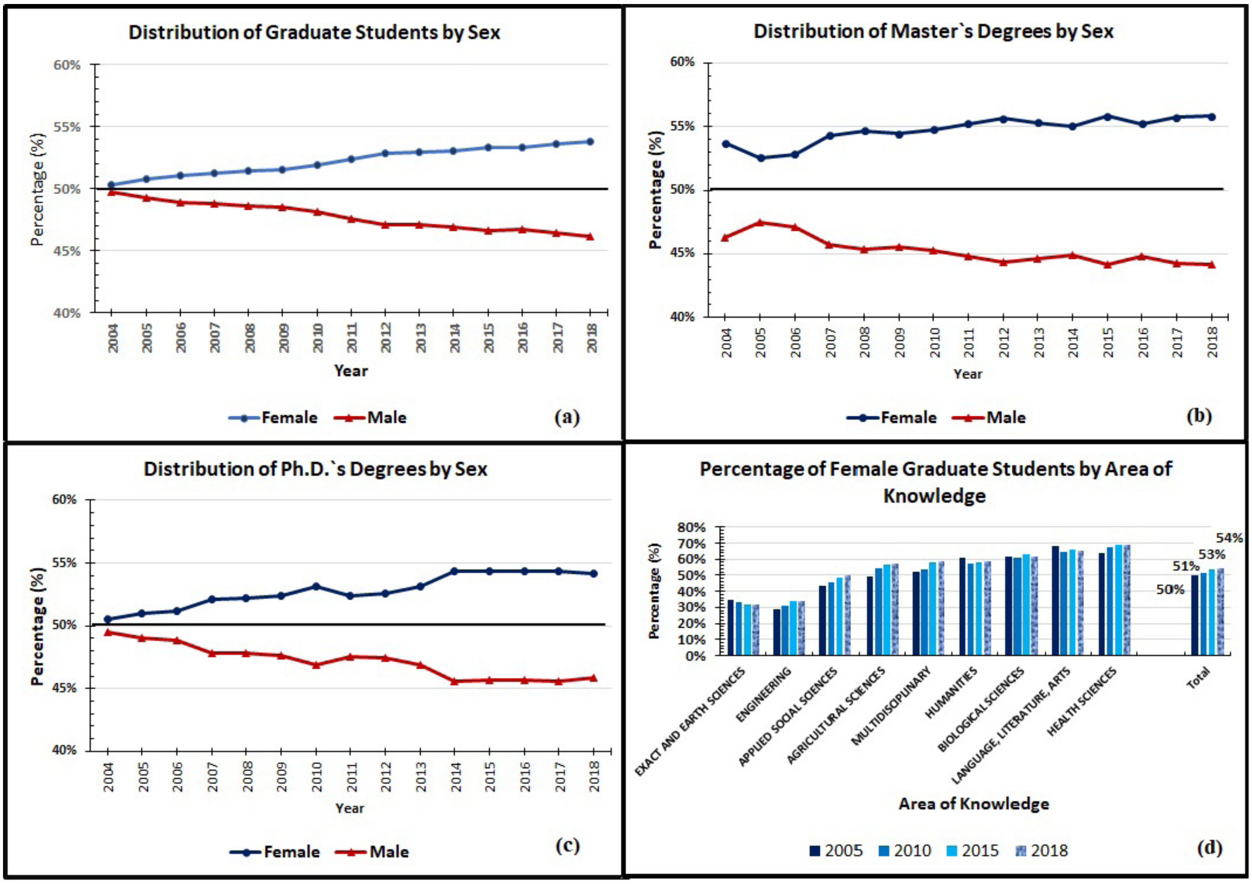

Figure 1. (a) Distribution of graduate students by sex. (b) Percentage of Master's degrees by sex. (c) Percentage of Ph.D. degrees by sex. (d)Percentage of female graduate students by area of knowledge. Source: CAPES.

temporal series. In some areas you may find an increase in the number of women, but this is not the case with areas associated with new technologies production. For instance, in Figure 1(d), in exact and earth science areas (which include physics, chemistry, geophysics, geology and mathematics) women were 35% of the total of students at the undergraduate level in 2005; while in 2018 this number decreased to 32% (a difference of 3% is equivalent to 1.122 female students).

