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Evaluation of Brazilian women's participation in the CNPQ in the field of medical research

Avaliação da participação das mulheres brasileiras no CNPQ na área de pesquisa médica

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ABSTRACT

Introduction: Brazilian scientific production has shown substantial growth and achieved international visibility. However, in general, the participation of women in scientific activities remains limited.

Objective: This study aimed to evaluate the indicators of scientific productivity of women fellows of the Council for Scientific and Technological Development (CNPq) in the field of Medicine.

Method: This cross-sectional study was conducted on 541 (211 women, 39%) researchers registered as recipients of CNPq research productivity (PQ) scholarships in Medicine according to a list provided in December 2022.

Results: There was a predominance of male researchers (n=330; 61%). In both the male and female groups, most researchers were at level 2, with 62.5% women and 47.2% men (p=0.018). All 211 female PQ scholars were distributed among 37 different institutions and published 34,969 papers in scientific journals, averaging 165.7 articles per researcher. In the last five years of the study period (from 2018 to 2022), 9,679 papers were published. Over their careers, the 211 researchers supervised 5,440 undergraduate research students, 4,144 master's degree students, and 2,923 PhD candidates. There was a significant difference between the scholarship levels for the development of human resources in undergraduate research (p=0.040), master's degree (p=0.027), and PhD. (p<0.001).

Conclusion: There are still less women participating in CNPq medical research than men. However, we observed a substantial participation of women in all the assessed items, including technical and scientific production and the human resources training.

Keywords: Bibliometric Indicators; Scientific Publication Indicators; Research Personnel; Medicine.

RESUMO

Introdução: *A produção científica brasileira apresentou crescimento substancial e visibilidade internacional. Contudo, em geral, a participação das mulheres em atividades científicas ainda é limitada.*

Objetivo: *Este estudo objetivou avaliar os indicadores de produtividade científica de mulheres bolsistas do Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) na área de medicina.*

Método: *Foi realizado estudo transversal com 541 (211 mulheres, 39%) pesquisadores cadastrados como bolsistas de produtividade em medicina do CNPq conforme lista disponibilizada em dezembro de 2022.*

Resultado: *Houve predomínio de pesquisadores do sexo masculino (n = 330; 61%). Em ambos os grupos, masculino e feminino, a maioria dos investigadores encontra-se no nível 2, sendo 62,5% mulheres e 47,2% homens (p = 0,018). Todos os 211 pesquisadores foram distribuídos em 37 instituições diferentes e publicaram 34.969 artigos em revistas científicas, com média de 165,7 artigos por pesquisador. De 2018 a 2022, foram publicados 9.679 artigos. Ao longo de suas carreiras, os 211 pesquisadores orientaram 5.440 alunos de iniciação científica, 4.144 alunos de mestrado e 2.923 alunos de doutorado. Houve diferença significativa entre os níveis de bolsas quanto ao desenvolvimento de recursos humanos em iniciação científica (p = 0,040), mestrado (p = 0,027) e doutorado (p < 0,001).*

Conclusão: *Ainda há menor participação de mulheres do que de homens entre os pesquisadores médicos do CNPq. Contudo, foi possível observar participação substancial das mulheres em todos os quesitos avaliados, incluindo a produção técnica e científica e a formação de recursos humanos.*

Palavras-chave: *Indicadores Bibliométricos; Indicadores de Produção Científica; Pesquisadores; Medicina.*

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INTRODUCTION

Science can be described as a complex, self-organizing, and constantly evolving multiscale network[1]. Scientific discoveries, new technologies, and the intensive application of forefront knowledge are key factors for success in a competitive global economy. Therefore, the strength of a country's overall Research and Development endeavor can be a relevant indicator of current and future national economic advantage[2].

During the COVID-19 pandemic, the role of science for Brazilian citizens became even more evident, particularly in the country's duly quick and robust response to the enormous challenge of the pandemic. The global pandemic stimulated extraordinary amounts of scientific investigation around the world[3]. In the first year of the pandemic alone 60,830 COVID-19-related articles were published and indexed in the Web of Science database from January 24 to December 13, 2020. Four countries accounted for about 60% of the papers (USA, China, Italy, and the United Kingdom) and 12 countries accounted for about 95% of the world scientific output on COVID-19 (USA, China, Italy, the United Kingdom, India, Canada, Germany, Spain, Australia, Brazil, Iran, and Turkey)[3].

