



Interventional Neuroradiology: Why Don't Brazilian Female Physicians Like It?

Neurroradiologia intervencionista: Por que as médicas brasileiras não gostam?

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Abstract

Objective Much has been discussed about gender diversity in all professional fields, particularly in medicine. Recent studies showing that there are fewer than ten female professionals in interventional neuroradiology (INR) in a continental country like Brazil, and less than thirty in all of Latin America, have prompted an investigation into the causes of the low numbers of women choosing to follow this medical specialty. This project intended to reveal the reasons through an anonymous form applied to women in the final year of the three medical residencies considered prerequisites for INR in Brazil: neurology, radiology and neurosurgery.

Materials and Methods The questionnaire addressed to each of the three fields contemplated the professionals' preference to follow their respective subspecialties, in addition to common considerations that could be deemed barriers to INR.

Results Surprisingly, the weak link in the chain was demonstrated to be radiology, which is the exclusive prerequisite residency for training in INR in many countries. However, in Brazil, most doctors who graduate in INR come from Neurosurgery and, secondly, from neurology. These two specialties together account for less than half of the female residents compared to radiology alone.

Conclusion All of the following items were already expected: difficulty in reconciling a double shift; employment opportunity; long training time; the lack of female leaders inspiring new generations of doctors; issues involving radiation and motherhood; and still the barriers of misogyny and machismo. But specific studies need to be conducted to find out why very few radiology residents follow INR training in Brazil.

Keywords

- ▶ interventional radiology
- ▶ gender inequality
- ▶ neurosurgery
- ▶ professional practice
- ▶ neurology
- ▶ radiology

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Resumo

Objetivos Muito se tem discutido sobre a diversidade de gênero em todas as áreas profissionais, particularmente na medicina. Estudos recentes que mostram que há menos de dez profissionais do sexo feminino em neurorradiologia intervencionista (NRI) em um país continental como o Brasil, e menos de trinta em toda a América Latina, levaram a uma investigação sobre as causas do baixo contingente de mulheres que opta pelo seguimento dessa especialidade médica. Este projeto pretende revelar os motivos, por meio de um formulário anônimo aplicado às mulheres que cursavam o último ano das três residências médicas consideradas pré-requisito para a NRI no Brasil: neurologia, radiologia e neurocirurgia.

Materiais e Métodos O questionário dirigido a cada um dos 3 ramos contemplou a preferência das profissionais em seguir suas respectivas subespecialidades, além de considerações comuns que poderiam ser tidas como barreiras à NRI.

Resultados Surpreendentemente, demonstrou-se que o elo fraco da corrente é a radiologia, que é o pré-requisito exclusivo de residência para treinamento em NRI em muitos países. No entanto, no Brasil, a maioria dos médicos formados em NRI é proveniente da neurocirurgia e, em segundo lugar, da neurologia. Essas duas especialidades juntas contam com menos da metade das residentes do sexo feminino em comparação com a radiologia sozinha.

Conclusão Todos os seguintes aspectos já eram esperados: dificuldade em conciliar dupla jornada; oportunidade de emprego; longo tempo de treinamento; a falta de lideranças femininas que inspirem as novas gerações de médicas; questões que envolvem radiação e maternidade; e, ainda, as barreiras da misoginia e do machismo. Mas estudos específicos precisam ser feitos para descobrir os motivos pelos quais pouquíssimas residentes de radiologia seguem o treinamento de NRI no Brasil.