Scholarships in Brazil

Considering the total amount of scholarships awarded by CAPES and CNPq, it is clear from Table I that the percentage of women is larger than men, though at CNPq the difference is smaller than at CAPES.

CAPES organizes the greater areas of knowledge as: (1) Exact and Earth Sciences (Chemistry, Computational Science, Geology, Mathematics, Statistics and Physics), (2) Engineering, (3) Applied Social Sciences (Administration, Architecture, Communication, Economy, Law, Social Sciences and Urban Development, (4) Agriculture Sciences (Agronomy, Fishery Resources, Food Science, Veterinary and Zootechnics), (5) Multidisciplinary (Biotechnology, Environmental Sciences, Teaching and Material), (6) Humanities (Anthropology, Political Sciences, International Relations, Education, Geography, History, Philosophy, Psychology, Sociology and Theology),

Table I. Percentage of national scholarships for females. Source: CAPES and CNPq.

	2005	2010	2015
CAPES's Master's Fellowships	54%	57%	58%
CAPES's PhD's Fellowships	54%	54%	57%
CNPq's Master's Fellowships	**51%**	**52%**	**52**%
CNPq's PhD's Fellowships	50%	51%	51%

(7) Biological Sciences (Biological Sciences and Biodiversity), (8) Language, Literature, Arts, and (9) Health Sciences (Collective Health, Medicine, Nursing, Nutrition, Odontology, Pharmacy and Physical Education). Looking at the stratification by areas of knowledge we observe in Figures 2(a) and 2(b) women are always a minority in hard sciences. For the Exact and Earth Sciences area, women correspond to 37% of the CAPES scholarships, while in CNPq they reach only 34%. It is worth noting that in Figures 1(a) and 1(b) the undergraduate scholarships were considered, and because of that the total percentage is different from Table I. Besides, women in "hard sciences" areas at the undergraduate level correspond to 32%.

Professionals in higher education and research

In this section, a gender profile of professionals acting in science and higher education Brazilian institutions is presented. Most of this group is living the "rush hour" the stage of life, in which career and domestic demands are high enough to compete among themselves. It imposes crossroads particularly on women, who have to constantly make choices related to either having children, for example, or to develop their career (European Science Foundation [ESF] 2009). The data reflect the unbalanced participation of women in scientific activity and, to some extent, provide a measure of *discrimination of intelligentsia* in Brazilian scientific institutions.

Lecturers and researchers in higher education

In the domain of teaching staff working in Brazilians universities, the National Higher Education Census identified a total of 388.004 professionals in 2015, from which 211.889 (55%) were men and 176.115 (45%) women (INEP 2015). Specifically working in graduate programs, 43% are women and 57% are men. Analyzing these numbers from 2005 to 2018 we can see an increase in the percentage of women working in these activities. Looking at the numbers by areas of knowledge, according to Figure 2(c), only in the area of Language, Literature, and Arts the average percentage of women in the four periods is higher than 50%. The worst case is in Hard Sciences (Exact and Earth Sciences and Engineering). In this case, the average percentage of women in the four periods is less than 25%.

Another critical aspect being analyzed is the amount of female Graduate Programs Coordinators. The numbers are presented in Figure (2d), considering the distribution by areas of knowledge. In total, only 41% are female coordinators; in Exact and Earth Science, this number is about 20% over one decade. This number is greater than 50% in two areas: Language, Literature, Arts and Health Science. It is important to note that there was no change in the total percentage over the analyzed series.

Research group leadership grants

In Brazil, the graduate system and scientific research are intimately connected since it is at the universities where the main parts of