Brazilian scientific production presented substantial growth and increased international visibility. This fact influenced the country's position in the world ranking in the number of publications in journals indexed in the Scopus database[2]. However, in general, the participation of women in scientific activities is still limited[4,5]. There is a lack of studies conducted in Brazil that evaluate the participation of women in science, particularly in the medical field. An important field of study has been the researchers with a research productivity (PQ) grant from the National Council for Scientific and Technological Development[4].

Several studies have examined the profile and the scientific production of CNPq researchers in various areas of knowledge, including pharmacy[6], chemistry[7], neurosciences[8,9], cardiology[10] and nephrology[4]. Accordingly, the objective of this study was to evaluate technical and scientific indicators, in addition to the training of human resources, of women CNPq PQ researchers, in the area of Medicine.

METHOD

Design and participants

The subjects of this cross-sectional study are registered recipients of CNPq research productivity scholarships in Clinical Medicine according to a list provided by the research funding agency in February 2022.

Data collection and covariates

We initially established a database of 541 researchers registered as CNPq medical fellows based on a list provided by the research funding organization in December 2022. Researchers who are the recipients of this grant are currently classified into three main categories: researcher category 1, 2, and senior. Category 1 researchers are subdivided into 1A, 1B, 1C, and 1D levels *(http://www.cnpq.br/web/guest/bolsistasvigentes)*. According to the CNPq Advisory Committee, the selection and classification criteria for researchers in Medicine include, amongst several indicators: scientific production with outstanding Impact Factor (IF), human resource training (supervision of undergraduate research students, master's degree students, and PhD candidates), contribution to technological innovation, development of research projects with funding of research agencies and participation in published articles[11].

Using the Lattes curriculum directory publicly available on the Lattes Platform (http://buscatextual.cnpq.br/buscatextual/busca.do?metodo=apresentar), we constructed a database with information on each researcher, comprising geographical and institutional distribution, the time elapsed since their PhD graduation, scientific production (published papers), and human resource training (undergraduate research students, master's degree students, and PhD candidates). The primary variable of interest was the gender of the researcher.

To analyze scientific production, we considered all publications and supervisors of undergraduate and postgraduate students within the period between their first published scientific paper to December 2022. We also analyzed the publications and supervision activities from 2018 to 2022 (average scholarship duration). The Thomson Reuters Web of Science (Institute for Scientific Information – http://apps.JCRknowledge.com/) database was also investigated to identify indexed scientific production.

Statistical analysis

A database was built using the Statistical Package for the Social Sciences, for Windows, Inc., USA (SPSS®) version 24.0. Descriptive analyses were performed with absolute, relative, and mean frequencies, with respective 95% confidence intervals (CI95%). To analyze the normality of the data distribution, the Shapiro-Wilk test was performed, verifying that the sample did not present a normal distribution. Firstly, a comparison of the number of female and male researchers was conducted, providing proportions with a 95% confidence interval and performing a chi-square test. Then, the indicators of female researchers were analyzed using the non-parametric Kruskal-Wallis test, since the variables presented more than two categories, assuming a significance level ≤ 0.05.

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Table 1. Distribution of medical researchers with a research productivity scholarship from the Brazilian National Council for Scientific and Technological Development (CNPq), according to gender, male and female, and to the level of the scholarship.

Level	Female % ($IC_{95\%}$)	Male % ($IC_{95\%}$)	Female/Total % ($IC_{95\%}$)	*p*-value*
1A	9 (5.8-13.6)	14.2 (10.8-18.4)	3.5 (2.2-5.4)	
1B	8 (5.0-12.5)	10.6 (7.7-14.4)	3.1 (1.9-4.9)	
1C	7.5 (4.7-11.9)	9.7 (6.9-13.3)	2.9 (1.8-4.7)	
1D	11.8 (8.1-17.0)	18.4 (14.6-23.0)	4.6 (3.1-6.7)	0.018
2	62.5 (55.8-68.8)	47.2 (41.9-52.6)	24.4 (20.9-18.2)	
Senior	0.9 (0.2-3.3)	0.6 (0.1-0.2)	0.3 (0.1-1.3)	
Total	100	100	39 (34.5-43.1)	

**Chi-square test*

RESULTS

Of the total of 541 researchers in Medicine, 211 (39%) were women. The distribution of researchers by fellowship category is summarized in Table 1. In both groups, male and female, level 2 researchers represent the largest group, with 62.5% of women and 47.2% of men (p=0.018).