Palavras-chave

- ▶ radiologia intervencionista
- ▶ iniquidade de gênero
- ▶ neurocirurgia
- ▶ prática profissional
- ▶ neurologia
- ▶ radiologia

Introduction

Despite the technological evolution combined with the high efficiency of the interventional treatments for cerebrovascular diseases, the progressivism of interventional neuroradiology (INR) does not extend to modern concepts of gender equality.¹⁻⁵ The female workforce specializing in INR is notoriously the minority of professionals.⁶⁻⁸ This causes the field to be considered very advanced from a technical point of view, but this advance remains on the fringes of current feminist advances.^{9,10}

With the growing prominence of themes related to inclusion and diversity, a discussion arises about the main reasons behind the prevalence of male professionals in INR and the low rate of female participation.^{1,4,7,8} This scenario is not reflected in the training of professionals in medicine and in other health-related professions.¹¹⁻¹⁵ The female gender, since 2019, is numerically superior to the male gender among health professionals.¹⁶

In Brazil, three specialties are prerequisites for the subspecialization in INR: neurosurgery, neurology and radiology. Currently, there are 9 female interventional radiologists in Brazil, out of a total of 149 professionals (6.04%). There are 22 INR training centers, which offer a total of 30 vacancies per year. Among these, only 6 (20%) are occupied by women in training/fellowship (4 in the first year of training, 2 in the second year), which may indicate a small and initial change in this scenario.¹⁷

The factors behind the low numbers of women in INR are still nebulous. One can infer the issue about motherhood and exposure to ionizing radiation – which, in addition to being oncogenic, is teratogenic – and the professionals who can opt for this field are generally in the years of fertility and offspring planning.^{1,2} Moreover, psychosocial factors are added due to challenges brought about by the choice of a subspecialty with highly complex cases and great demand for urgent procedures.^{4,6,8}

Considering that women are moving towards representing the largest percentage of the medical workforce in Brazil,¹⁸ as well as the growing demand of the population for the diagnosis and treatment of cerebrovascular diseases, we intend to identify possible factors of disinterest in the subspecialization in INR among female residents of the last year of neurosurgery, neurology and radiology. Furthermore, we intended to raise possible cases of misogyny experienced by these residents during their formative years, which could further discourage them from following a predominantly male field.

Materials and Methods

The present is a prospective cross-sectional study conducted through a questionnaire applied to all female residents who are currently in the last year of residency in neurosurgery

(fifth year of residency or R5), neurology (third year of residency or R3), and radiology (R3) in the Brazilian territory.

It was a voluntary and anonymous questionnaire sent via email and social media, and hosted by the virtual program Microsoft Forms. Contacts were provided by national organizations, namely: the Brazilian Society of Neurosurgery, the Brazilian College of Radiology, and the Brazilian Academy of Neurology.

Data collection was performed through 18 questions in specific questionnaires for each of the 3 major specialties, divided into 3 sections. The first one, consisting only of the informed consent form, was presented to all participants as the first mandatory question necessary to continue participating in the research. The second section consisted of nine questions related to the reasons why these women chose to follow INR, another subspecialty, or no subspecialty. The third one had three questions regarding gender inequality during medical residency.

The results of the quantitative variables were expressed as means, medians, minimum and maximum values, and standard deviations. The qualitative variables were expressed as frequencies and percentages.

All questions were formulated by the main author, and they are subjective and in multiple-choice format, with specific ramifications capable of directing participants to the next appropriate questions and related to previous answers. Just one of the questions is descriptive and discursive.

Results

The questionnaire was sent to 312 Brazilian residents in their last year of training. Of these, we obtained responses from all 23 R5s in neurosurgery, 82 of the 222 R3s in radiology, and 21

of the 67 R3s in neurology, totaling 126 physicians. We did not describe the women's sociodemographic data to preserve the anonymity of the study.

