

The profile of Radiologist in Brazil

THE PROFILE OF RADIOLOGIST IN BRAZIL

2019

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Address: Avenida Paulista, 37, 7th floor, Block 71

São Paulo – State of São Paulo - ZIP Code 01310-1000 - Telephone.: (11) 3372-4544

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Elaboration of Maps

Aline Gil Alves Guilloux

Graphic Design / Diagramming

André Meyer

Cover

Team of the Brazilian College of Radiology

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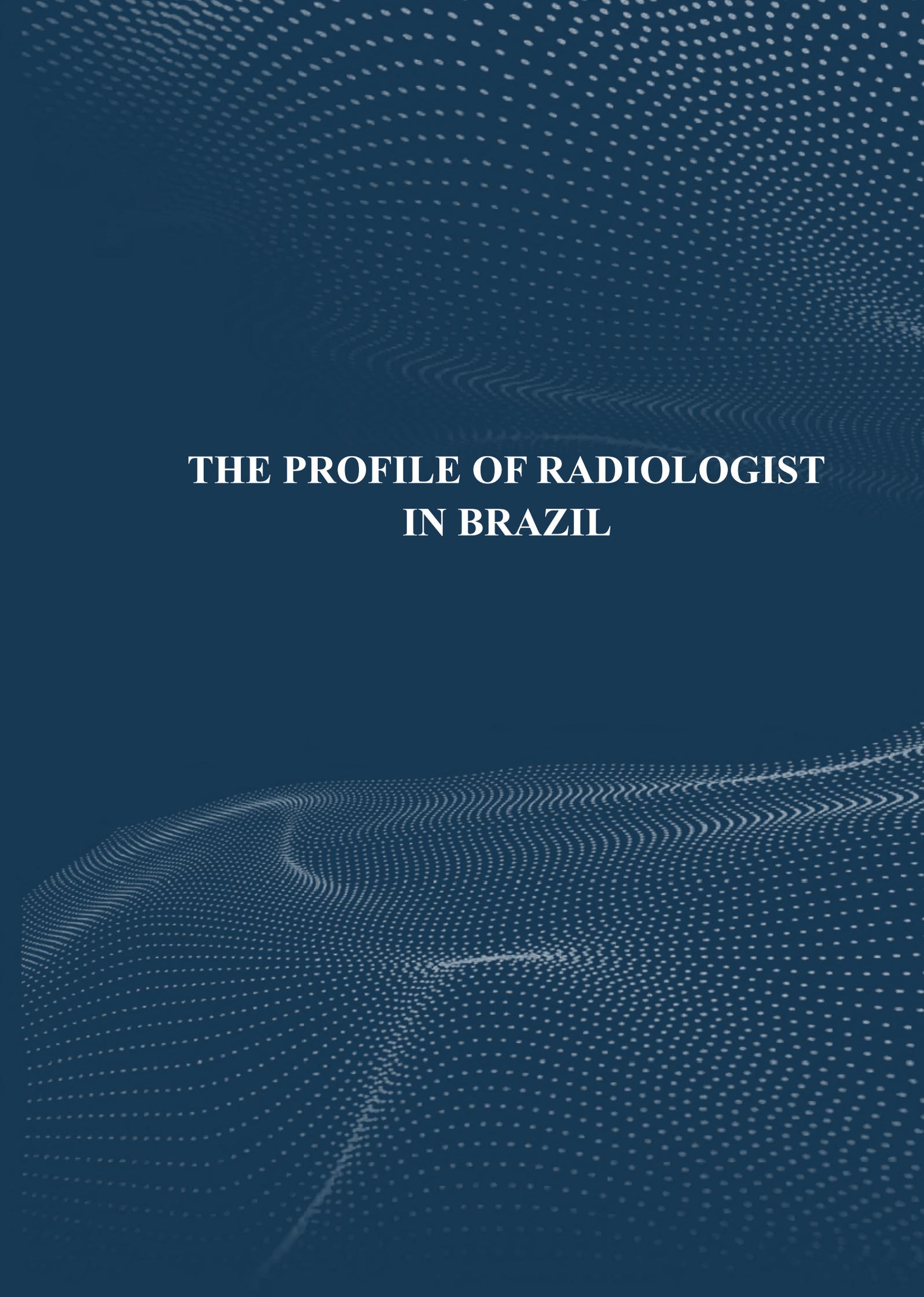
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IN BRAZIL**

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Dr. Manoel de Souza Rocha

President of CBR, Management 2017-2018

The history of radiology shows that the specialty and its specialists are inserted in the health care system and are essential to provide answers that positively impact the health of the population.