There was a predominance of researchers in the Southeast region (163; 77.25%), followed by the South (30; 14.21), while in the North, no PQ researcher was identified. All 211 PQ researchers were distributed among 37 different institutions, seven of them concentrated 156 (74.67%) researchers (Table 2).

Among the 211 researchers, 94 (44.54%) of them work in the five most prevalent fields: endocrinology (26; 12.32%), gynecology/obstetrics (23; 10.9%), infectious and parasitic diseases (20; 9.47%), nephrology (14; 6.63%) and psychiatry (11; 5.21%). The average time since the PhD degree had been obtained was 28.98 years (ranging from 29.53 for researchers at level 1 to 46,50 for Senior level).

Table 2. Distribution of female medical researchers with a scientific productivity scholarship by the Brazilian National Council for Scientific and Technological Development (CNPq), by Institution.

Institution	n	% ($CI_{95\%}$)
University of São Paulo	54	25.6 (20.1-31.9)
Federal University of São Paulo	23	10.9 (7.4-15.8)
State University of Campinas	18	8.5 (5.4-13.0)
São Paulo State University "Júlio de Mesquita Filho"	18	8.5 (5.4-13.0)
Federal University of Rio de Janeiro	14	6.6 (4.0-10.8)
Federal University of Rio Grande do Sul	14	6.6 (4.0-10.8)
Federal University of Minas Gerais	12	5.7 (3.3-9.7)
Oswaldo Cruz Foundation	5	2.4 (1.0-5.4)
Federal University of Ceará	5	2.4 (1.0-5.4)
Others	48	22.7 (17.6-28.8)
Total	211	100.0

Table 3. Average number of scientific articles published by female researchers in medicine in the National Council for Scientific and Technological Development (CNPq).

Level	Articles published in career (34,969) Mean (SD)	*p*-value*	Articles published between 2018-2022 Mean (SD) (9,679)	*p*-value*
1A	302.47 (150.27)	<0.001**	68.58 (32.52)	<0.001***
1B	206.12 (70.34)		52.59 (40.07)	
1C	205.88 (95.11)		44.81 (20.81)	
1D	193.36 (74.26)		54.12 (36.29)	
2	126.34 (57.32)		39.87 (22.38)	
Senior	456.5 (85.56)		74.5 (37.47)	
Total	165.73 (97.42)		45.87 (28.33)	

*Kruskal-Wallis test. **Significant difference between level 2 and all other levels. There was no significant difference among the other groups.
***Significant difference between level 2 and 1A. There was no significant difference among the other groups.

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Table 3 shows the number of articles published in the researchers' careers and in the last five years in relation to the level of the scholarship. The 211 researchers published 34,969 papers in scientific journals throughout their careers, with an average of 165.73 articles per researcher. During the last five years (from 2018 to 2022), 9,679 papers have been published with an average of 45.87 articles per researcher. There was a lower average (126.34) of papers published by the level 2 researchers, compared to the researches in other levels throughout their careers ($p<0.001$). As for the articles published in the last 5 years, there was a significant difference between the number of articles published by the level 2 (39.87) and level 1A (68.58) researchers ($p<0.001$).

Over the course of their careers, the 211 researchers supervised a total of 5,440 undergraduate research students, (mean of 25.78), 4,144 master's degree students (mean of 19.64) and 2,923 PhD candidates (mean of 13.85); and in the last five years (from 2018 to 2022), they supervised 1,342 undergraduate research students, (mean of 6.36), 1,125 master's degree students (mean of 5.33) and 896 PhD candidates (mean of 4.25). Regarding the training of human resources, there was a significant difference between the levels of scholarships in undergraduate research ($p=0.040$), master's degree ($p=0.027$) and PhD ($p<0.001$). As regards the training of human resources in the last 5 years, there were no significant differences between any of the levels (Table 4).

DISCUSSION

In our study, we provide relevant and timely information on the distribution and representativeness of women CNPq PQ researchers, in the area of Medicine, including characteristics inherent to professional training and performance, scientific publications and human resource training. Our results demonstrate that women still are still underrepresented among CNPq medical researchers in Brazil.