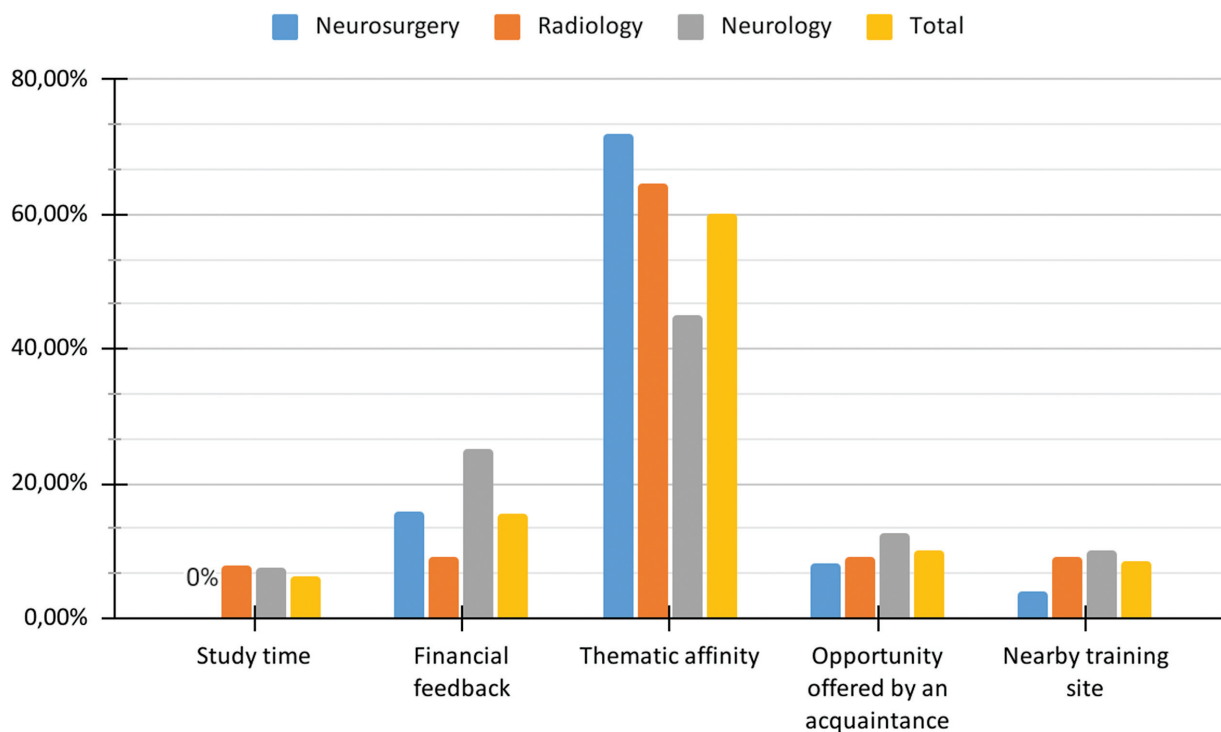
Currently, in Brazil, 156 physicians are R5s in neurosurgery, 23 of whom are women (14.74%); half of the R3s in radiology are women (322/643); and there are 67 women among the 329 R3s in neurology (20.3%). Therefore, of the 1,128 physicians eligible to follow the INR training, 412 (36.52%) are women. An average of 92% of all respondents intend to continue their studies after completing their medical residency, either with some subspecialty, fellowship, or postgraduate modality.

As for the reasons for choosing the subspecialty, we received 25 responses from neurosurgery, 65 from radiology and 40 from neurology residents due to the possibility of choosing more than 1 alternative among those provided. ► **Graph 1** shows the total percentage of responses to each question by specialty. Affinity with the subject was the most chosen among all. The subspecialties chosen by the 116 participants who intend to proceed the studies are shown in ► **Tables 1, 2 and 3**.

Among the residents of neurosurgery, radiology and neurology, 13 (56.52%), 13 (15.85%), and 11 (52.38%) respectively considered at any moment subspecializing in INR. Of these, only 4 (30.76%) neurosurgery residents will actually remain working in the field.

Regarding the professionals who considered subspecializing in INR but will not, ► **Table 4** exemplifies the main reasons for this choice by the total number of responses recorded (68).