Radiology has a great ability to reinvent itself, with the incorporation of new technological tools, that make the professional practice of radiologists increasingly useful and effective.

As a science, Medicine must be based on the most accurate and complete data available. Scientific evidence should also guide discussions and propositions when you are thinking about the future of a specialty.

In preparing this profile of the specialty and the specialist physician, the goal of the Brazilian College of Radiology and Diagnostic Imaging (CBR) is to provide data and trigger reflection. Without evidence, analysis can become mere speculation.

This paper seeks to answer how many and where are the Brazilian doctors who are dedicated to imaging diagnosis. It presents data on the training capacity of specialists and traces the scenario of supply of equipment and exams in the health system.

As the first exploratory study, there are limitations and gaps that will only be filled with periodic surveys and new research.

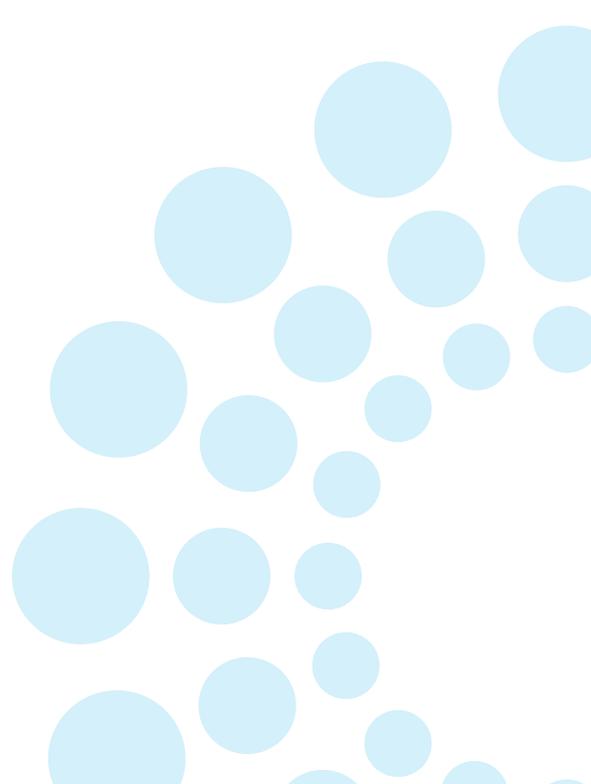
We draw attention to the unequal distribution of imaging diagnostic specialists in our country, reflecting the fragmentation of the health system, inequalities in access to healthcare and the social and economic inequalities present in various other aspects of our society.

It is also noteworthy that the population's access to imaging exams presents a large discrepancy between those assisted by the Government Unified Health System (SUS) and those who, in addition to the right to SUS, have health plans and insurance.

We hope that Brazil will be able to reduce this inequality between public and private, one of the characteristics of health care in the country.

May the reader take advantage of this survey done by CBR in partnership with researchers from the Department of Preventive Medicine at USP's School of Medicine, whom I personally thank for accepting this challenge.

And that from this work may give rise to good reflections and ideas to understand the present and plan the future of Radiology and Diagnostic Imaging in Brazil.



Radiology is a structuring and fundamental specialty in health care system in Brazil, both at the outpatient and hospital level of the Unified Health System (SUS) and supplementary health. It involves significant resources invested in equipment, procedures and examinations for the diagnosis of diverse health conditions, including those with high prevalence in the population such as cancer, cardiovascular disease and trauma.

The relevance of Radiology is based on the diagnostic skills and competence of specialists physicians working in different areas and services. They are professionals trained for the use of the imaging methods and for providing results, in constant interaction and cross-cooperation with other doctors and health professionals.

Since its beginnings, Radiology, in Brazil and worldwide, has aimed to provide medical images in order to contribute to diagnoses. With the advance of technologies, the radiologists began to analyze, in greater volume, increasingly complex images.