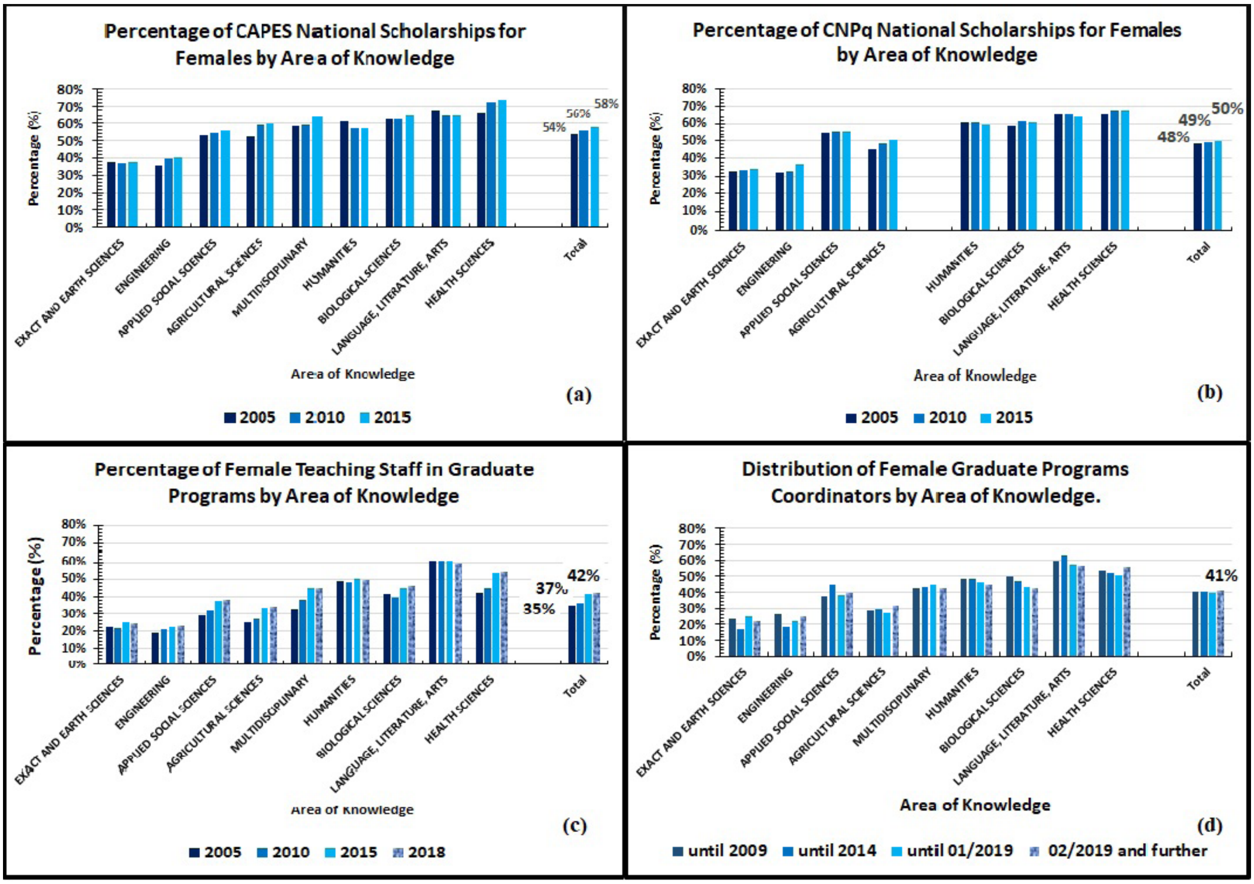

Figure 2. (a) Percentage of Master's and Ph.D. CAPES national scholarships for females by area of knowledge. Source: Capes. (b) Percentage of Master's and Ph.D. CNPq national scholarships for females by area of knowledge. Source: CNPq (c) Percentage of female teaching staff in graduate programs by area of knowledge. Source: CAPES. (d) Distribution of female Graduate Courses Coordinators by area of knowledge. Source: CAPES.

applied and theoretical scientific knowledge are developed. Therefore, to have a clear picture of scientific production in Brazil, an analysis of the national system of graduate programs has to be performed in parallel to the National System of Science, Technology, and Innovation. The main research groups in the country are registered and organized by CNPq, which maintains an updated platform for such a purpose also the main institution in Brazil providing grants for researchers. Through its data we can analyze the distribution of scientific grants.

The numbers related to the very competitive Productivity in Research Fellowship granted by CNPq are a much more prestigious indicator that gathers major scientific leaderships in Brazil. This grant is divided in five levels according to ranks: 1A, 1B, 1C, 1D, and 2. The most prestigious is the 1A category which is composed of researchers who also influence national policies for science and technology. The fellowship selection process is well organized: first, a public edict is released establishing rules and inviting qualified researchers to present research projects. Then, the proposals are evaluated by Committees distributed in the different areas of knowledge that use peer-review through usual referee system of CNPq (figure 3(a)).