In total, 10 (43.47%) neurosurgery, 68 (84.14%) radiology, and 10 (47.61%) neurology female residents never consid-



Graph 1

Table 1 Subspecialties chosen by Neurosurgery residents

Subspecialty	Number of residents
Pediatrics	5
Endovascular neurosurgery (interventional neuroradiology)	3
Spinal neurosurgery	3
Functional neurosurgery	3
Neurosurgical treatment of epilepsy	2
Peripheral nerves	1
Oncological neurosurgery	1
Vascular	1
Neurotraumatology	0
Neurointensivism	0
Urgent/Emergency care	0
Hydrodynamics and neuroendoscopy	0
Fetal neurosurgery	0
Base of the skull	0

Table 2 Subspecialties chosen by Radiology residents

Subspecialty	Number of residents
Breast	8
General advanced radiology	7
Abdominal	6
Diagnostic neuroradiology	6
Other	6
Thorax	5
Internal medicine	5
Non-vascular intervention	1
Interventional radiology (peripheral endovascular interventional)	1
Head and neck	1
Pediatrics	1
Oncology imaging	0
Interventional neuroradiology	0
Cardiac imaging	0

ered INR. ► **Table 5** shows the main reasons for this by the total number of responses recorded (230).

As for the cases of misogyny experienced by these residents during their training, most claimed to have suffered situations of abuse: 100% of the neurosurgery, 54.88% of the radiology, and 61.91% of the neurology residents.

As for the types of abuse reported, the participants were able to select the options: psychological, moral, physical, sexual, all types of abuse, cannot say, and did not suffer any

Table 3 Subspecialties chosen by Neurology residents

Subspecialty	Number of residents
Neuropediatrics	5
Neurophysiology – electroneuromyography and neuromuscular diseases	4
Neurophysiology – electroencephalography and epilepsy	3
Movement disorders	2
Cerebrovascular	1
Pain	1
Cognition and behavior	1
Neuroimmunology	1
Neuro-oncology	1
Sleep	0
Neurogenetics	0
Interventional neuroradiology	0
Neuroinfectology	0
Neurovestibular	0
Hansenology	0
Somatoform disorders	0
Other	0

abuse. Most of the participants reported cases of abuse, mainly psychological. More details are shown in ► **Table 6**.

► **Graph 2** shows the percentages of participants who experienced difficulties during residency just because they were women.

Discussion

We found studies^{2-4,8,16,18} that assess the male predominance in INR and the obstacles faced by women in this fields. But the present study is the first to assess female interest in the field of INR and the misogynistic experiences reported by female residents in the final year of the three specialties that are prerequisites for INR in Brazil.

More than 92% of the residents intend to do a subspecialty, but only 32.17% have considered training in INR at any moment of their formation. Of these, only 16.2% actually decided on the field, all of them from neurosurgery.

The main reasons reported by residents for dropping out of the subspecialty were: radiation (25%); exhaustive work pace (23.53%), and long training time (22.06%). Similar responses were reported by Wah and Belli:⁴ 32% of the participants agreed that interventional radiology (IR) is less attractive to women due to concerns about the balance between working shifts and family life, the risks of radiation exposure, the effect of pregnancy on training and practice, and the male-dominated work environment.

A systematic meta-analysis³ published in 2021 clarifies that, in the academic environment, women have lower H-

Table 4 Reasons reported by residents who considered subspecializing in interventional neuroradiology BUT WILL NOT

	Neurosurgery	Radiology	Neurology	Total
Long training time	18.18%	33.33%	8.33%	22.06%
Glimpse of difficulty in the job market	0%	18.18%	20.83%	16.18%
Unfeasible remuneration	0%	3.03%	0%	1.47%
Exhausting work pace, with emergencies at night and on weekends	9.09%	27.27%	25%	23.53%
Overly complex clinical cases	0%	0.00%	0%	0%
Radiation (teratogenic and oncogenic risk)	45.45%	9.09%	37.5%	25%
Work for hemodynamics machine owners (due to the high cost of the machines)	0%	6.06%	8.33%	5.88%
Other	27.27%	3.03%	0%	5.88%

Table 5 Reasons reported by residents for NEVER considering subspecializing in interventional neuroradiology