In the field of research, the collaboration between engineering, medical physics and imaging diagnostics has undeniable advances, either in improving the resolution of the images themselves or in extracting more accurate information. With that, the medical sciences benefited; anatomy and physiology studies, for example, or clinical applications, from disease detection and prevention to the definition of more effective treatments.

Although scientific and technological development has changed the history and performance of Radiology, its insertion in the Brazilian health system is marked by inequalities in the distribution of specialists and imbalances in the population's access to physicians, medical exams and procedures in Radiology.

Radiology's current profile is also impacted by the organization and financing of the Brazilian health system, by the professional choices, market interests and equipment and technology producers, the provision of medical residency, the performance of its representative entities, among others factors.

As will be seen below, the history of the specialty and its representative entity in Brazil follows the evolution of Radiology around the world and reveals a multifaceted dimension and peculiarities of the profile and distribution of these professionals, as well as the specialized training and work of the most 12 thousand radiology and imaging diagnostic physicians working in the country.

This work aims to outline characteristics, profiles and distribution of medical specialists in Radiology and Diagnostic Imaging in Brazil, as well as to describe the supply of diagnostic imaging equipment, services and exams in the public and private health departments.

The definition of specialty and areas of expertise in Radiology and Diagnostic Imaging used here, as well as the criteria for obtaining the title of specialist, are set out in Resolution 2,162 of the Conselho Federal de Medicina (Federal Council of Medicine).

The results were obtained by crossing data contained in the databases of the Brazilian College of Radiology and Diagnostic Imaging (CBR) and the National Commission of Medical Residency (CNRM). We also considered specialty data already published by the *Medical Demography study in Brazil*.

The CBR database with information on qualified physicians recognized as specialists was linked to the CNRM bank with a record of physicians who have completed residency but are not CBR members. From the CBR database were also used data from doctors with certificates in the areas of expertise and information on improvement programs recognized by the entity. From the CNRM database were extracted data about offer and distribution of Medical Residency programs and vacanciespositions.

The study uses the “physicians” and “physicians’ records” denominations in different tables and graphs. The number of physicians is used when individual data (gender, age, etc.) are analyzed. When addressing the physician’s geographic location (city, state, etc.), physician records are used in CRMs (Regional Council of Medicine). There are physicians who keep records in more than one CRM because of acting in different states, temporary interstate mobility or personal decision. In these cases, physicians are counted by the study in each state, and the term “physicians’ records” is used.

The lack or outdated registration data of physicians explains minor differences in some tables and graphs.

The study listed qualified radiologists in other specialties. Also due to data limitation, as with professional records in more than one state, it is not possible to know which specialty is practiced by radiologists who have two or more titles of specialists.

The population base used was the “Estimativas de População do Instituto Brasileiro de Geografia e Estatística - IBGE” study, or in english, *Population Estimation of the Brazilian Institute of Geography and Statistics*, which presents an annual projection for the municipalities and states, with reference date on July 1st, 2018.

The total number of Brazilians used here was 208,494,900.

Table 1

Total Brazilian Population, SUS Users Population and Private Health Insurance Plan Users, Brazil - 2019.