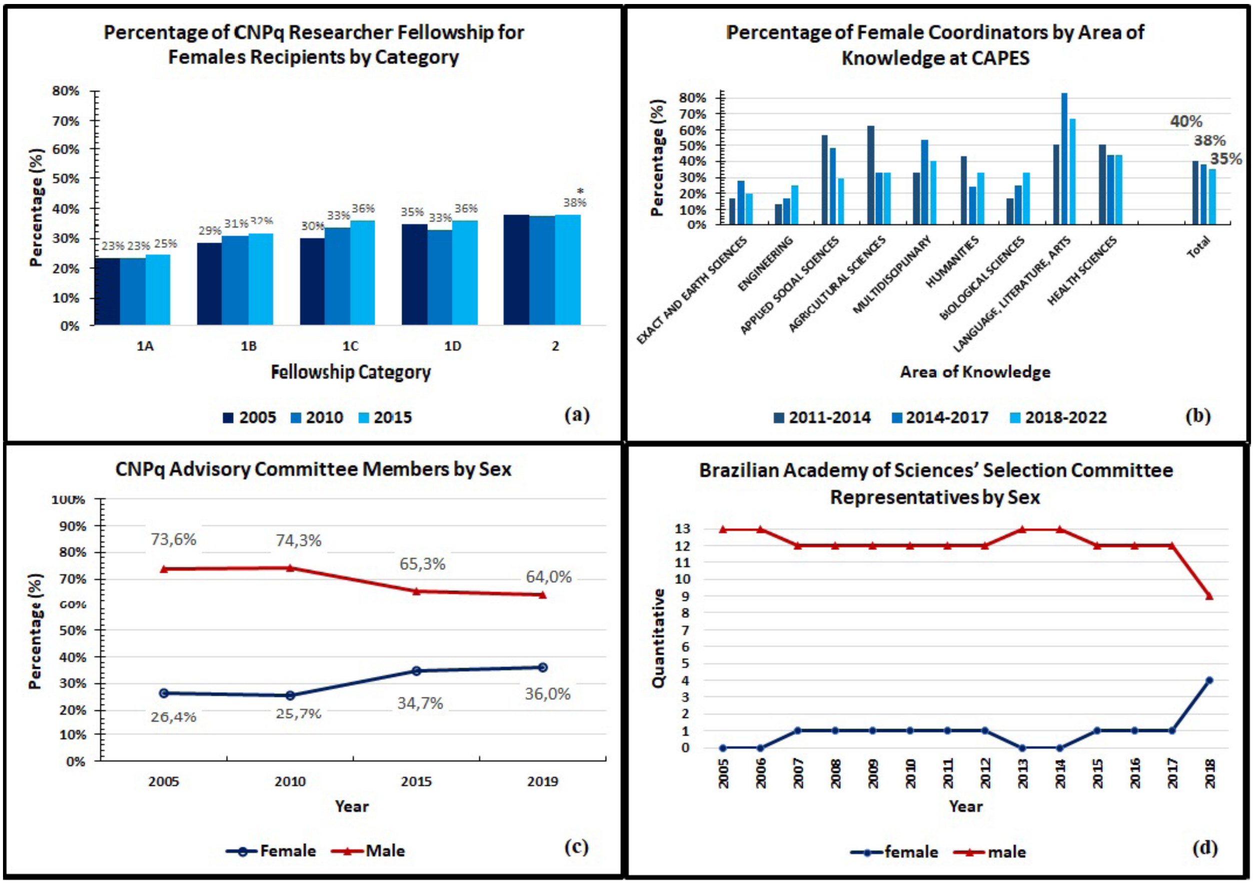

Figure 3. (a) Percentage of female CNPq Researcher Fellowship Recipients by category. Source: CNPq. (b) Distribution of female coordinators by Area of Knowledge at CAPES. Source: CAPES. (c) Distribution of CNPq Advisory Committee Members by sex. Source: CNPq. (d) Brazilian Academy of Sciences' Selection Committee representatives by sex. Source: ABC.