Concerning the gender disparities in science, Larivière et al.[12] have recently presented a bibliometric analysis confirming that gender inequalities persist in research output worldwide. Moreover, although there are more female than male undergraduate and graduate students in many countries, there are relatively few female full professors, and gender inequalities in hiring, earnings, funding, satisfaction, and patenting persist. Besselaar and Sandstro's[13] comment in their review cites several possible explanations for gender differences in scientific production. Women researchers are substantially younger than their male counterparts. There are structural factors that

Table 4. Average training of human resources by female researchers in medicine in the National Council for Scientific and Technological Development (CNPq).

Level	Human resources development (career formation)					
	Undergraduate research (5,440) Mean (SD)	***p*-value***	**Master's degree (4,144) Mean (SD)**	***p*-value***	**PhD degree (2,923) Mean (SD)**	***p*-value***
1A	44.32 (32.55)	0.040**	31.37 (25.02)	0.027**	29.26 (12.07)	<0.001***
1B	32.06 (28.56)		20.82 (10.10)		18.88 (7.53)	
1C	25.44 (20.81)		21.00 (14.18)		16.63 (7.45)	
1D	24.60 (21.48)		19.56 (13.68)		14.12 (6.54)	
2	22.80 (21.90)		17.42 (12.75)		10.34 (6.84)	
Senior	11.00 (9.89)		34.50 (36.6)		31.00 (1.41)	
Total	25.78 (24.05)		19.64 (14.92)		13.85 (9.46)	
	Human resources development (2018-2022)					
	n (1,342)		n (1,125)		n (896)	
1A	6.58 (7.93)	0.716	6.58 (8.64)	0.242	5.74 (3.38)	0.155
1B	6.82 (9.10)		4.47 (3.76)		5.29 (4.60)	
1C	4.25 (5.05)		4.13 (4.67)		4.38 (3.38)	
1D	7.56 (12.20)		5.16 (5.90)		4.48 (2.94)	
2	6.38 (8.86)		5.46 (3.72)		3.87 (2.75)	
Senior	-		4.00 (4.24)		-	
Total	6.36 (8.96)		5.33 (4.70)		4.25 (3.09)	

*Kruskal-Wallis test. **Significant difference between level 2 and 1A. There was no significant difference among the other groups. ***Significant difference between levels 2-1C, 2-1B, 2-1A, and 1D-1A. There was no significant difference among the other groups.

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may be behind gender productivity differences such as the fact that women are heavily represented in lower academic positions and in temporary contract work positions which entail a higher teaching load, less access to funding and fewer prospects, career paths and research opportunities. As expected, in Brazil the state of affairs is quite similar, and women account for a lower proportion in the higher academic positions, that is, positions associated with higher income and higher academic prestige[4].

Filardo et al.[14] evaluated the representation of women in medicine as the first author of papers published in important journals (Annals of Internal Medicine, Archives of Internal Medicine, The BMJ, JAMA, The Lancet, and the New England Journal of Medicine) between the years 1994 and 2014. It was shown that women researchers in 1994 occupied the position of first author in 27% of the publications and in 2014, 37%. Among the total of 541 researchers in Medicine, 330 (61%) were male, while 211 (39%) were women (1:1.56). In 1990, women accounted for 30.8 % of the medical workforce in Brazil. Thirty years later, they now represent almost half of the active workforce, with a total of 222,942 women holding a medical degree[15]. A recent study evaluating the participation of women in surgical specialties showed that in 2020, Brazil registered 34,479 general surgeons, of which 77.9 % were men. The disparity is even more evident in some surgical subspecialties such as orthopedics and traumatology, with only 6.5% women surgeons, and urology, with only 2.3% surgeons being women[15].

The distribution of women researchers in the field of medicine varies greatly around the world. Filardo et al.[14] report a very small participation of women researchers in high impact journals in Asia, South America, Africa and Australia. In a study that investigated researchers in the fields of tropical medicine and infectious diseases, it showed that the majority were male (62.75%) and concentrated in the Southeast region of Brazil[16]. In the present study, there was a predominance of male researchers (61%) and also a concentration in the Southeast region (77.25%). No researcher was found in the North region. On the other hand, in a study we conducted in the area of nutrition, a prevalence of female researchers (67.5%) was found. As in medicine, in this study the highest concentration of researchers was in the Southeast region[17].