State	Total Population	Plan Population Private Plans Users	%	SUS Population Users	%
Acre	869,265	45,315	5.2	823,950	94.8
Alagoas	3,322,820	377,437	11.4	2,945,383	88.6
Amapá	829,494	69,114	8.3	760,380	91.7
Amazonas	4,080,611	523,275	12.8	3,557,336	87.2
Bahia	14,812,617	1,585,001	10.7	13,227,616	89.3
Ceará	9,075,649	1,268,703	14.0	7,806,946	86.0
Distrito Federal	2,974,703	879,422	29.6	2,095,281	70.4
Espírito Santo	3,972,388	1,101,566	27.7	2,870,822	72.3
Goiás	6,921,161	1,108,083	16.0	5,813,078	84.0
Maranhão	7,035,55	461,893	6.6	6,573,162	93.4
Mato Grosso	3,441,998	561,082	16.3	2,880,916	83.7
Mato Grosso do Sul	2,748,023	58,374	2.1	2,689,649	97.9
Minas Gerais	21,040,662	5,105,297	24.3	15,935,365	75.7
Pará	8,513,497	801,656	9.4	7,711,841	90.6
Paraíba	3,996,496	41,795	1.0	3,954,701	99.0
Paraná	11,348,937	2,850,892	25.1	8,498,45	74.9
Pernambuco	9,496,294	1,307,278	13.8	8,189,16	86.2
Piauí	3,264,531	315,326	9.7	2,949,205	90.3
Rio de Janeiro	17,159,960	5,423,425	31.6	11,736,535	68.4
Rio Grande do Norte	3,479,010	517,768	14.9	2,961,242	85.1
Rio Grande do Sul	11,329,605	2,623,556	23.2	8,706,049	76.8
Rondônia	1,757,589	156,015	8.9	1,601,574	91.1
Roraima	576,568	28,749	5.0	547,819	95.0
Santa Catarina	7,075,494	1,507,924	21.3	5,567,570	78.7
São Paulo	45,538,936	17,225,240	37.8	28,313,696	62.2
Sergipe	2,278,308	319,414	14.0	1,958,894	86.0
Tocantins	1,555,229	107,355	6.9	1,447,874	93.1
Brazil	208,494,900	47,307,461	22.7	161,187,439	77.3

Source: Adapted of IBGE (Brazilian Institute of Geography and Statistics) – 2018, ANS (National Supplementary Health Agency)/Tabnet – 2018, Scheffer M. Et. al, O perfil do medico especialista em Radiologia e Diagnóstico por Imagem, 2019. (The profile of the specialist physician in Radiology and Diagnostic Imaging, 2019).

The data of users of health plans and insurance - 47,307,461 people in the country in June of 2018 - were extracted from the public databases of the National Supplementary Health Agency (ANS). The population exclusively using SUS was obtained by subtracting from the total population of the country the users of health plans (Table 1).

However, this is an approximation, since health insurance users also frequently use SUS due to limitations of supplementary health coverage.

The data about the supply offer (mammography, x-ray, computed tomography, magnetic resonance and ultrasound equipment) were extracted from the National Register of Health Facilities of Brazil - CNES - for May and June 2018.

For longitudinal analysis of the production of imaging services and comparisons between the public and private departments, information was used from the Unified Health System Outpatient Information System (SIA / SUS), and from the ANS Care Map. In both bases (DataSUS and ANS) were analyzed the years 2014, 2015 and 2016.

The research has limitations inherent to the secondary databases consulted, which depend on the food, completeness and updating guaranteed by the source agencies.

The Radiology in Brazil and in the world

The first X-ray machine in Brazil was acquired by physician José Carlos Ferreira Pires in 1897 and installed in the city of Formiga, State of Minas Gerais, just a few years after the discovery of X-rays by Röntgen, in Germany. Its full operation was only possible after improvising a gasoline engine capable of generating electricity.

The first Radiology class in Brazil was given by Professor João Américo Garcez Fróes, in 1903, to third year students at the School of Medicine of Bahia.

In the year 2020 Radiology completes 125 years. Its history in the world begins in 1895, when the engineer Wilhelm Conrad Röntgen discovered X-rays, one of the most important finds in the Physics' history, which earned him the first Nobel Prize in this field in 1901.

Röntgen submitted the results of his discovery to the president of the Würzburg Society of Medical Physics and demonstrated his discovery at a meeting of the society by producing a radiograph of one of the hands of anatomist Rudolf Albert von Köllike.

Since Röntgen's experience was easily replicable, in just one year the application of X-rays to diagnose fractures, calculus and foreign bodies, as well as therapies against cancer and skin lesions, was already part of medical practice. Thus arise the first radiologists. Once proven to be very applicable in medicine, medical clinics and hospitals gradually housed X-ray laboratories. Medical schools have also progressively included teaching X-ray use in their curricula. Only a few years later the harms of prolonged radiation exposure were elucidated.

In the **early twentieth century**, shortly after US hospitals such as Massachusetts General Hospital and the Medico-Chirurgical College and Hospital of Philadelphia had officially created departments and the discipline of Radiology, the first Radiology course in Brazil came up, idealized by Professor Roberto Duque Estrada in 1916, near the Santa Casa de Misericórdia of Rio de Janeiro.