Senior management of science and technology in Brazil

In this section we present data from the top management of science and technology in Brazil. This section is particularly important since it is in this level that policies for education, science, and technology are defined. This information is crucial for understanding the dynamics of discrepancies between sexes that were observed in previous sections. The starting point is CAPES and CNPq, but we consider many other institutions in the national sphere as the Ministries and the Brazilian Academy of Sciences.

The area of knowledge coordinator at CAPES

The Area of Knowledge Coordinator is a very a prestigious position in the National Graduate System monitored by CAPES. This distinct group is formed by lecturers, mainly from public universities, working as scientific advisors for CAPES. Such Coordinators are responsible for the evaluation of graduate programs in different areas of knowledge. The academic community votes in three names, usually very active researchers, and the Superior Council of CAPES elects one of them for a mandate of three years. During this period, this Coordinator participates in high-level commissions and workgroups at CAPES in order to define financial resources allocation, rules and norms for graduate programs, among other activities.

Taking into consideration the importance of this position, we have analyzed the composition of this group by sex in the periods of 2011-2014, 2014-2017, and 2018-2022. Figure 3(b) shows a strong oscillation regarding the sex composition of this group and a discrepancy among areas. One very clear evidence is that the percentage of female coordinators in hard science areas is less than 25% in the average period. This quite unbalanced participation of women scientific disciplinary areas is consistent with other results discussed above. Another important observation is that the global female percentage among area coordinators had a reduction from 40% in the period of 2011-2014 to 35% in the period of 2018-2012.

In CNPq there are equivalent positions in terms of duties and responsibilities: the member of Advisory Committees for the different disciplinary areas. They are about 300 in total throughout all disciplinary areas. The CNPq Deliberative Council, the agency's highest council within the agency, selects each member after receiving the names voted by the academic community. Figure 3(c) shows that the percentage of female advisors was 26,4% in 2005 increasing to 36% in 2019. It is hard to discern a trend with the available data, although a strongly unbalanced distribution of positions in this likewise important group can be confirmed.

The Brazilian Academy of Sciences' selection committee

The Brazilian Academy of Sciences (ABC, in Portuguese), founded in 1916, operates as an honorific scientific society and as a consultant for the government when requested, to perform technical studies and research on scientific policies. Its focus is the scientific development in Brazil, the interaction among Brazilian scientists and their interaction with researchers of other nations. One of the most prestigious committees is the Selection Committee, composed of the Academy President and 12 other members. They organize the election of new members by that agreeing on which candidates will run. Such composition in the Committee is closely related to the androcentric nature of the ABC. Under this perspective, we have analyzed the Committee formations from 2005 to 2018 regarding sex.

According to Figure 3(d), in the years 2005, 2006, 2013, and 2014 the Committee was composed only by men. From 2015 to 2018 there was only one woman and in 2018 there were three women, corresponding to 23% of its total composition. Though the temporal series is of 13 years, it is hard to define a precise trend due to the small number of Committee components. We also looked at the sex composition of the administrative structure of the Academy, which included the Board and different councilors, a total of 46 people from which 24% were women.

DISCUSSION

In this section, we present an analysis of the set of information collected in previous sections. Even though some preliminary evaluation has been presented, at this moment we will consider how different sections interrelate.

An overview of women participation in science was presented in Brazilian women in science seccion focusing on studies regarding the situation in Brazil and other regions, pointing to a historical and present-day perspective. From this, two primary results are inferred, which permeate a diversity of social circles. The first result comes from, for instance, the work by Leslie et al. (2015). Their study clearly shows that sex discrimination in science cannot be supported by a naturalistic fallacy for such a discrepancy is a social construction. This type of work gives rise to a shift from an androcentric naturalism to *discrimination of intelligentsia* in the analysis as a social phenomenon in the scientific field. A second result, from “Brazilian women in science seccion, is the effective increase in female participation in many areas of human activities, including science.

Following the methodological guide considered in this study (Thomson 1981, Demo 2004, Thomson 2011), some interpretative results from Introduction are now revisited, considering the data presented in this article.

The data displayed in previous sections reveals a hierarchical chain regarding the production of scientific knowledge which starts in undergraduate and graduate courses. In 2005, the percentage of women in all graduate courses was 51%. In 2018, this proportion rose to 54%. Similar results are observed for students finishing MSc and PhD courses according to Figures 1(b) and 1(c).