In the international context, regarding the area of activity of women researchers in medicine, Filardo et al.[14] report a predominance of publications in the fields of general medicine, cardiology, surgery and infectology. Regarding scientific production, throughout their academic career, cardiology researchers published 2,958 articles in journals, averaging 89 articles per researcher[10]. In this study, female researchers engaged in medicine in general published, on average, 165.7 articles per researcher throughout their career. During their academic careers, PQ researcher in the areas of hematology/oncology published 2,655 articles in journals, with a mean of 87 articles per researcher, ranging from a minimum of 19 articles to a maximum of 220[18].

In another study, on the 33 CNPq PQ researchers in pediatrics, it was found that they supervised 290 undergraduate students per researcher (mean: 6), as well as 390 master's students (mean: 9), and 169 PhD candidates (mean: 4). When compared to the values adjusted for time of PhD completion, there was no significant difference between researcher categories regarding the supervision of undergraduate students (Mann-Whitney; p=0.07) and master's students (Mann-Whitney; p=0.57), but there was difference in relation to PhD candidates. The mean number of supervisions of PhD candidates for category 1 researchers was 0.36/year and, for category 2 researchers, 0.13/year (Mann-Whitney; p=0.046)[19].

In this study, female researchers throughout their careers supervised 5,440 undergraduate research students, (mean of 25.7), 4,144 master's degree students (mean of 19.6) and 2,923 PhD candidates (mean of 13.8). There was a significant difference between the levels of scholarships in undergraduate research (p=0.040), master's degree (p=0.027) and PhD (p<0.001). When analyzing the training of human resources in the last 5 years, there were no significant differences between any of the levels. The mean number of supervisions provided by oral pathology and oral medicine scholars over the course of their careers were 14.20 for undergraduate students, 9.58 for master's students and 7.80 for PhD candidates[20]. These results show female CNPq medical researchers are concentrated in human resources training.

It is observed that, despite the advances in female participation in science in recent years, women are still underrepresented in science worldwide, especially in the top positions. Recently, a ranking of the most influential scientists in the world was created based on several metrics, including the number of published papers and citations. Female Brazilian scientists are greatly underrepresented in the list (11% in the Top 100,000; 18% in the Top 2%). Possible reasons for this scenario are related to the metrics used to rank scientists, which reproduce and amplify the well-known implicit bias in peer-review and citations[18].

A clear limitation of this study was that it considered only the recipients of CNPq research productivity scholarships in the analysis. We know that the qualified universe of researchers in Brazil, in medicine in general, extends far beyond CNPq researchers. However, despite this limitation, it was possible to observe relevant indicators of women's participation in medicine associated to the CNPq, in all the items evaluated,

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including technical and scientific production and the training of human resources.

CONCLUSION

In conclusion, our study reveals a persistent gender disparity among CNPq PQ recipients in Medicine in Brazil. This aligns with global trends of gender inequalities in research output, hiring, funding, and academic positions. Structural factors contribute to these disparities, such as women being overrepresented in lower academic positions with limited research opportunities. Female representation varies worldwide, with limited participation in Asia, South America, Africa, and Australia. In Brazil, the Southeast region has the highest concentration of researchers, but there is a noticeable gender disparity in surgical subspecialties. While women make significant contributions in scientific production and the training of human resources, discrepancies remain in scholarship levels. Addressing these disparities and promoting gender equality in Medicine is crucial for progress in the field.

AUTHOR CONTRIBUTIONS

Gabriele Martins Keffer contributed in the data collection, initial drafting of the article, critical review and intellectual content. Árlen Almeida Duarte de Sousa contributed in the data collection, statistical analysis, initial drafting of the article, critical review and intellectual content and administrative and technical support. Fabrício Emanuel Oliveira contributed in the data collection, statistical analysis, initial drafting of the article, critical review and intellectual content and administrative and technical support. Marcelo José da Silva Magalhães contributed in the initial drafting of the article and critical review and intellectual content. Eduardo Araújo Oliveira contributed in the study concept and design, statistical analysis, initial drafting of the article and administrative and technical support. Hercílio Martelli Júnior contributed in the study concept and design and administrative and technical support.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest related to this study.

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