The first society of radiologists physicians in Brazil was founded in 1929, at the headquarters of the Society of Medicine and Surgery of Rio de Janeiro,

and was called the Brazilian Society of Radiology and Electrology. In their meetings were presented clinical cases and conferences about important radiological topics.

In the 1930s two other Radiology courses were created in Rio de Janeiro, one by Professor José Guilherme Dias Fernandes, at the Hahnemaniano Institute School of Medicine (now Gaffrée Guinle Hospital), and another by Professor Manoel de Abreu, at the School of Medical Sciences. Abreu has gained notoriety for developing a low-cost, high-efficiency examination based on screen photography of 35 or 70 mm plain film documentation, which he called miniature chest radiograph, used in several countries around the world to screen for tuberculosis and pulmonary occupational diseases. The exam was initially presented to the Society of Medicine and Surgery of Rio de Janeiro in 1936, and in 1939, during the First National Tuberculosis Congress, in Rio de Janeiro, came to be called “abreugrafia” or “abreugraphy” in English, in honor of its creator. The importance of the examination led to the creation of the Sociedade Brasileira de Abreugrafia (Brazilian Society of Abreugrafia) in 1957, and the publication of the Revista Brasileira de Abreugrafia (Brazilian Journal of Abreugrafia).

The creation of radiological societies in various European countries and the United States in the early twentieth century contributed to the establishment of radiology as a medical specialty. More than promoting the exchange of experiences and information related to the application of X-rays in Medicine, these societies were responsible for the professionalization of radiological practice, since until then there were no rules or organization of competences of a radiologist, as well as specialized training. A few years later World War I (1914-1918) was also a determining factor for the professionalization of the practice, as X-ray machines began to operate on battlefields in diagnosing the injuries and trauma of the soldiers, which required prior training. professionals for handling the devices and interpreting the images. The construction of portable battlefield devices has also contributed to an increase in equipment safety and standardization.

In 1920, the establishment of the Certificate in Medical Radiology and Electrology (Cambridge Diploma) by the *British Association for the Advancement of Radiology and Physiotherapy* becomes a milestone in the professionalization of Radiology, as its acquisition becomes mandatory for the occupation of a Radiology Post in hospitals.

The first Radiology Medical Residency program in Brazil was created in 1952 by Nicola Caminha and Waldir Maymone at the Hospital dos Servidores do Estado do Rio de Janeiro State (Rio de Janeiro State Servants Hospital). The first Radiology Department was inaugurated in 1972 at the Federal University of Rio de Janeiro.

In 1943, the former Brazilian Society of Radiology and Electrology was reorganized into the new Brazilian Society of Medical Radiology, also headquartered in Rio de Janeiro, to promote the progress of Radiology as a science and as a professional practice, and to promote cooperation between radiologists. In 1957 the name was changed to Brazilian Society of Radiology, becoming the current Society of Radiology of Rio de Janeiro.

The first **CT scanner in Brazil** was installed in 1977 in São Paulo, at the Hospital da Real and Benemérita Sociedade Portuguesa de Beneficência (Hospital of Royal and Beneficent Portuguese Charity Society). Shortly thereafter, still in 1977, a second CT scanner began operating at the Santa Casa de Misericórdia in Rio de Janeiro.

Despite the technological advancement of X-ray machines, many decades followed from Röntgen's discovery until Radiology underwent a major new technical advance. In the early 1970s, with the emergence of computerized tomography, devised by Godfrey Hounsfield, who was to win the Nobel Prize of Medicine in 1979 for his great achievement, it was possible to use digital images in diagnostics and treatments, providing more patient safety, faster imaging and reporting, and more accurate diagnostics. In the same decade, the first magnetic resonance and real-time ultrasound equipment appeared. Since then, technology has continued to evolve with the emergence of newer, faster equipment with more accurate imaging, reduced time and optimized costs.

The modernization of highly sensitive tomography that produce three-dimensional and volumetric data; combinations of technologies such as positron emission (PET-CT) associated with tomography and, more recently, magnetic resonance imaging; computerization; telemedicine; the storage of exams and reports in clouds; In addition to the promising use of artificial intelligence, these are some of the agenda items for the evolution of radiology in the twentieth-first century.