A general increase in scholarship number is observable for women. In the period from 2005 to 2015, the average increase was of 3,5% for CAPES scholarships nationally at all levels. Nevertheless, heterogeneity has to be considered in this evolution. Indeed, in all raised data there are differences associated with the Agency, the modality, and the areas of knowledge. For instance, female percentage is more significant than its male counterpart in CAPES for scholarships in areas of humanities and arts. On the other hand, male percentage is higher than female percentage for CNPq scholarships in hard sciences.

Considering the number of researchers and teaching staff, an improvement in the total number of female positions was observed in ten years. Such positions rose from 39% in 2005 to 46% in 2015. Data from CNPq research leaders reflect this fact. In 1995, women in research leadership positions were 35%; a number that jumped to 46% in 2016.

Such asymmetry regarding the overall growing female percentage reaches the high hierarchy circles in science, including researchers with prestigious grants by CNPq and in scientific senior management. From total research grants in 2015, 35% were for women. However, this percentage falls to 25% for the 1A level, the most prestigious grant.

In Figure 3(d), detailed data about the Selection Committee for 13-member ABC composition regarding sex is presented. Considering then the 14 years period from 2005 to 2018, the overwhelming minority of women participation is observed: in 9 out of 14 years, only one woman occupied a position in this committee, while in the other four years the Selection Committee was entirely composed by men.

In short, Figure 4 provides a global view of these data gathered in previous sections. They were arranged in such a way to reveal the dynamics of occupied within the Graduate Studies and Science and Technology Systems. It is clear that women have been entering the system in significant numbers, representing higher percentage in the initial stages than men. However, the percentage of women historically diminishes as higher positions are taken into consideration. The arrangement presented in Figure 4 demonstrates this situation. One consequence of this view is that androcentrism biases the policies of different institutions. These kinds of policies permeate the entire structure, from the entrance in undergraduate levels to the graduate positions. Although that the percentage of women is higher than that of men throughout all of these levels, women are being used as workforce in the process of knowledge production. This conclusion comes from the fact that women are definitely very far