	Neurosurgery	Radiology	Neurology	Total
Preference for another field	40%	19.35%	29.17%	22.17%
Lack of interest/affinity for the field	15%	18.28%	16.67%	17.83%
Long training time	5%	11.83%	12.5%	11.3%
Forethought of difficulty in the job market	5%	7.53%	12.5%	7.83%
Unfeasible remuneration	0%	1.08%	0%	0.87%
Exhausting work pace, with emergencies at night and on weekends	0%	23.12%	16.67%	20.43%
Overly complex clinical cases	0%	5.38%	0%	4.35%
Radiation (teratogenic and oncogenic risk)	20%	10.75%	8.33%	11.3%
Work for hemodynamics machine owners (due to the high cost of the machines)	15%	2.69%	4.17%	3.91%
Other	0%	0%	0%	0%

Table 6 Types of harassment suffered by female residents by specialty

	Yes, psychological	Yes, moral	Yes, physical	Yes, sexual	Yes, all options	I cannot say	No
Neurosurgery	69.56%	56.52%	4.34%	4.34%	13.04%	8.69%	0%
Radiology	45.12%	37.8%	2.43%	3.65%	1.21%	3.65%	45.12%
Neurology	52.38%	8.53%	4.76%	9.52%	0%	0%	38.09%
Total	51.2%	40.8%	3.2%	4.8%	3.2%	4%	36%

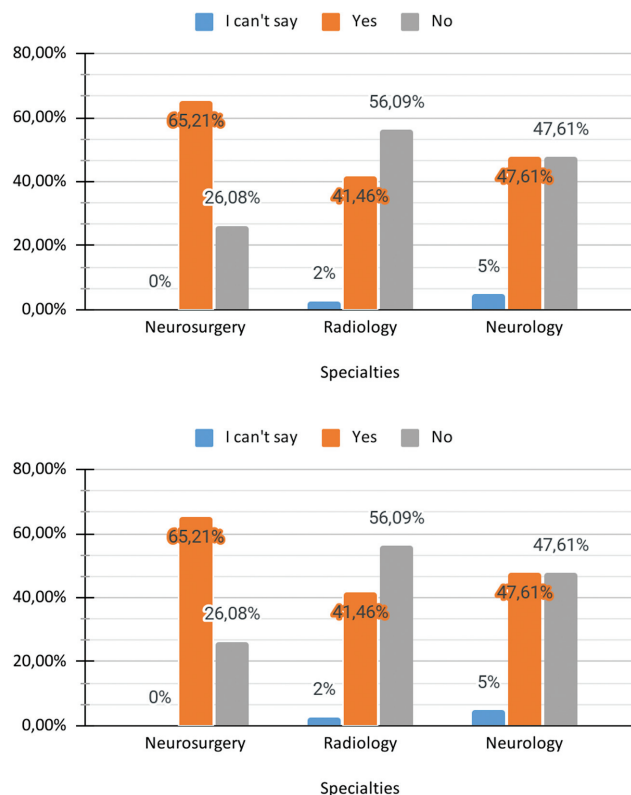
indexes (calculated by counting publications and their citations in documents available on the internet) and fewer publications, in addition to being less frequently relevant in rankings, which causes a causality dilemma: are women less successful because they have fewer opportunities or do they have fewer opportunities of being successful because they are not as good as men?

As for working time and exhaustive on-call routine and family/personal life, the same meta-analysis³ showed that the rate of part-time employment ranged from 11% to 50% for women and from 1% to 22% for men.³ According to a review of 707 studies on radiology,¹⁹ male professors reported the possibility of working more hours than female physicians

data corroborated by Lewis et al.,¹⁶ demonstrating that it is more complex for women to reconcile the pace of work and personal life. Overwork is required even more, when notoriously women in the same positions are paid worse than their male counterparts in underdeveloped countries.¹⁸

Regarding radiation versus maternity, it becomes contradictory when there is a trend towards feminization in radiology and diagnostic imaging: in 2020, 38% of physicians specializing in this field in Brazil were women. In 2021, more than 50% of the residents in the final year of radiology were also women.¹⁷ However, this feminization is not reflected in INR.^{18,20-22}

When questioned about the possibility of working with INR, only 16% (13) of radiology residents said they had