Brazilian radiology follows and reflects the evolution of the specialty in the world, but has its own characteristics and produces new knowledge, either due to the expanded clinical practice, considering the large number of specialists and the dimensions of the Brazilian health system, be it for the qualification of educational and research institutions or for the performance of the scientific entities of the specialty. One of the peculiarities of Brazilian Radiology is the practice of ultrasonography, a method performed by radiologists who has achieved great development in the country.

The Brazilian College of Radiology and Diagnostic Imaging

The Brazilian College of Radiology and Diagnostic Imaging (CBR) is the representative associative agency of Radiology throughout the country and had over ten thousand associates in 2018. Affiliated to the Brazilian Medical Association (AMB), the entity represents the specialty physicians of Radiology and Imaging. It has 27 affiliated regional societies and aims to “disseminate scientific knowledge, defend the specialty, stimulate professional development and support the principles of excellence of diagnostic and therapeutic imaging methods and procedures”.

The CBR was founded on September 15th, 1948 during the first Brazilian Journey of Radiology, at the Theater of the Medical School of the Universidade de São Paulo (University of São Paulo). Initially designated only as the Brazilian College of Radiology, it was founded by professors Rafael de Barros, José Maria Cabello Campos, Carlos Osório Lopes, Adelaido Ribeiro, João Baptista Pulchério Filho and Walter Bonfim Pontes. Its first president was José Maria Cabello Campos, professor of radiology at Santa Casa de São Paulo, its secretary was João Baptista Pulchério Filho and Walter Bonfim Pontes. Its first physical headquarters was established in 1949, at Rua Sete de Abril, central region of São Paulo. In 1950 it was legally made official and, in 1951, the CBR was headquartered at Rua Marconi, also in the central region São Paulo, becoming a state public utility entity through Decree No. 1,268/1951.

From 1992, the CBR began to develop qualification programs in the different areas of Radiology, annually awarding quality labels, specialist titles and accreditation certificates.

Today, the activities performed by its associates include bone densitometry, splanchnic and peripheral Doppler, mammography, neuroradiology, conventional and specialized radiology, pediatric radiology, interventional radiography and angio-radiology, magnetic resonance imaging, computed tomography, general ultrasound and gynecological and obstetric ultrasound.

In addition to having a president, regional vice presidents, and board of directors, with biannual terms, the CBR has several committees formed by radiologists, members of the organization, such as, for example, the scientific, admission and titling, events, teaching, improvement and medical residency, radiological report, teleradiology, mammography, magnetic resonance, computed tomography and ultrasound committees. It also has partnerships and affiliation with important international Radiology entities, and produces its own scientific publications, such as the indexed journal *Radiologia Brasileira* (Brazilian Radiology), first published in 1958, as well as producing the monthly CBR Bulletin, and support the making of books of relevant topics of the specialty. The CBR uses media and digital media, including for the professional qualification of its members.

Profile of the radiologist physician in Brazil

In 2018, 12,868 “radiologist” physician worked in Brazil, this is term used to designate the professional specialist in Radiology and Diagnostic Imaging, a medical specialty officially recognized through two degrees: the completion of a MEC (Ministry of Education and Culture)-accredited Medical Residency program or obtaining Certificate issued by the Brazilian College of Radiology and Diagnostic Imaging (CBR) linked to the Brazilian Medical Association (AMB).

This chapter presents the quantitative survey, profile and distribution of radiologist physicians in Brazil. In addition to the number of specialists, distribution by age, time since graduation, gender, public or private nature of the undergraduate school, other radiologist specialties will be presented, as well as comparisons with the general population of physicians and presentation of information on maps and georeferenced data in each Federation unit.

Among the 55 recognized specialties in Brazil, radiologists represented approximately 3% of the total of qualified physicians. They add up to 12,868 specialists and 14,217 medical records (Table 2). The difference is equivalent to radiologists registered in more than one CRM (Regional/State Council of Medicine), because they operate in two states or have temporarily moved from one state to another, among other reasons.