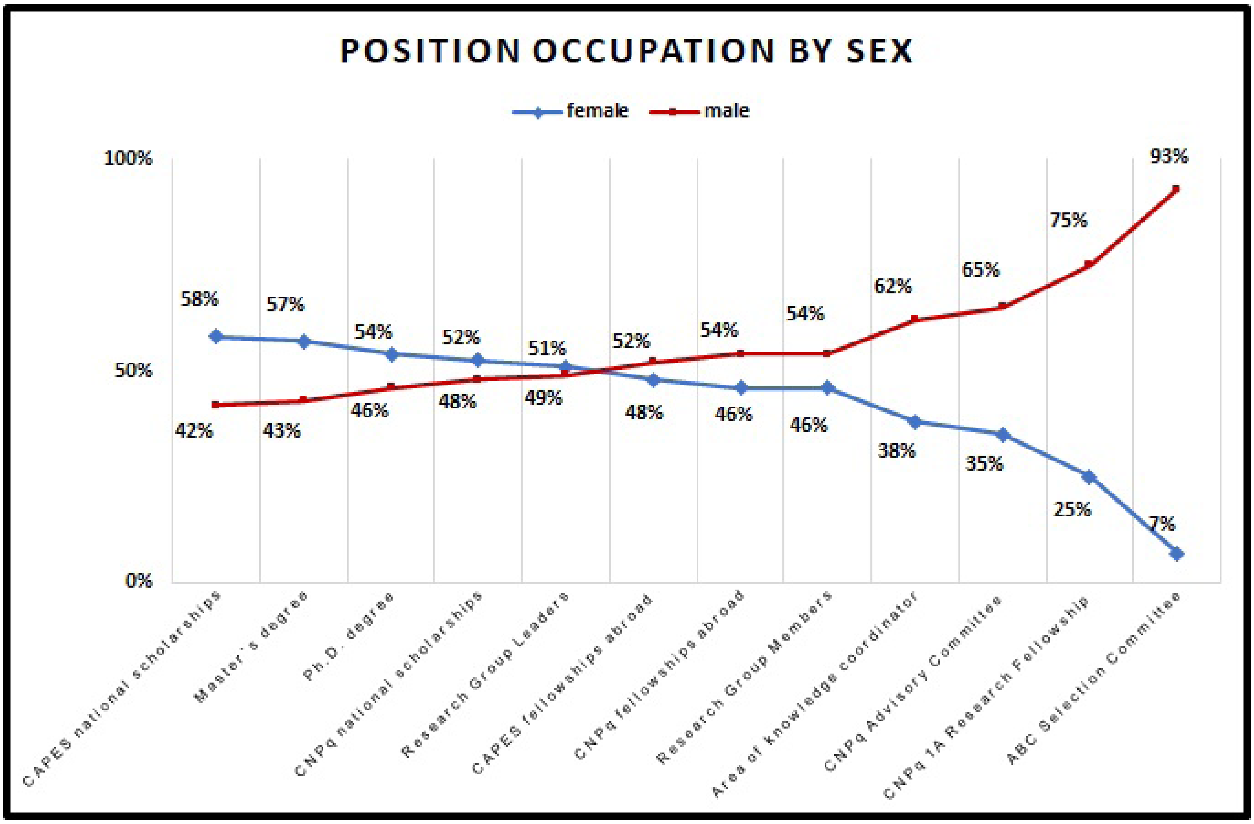

Figure 4. Positions occupation by sex. For the categories "Research Groups Leaders" and "Research Group Members", the database used refers to the year 2014. The other categories refer to the year 2015.

from of political decisions level, as it is shown in Figure 4.

The questions raised in the Introduction regarding *intelligentsia* discrimination, can now be investigated in detail. Although some works point to a vertical exclusion of women, as in the study by Lerback & Hanson (2017), the analysis has also been performed taking into consideration other assumptions. For instance, Lerback & Hanson emphasize the low participation of women in activities considered fundamental for reaching equity in science. These activities include, for instance, taking place in the process of refereeing in scientific journals. However, what is primary is to take place in the highest circles of decisions where policies are designed. Notwithstanding, in this case, global female percentage very small. Therefore, an androcentric bias is pervasive throughout the whole system.

Actions with the mark of androcentric policies come from higher hierarchical positions toward lower levels. This leads to the *intelligentsia* discrimination, already observed in lower levels of education and science as undergraduate and graduate courses in the most prestigious areas regarding i power, as those in the hard science (ACOLA 2013, Lancaster & Kent 2013, Rothwell 2013, NAO 2018). These areas are intrinsically connected with knowledge production for new technologies and, as such, are associated with the central political power of modern society granting the governments capability to interfere in local or even global geopolitics. The androcentric mark is present in these areas, and gender inequality is thus significant. Under this view, the increasing number of women in science becomes workforce in scientific work. The analysis from secondary assumptions as in the work by Lerback & Hanson (2017) leads to either a false trend or false possibility of equity.

The large-scale employment in science since the beginning of the 20th Century, a movement defined by geopolitical issues, generated a vertiginous increase of women in knowledge production. This is not a properly new observation; however, this increase does not reach the same percentage in the higher decision circles. As observed in previous sections, the social topologies of political decisions such as in banks, parliaments, departments, and governments, are systematically androcentric. This is reflected in the spheres of scientific knowledge production.

Women have been engaged in work and social production of goods and knowledge since immemorial time. In productive sectors of organized and democratic modern societies in the 21st Century, female participation percentage reaches, in some areas, the 92.3% mark (Abreu et al. 2016). In a cartography of careers (Jourdain & Naulin 2017) there are typically long-term male positions that, depending on social conditions of productions, can be changed in order to employ female workforce. Nevertheless, some other positions resist changing their androcentric characteristics, even when timescales in the order of centuries are considered. These irretrievable bunkers are closely connected to central structures of power which include government circles, parliaments, senior management positions, and, as it has been observed in this work, inner scientific circles.

We have proceeded with a theoretical and methodological analysis of female participation in science considering as a case study the Brazilian Graduate and Science Systems and the notions of scientific field and racism of *intelligentsia* as defined by Bourdieu (2003). Initially, an overall perspective is drawn considering data that points toward a movement in the direction of gender equity in science. This panoramic description was analyzed in contrast with the most critical elements in the Brazilian knowledge production network, including female participation in initial levels of scientific research as undergraduate and graduate courses, positions in research groups organization, and participation in scientific senior management positions. All of these include more than 5 million data entries.