Graph 2

considered the possibility, and none actually intends to subspecialize in INR. In neurosurgery and neurology, more than 50% (24) of the residents considered subspecializing in INR at least at some point in their training. This scenario was surprising, since, in Europe, radiology is the exclusive prerequisite for INR, and it is not possible for neurosurgeons and neurologists to subspecialize in this field. Of the 412 women theoretically able to attend INR as of 2022 in Brazil, more than 78% (321) are graduating in radiology, and this is precisely the group that is least interested in continuing in the field. Of the 82 radiology residents who answered the questionnaire, 84% never even considered INR as a subspecialty. The most frequent reasons mentioned by those who considered INR but abandoned the idea were the long training time and the exhausting pace of work. This may lead to the conclusion that there is a cultural difference between physicians who graduate in radiology in Brazil and in other countries. Here it must be the largest focus of attention for future projects.

In Brazil, only 6.04% of INR specialists are women, and a female minority is observed in other countries as well. An exacerbated and unjustified concern with the health of the developing fetus due radiation is the main cause of the gross underrepresentation of women in the area.^{18,22}

To better understand this issue, preconception fetal risks are related to genetic mutations culminating in hereditary anomalies (increase of 0.41% to 0.46% per 1 Gy of exposure). A woman can also become sterile due to radiation (variation of dose limit: 12 Gy before puberty to 2 Gy in premenopause). In practice, the gonadal radiation dose in common IR procedures is lower than 1 mrem (0.01 mGy), leading to a need for

20 years of maximum exposure to occupational radiation levels to reach a dose of 1 Gy.²⁰

Thus, to run any of these risks, a woman would need to be exposed directly to the beam of radiation for a continuous period of time, without the use of any personal protective equipment. In the case of pregnant interventionists, exposure is to scattered radiation only (following safe threshold doses), with most of the radiation attenuated by a 0.5-mm lead apron.^{20,21}

Efforts should be made to inform aspiring interventional neuroradiologists that the radiation effects of IR procedures are not deleterious when safety standards are followed. However, information about the safety of IR alone is not enough to encourage residents to pursue this subspecialty.

As for misogyny, difficulties related to gender, and various types of abuse, the present study revealed data similar to those found in a study with Brazilian neurosurgeons published in 2021,²¹ in which 100% of the women interviewed claimed to have suffered psychological, moral, physical, and/or sexual abuse; in the present research, this was also true regarding neurology (61.91%) and, to a lesser extent, radiology (54.88%), corroborating what was raised by the authors of this study regarding the feminization of radiology, in contrast to the low number of women in neurosurgery.^{18,22}

Conclusion

Obstacles already established are still responsible for keeping women away from training in INR in Brazil. They include the difficulty in finding a balance in the double journey that involves domestic life and a profession of such complexity. Women end up standing out less; thus, there are few successful female role models to inspire new professionals.

An exacerbated and unjustified concern with the issue of radiation versus motherhood is still taboo, since radioprotection provides adequate safety for the health of the pregnant interventionist and the fetus.

Among the obstacles imposed by misogyny and gender inequality, those who had the most history of experiences of moral abuse during their training were the physicians of the group in which there is a greater male predominance: neurosurgery.

However, what was revealed in the present paper in a more surprising and dramatic way was the great negative weight that the radiology residency contributes to the training of women INR. Despite representing 78% of the 412 women able to follow this subspecialty as of 2022 in Brazil, none will actually follow it, and 84% have never even considered this possibility. Affinity for other subspecialties was the most reported factor; however, it is necessary to better understand the factors that involve this issue, if the future objective is to numerically engage more women in this profession in Brazil.

Authors' Contributions

LMG: conceptualized and designed the study, collected, interpreted, and analyzed data, and reviewed the manuscript.

MAM: conceptualized and designed study, collected, interpreted, and analyzed data, and drafted the manuscript.

ESL: collected, interpreted, and analyzed data, and drafted the manuscripts.

Conflict of Interests

The authors have no conflict of interests to declare.

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