Table 2

Number of radiologist records, Brazil – 2019

Number of CRM records	Number of physicians	%
One	12,868	90.5
Two	1,228	8.6
Three	98	0.7
Four or more	23	0.2
Total	14,217	100

Source: Scheffer M. et. al., O perfil do médico especialista em Radiologia e Diagnóstico por Imagem, 2019. (The profile of the specialist physician in Radiology and Diagnostic Imaging, 2019).

Titles and practice areas of radiologists

Radiologists may have specialist titles with three different names: Radiology and Diagnostic Imaging (RDI), General Ultrasound (US), and Interventional Radiology and Angioradiology. (RIAR), (Table 3). The same single radiologist may have one or more titles in these three modalities.

The title in RDI is the most common among radiologists and 70% of specialists have this as the sole title. The title in RIAR is the least frequent: only 107 professionals in the country have this title exclusively.

Table 3

Number of radiologists, by degree method – 2019

Title	Number	%
RDI - Radiology and Diagnostic Imaging		
Intersection *	10,327	80.3
Exclusive**	9,003	70.0
US – General Ultrasound		
Intersection *	3,598	28.0
Exclusive**	2,434	18.9
RIAR - Interventional Radiology and Angioradiology		
Intersection *	273	2.1
Exclusive**	107	0.8
Total	12,868	100

RDI - Radiology and Diagnostic Imaging, US - General Ultrasound and RIAR - Interventional Radiology and Angioradiology;

* Intersection: professionals with more than one specialist title;

** Exclusive: Professionals with only one specialist title.

Source: Scheffer M. et. al., O perfil do médico especialista em Radiologia e Diagnóstico por Imagem, 2019. (The profile of the specialist physician in Radiology and Diagnostic Imaging, 2019).

Derived or related to the specialty there are five areas of expertise recognized by the Brazilian College of Radiology and Diagnostic Imaging:

1) Bone Densitometry, 2) Vascular Doppler Ultrasound, 3) Mammography, 4) Neuroradiology and 5) Ultrasonography in Gynecology and Obstetrics.

Bone Densitometry, Neuroradiology and Ultrasonography in Gynecology and Obstetrics (GO) are more frequent (220 certified professionals in each of them), while Vascular Doppler Ultrasound is the area with the lowest number (82 certified specialists) (Table 4).

Physicians from other specialties may also obtain certification in these areas, as long as regulated by the specialty societies and the Joint Specialties Commission (CME), which brings together the Federal Council of Medicine (CFM), the Brazilian Medical Association (AMB) and the National Commission

of Medical Residency (CNRM). Data from certified non-radiologist specialists in the above mentionedabove-mentioned fields were not computed in this study. The CBR has already certified, for example, over 1,000 doctors in the field of ultrasound in GO, but of these, only 220 were radiologists, who were accounted for in the study (Table 4).

Table 4

Practice area of radiologist physicians, Brazil – 2019

Practice area*	Number	% ¹	% ²
Bone Densitometry	225	25.7	1.7
Vascular Doppler Ultrasound	82	9.3	0.6
Mammography	130	14.8	1.0
Neuroradiology	216	24.7	1.7
Ultrasonography in GO	220	25.2	1.7
Total	873	100	100

1. (%) in relation to the total of radiologists with areas of expertise;

2. (%) in relation to the total of radiologists;

* Certified radiologists in practice areas

Source: Scheffer M. et. al., O perfil do médico especialista em Radiologia e Diagnóstico por Imagem, 2019. (The profile of the specialist physician in Radiology and Diagnostic Imaging, 2019).

About Practice Areas

Bone Densitometry - formation: 1 year CNRM, optional in PRM (Medical Residence Program) in Endocrinology and Metabology, Gynecology and Obstetrics, Nuclear Medicine, Orthopedics and Traumatology or Rheumatology. AMB: Contest of the AMB Agreement/Brazilian College of Radiology and Diagnostic Imaging Agreement. Requirements: TEAMB in Endocrinology, or TEAMB Metabology in Gynecology and Obstetrics, or TEAMB in Nuclear Medicine, or TEAMB in Orthopedics and Traumatology or TEAMB in Rheumatology;