In the initial levels, a significant increase in female percentage in scientific activities occurs except in the most prestigious areas. This increase is not followed by significant participation of women in the inner scientific circles of political decisions. An astonishing scissor effect is observed between initial level positions and prominent positions at the top of the scientific career. This is explicitly pictured in Figure 4, from which we observe that the presence of women is extremely low when these highest management posts are observed. Some consequences can be inferred here from these results.

A first note is that androcentrism is strongly fixed as a pervasive mark in scientific activity. In other words, due to the observed scissor effect, the accentuated presence of women in initial and intermediary levels of scientific activity demonstrates that female occupations are mostly as workforce, since in this career women are quite far from the social circles of political decisions.

A second observation is that *intelligentsia* gender discrimination is systemic in the academic arenas. Therefore, achieving gender equity in science demands a structural modification to the present-day division of scientific labor. These modifications have to be consistent with an equitable division of power in all the scientific centers of decision. Otherwise, the situation presents a perpetuation trend.

CONCLUSIONS

Our analysis show that women are half of the students but are still a minority in leadership positions. In order for Brazilian science to be more productive and qualified, it is urgently necessary to implement supporting policies for women scientists in all areas of knowledge, especially those linked to the hard sciences, such as the promotion and encouragement of female leadership in order to disseminate alternative examples of success and the stimulation of new discourses regarding scientific careers. It particularly raises concern the data showing no increase of the percentage of women graduate programs coordinators from 2009 to 2019 and a decrease from 40% to 35% of the women area coordinators of area from 2011 to 2022. This suggests that policies for promoting women participation in leadership positions need to be implemented.

Future research that discussing the processes of ascending to the highest levels of the scientific career may also create new subsidies toward the development of gender-balanced policies.

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ROBERTA ARÊAS[1,4]
https://orcid.org/0000-0003-4385-4623

ALICE ABREU[2]
https://orcid.org/0009-0008-5420-2472

CARLOS NOBRE[3]
https://orcid.org/0000-0002-5808-8784

MARCIA C. BARBOSA[1]
https://orcid.org/0000-0001-5663-6102

ADEMIR E. SANTANA[5]
https://orcid.org/0000-0003-0065-797X

[1]Universidade Federal do Rio Grande do Sul, Instituto de Matemática, Estatística e Física – IMEF, Campus Carreiros, Av. Itália, Km 8, Carreiros, 91501-970 Porto Alegre, RS, Brazil

[2]Universidade Federal do Rio de Janeiro, Av. Pedro Calmon, 550, Cidade Universitária, 21941-901 Rio de Janeiro, RJ, Brazil

[3]Universidade de São Paulo, Instituto de Estudos Avançados - IEA, Rua do Anfiteatro, 513, Butantã, 05508-060 São Paulo, SP, Brazil

[4]Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - CAPES, SBN Q.2 Bl. L, lote 6 térreo, 70040-020 Brasília, DF, Brazil

[5]Universidade de Brasília, Centro Internacional de Física da Matéria Condensada, pavilhão Multiuso II, 70910-900 Brasília, DF, Brazil

Correspondence to: **Roberta Arêas**
E-mail: aroberta.silva@capes.gov.br

Author contributions

Roberta Arêas - Conceptualization (Supporting), Data curation (Lead), Formal analysis (Lead), Methodology (Equal) and Writing – original draft (Supporting).
Alice Abreu - Methodology (Equal), Resources (Equal), Validation (Equal), Writing – original draft (Equal) and Writing – review & editing (Equal).
Carlos Nobre - Conceptualization (Lead), Methodology (Equal), Supervision (Equal), Validation (Equal), Visualization (Equal) and Writing – review & editing (Equal).
Ademir Santana - Conceptualization (Supporting), Methodology (Equal), Resources (Equal), Supervision (Equal), Validation (Equal), Visualization (Equal), Writing – original draft (Lead) and Writing – review & editing (Equal).
Márcia Barbosa: Conceptualization (Supporting), Funding acquisition (Lead), Methodology (Equal), Resources (Equal), Supervision (Equal), Validation (Equal), Visualization (Equal), Writing – original draft (Supporting) and Writing – review & editing (Equal).