Vascular Doppler Ultrasound - formation: 1 year CNRM, optional in PRM in Radiology, Vascular Surgery or Angiology. AMB: Contest of the AMB Agreement/ Brazilian College of Radiology and Diagnostic Imaging / Brazilian Society of Angiology and Vascular Surgery. Requirements: TEAMB (Specialty Title-TE- issued by Brazilian Medical Association-AMB) in Angiology, or TEAMB in Cardiology added certificate of performance in Echocardiography, or TEAMB in Vascular Surgery, or TEAMB in Diagnostic Imaging: exclusive performance General Ultrasound, or TEAMB in Radiology and Diagnostic Imaging;

Mammography - formation: 1 year CNRM, optional in PRM in Gynecology and Obstetrics or Mastology. AMB: Competition Agreement AMB / Brazilian College of Radiology and Diagnosis Imaging / Brazilian Federation of Gynecology and Obstetrics Societies / Brazilian Society of Mastology. Requirements: TEAMB in Diagnostic Imaging - exclusive performance: General Ultrasound, or TEAMB in Gynecology and Obstetrics or TEAMB in Mastology;

Neuroradiology - formation: 1 year CNRM, optional in PRM in Radiology and Diagnostic Imaging, Neurology or Neurosurgery. AMB: Contest of the AMB / Brazilian College of Radiology and Diagnostic Imaging Agreement. Requirements: TEAMB in

Neurosurgery, or TEAMB in Neurology or TEAMB in Radiology and Diagnostic Imaging;

Gynecology and Obstetrics Ultrasound - formation: 1 year CNRM, optional in Gynecology and Obstetrics PRM. AMB: Competition Agreement AMB / Brazilian College of Radiology and Diagnostic Imaging / Brazilian Federation of Gynecology and Obstetrics Societies. Requirement: TEAMB in Gynecology and Obstetrics.

Radiologist profile

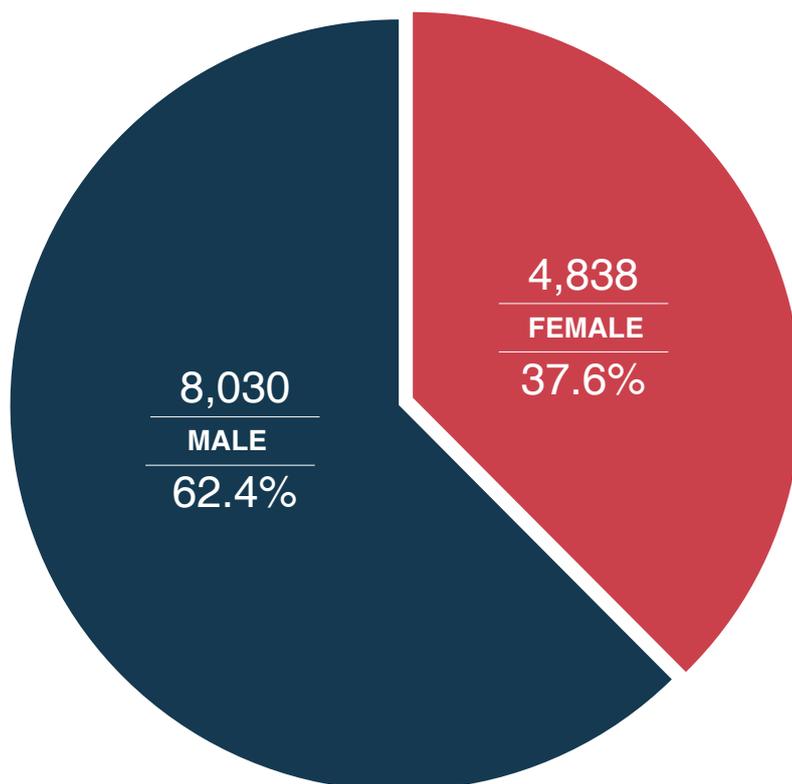
Radiology and Diagnostic Imaging is a predominantly male specialty. Among the radiologists active in the country, 62.4% (8,030) are men and 37.6% (4,838) are women (Figure 1).

Most specialists focus on the 30-54 age group (Table 5; Figure 2). The average age of radiologists is 46.1 years, with 47.5 years among men and 43.7 years among women.

There is a relatively small number of young professionals (≤ 29 years), a possible indication that part of the physicians are graduating later and/or entering the Radiology Medical Residency after completing other residency programs.

Figure 1

Distribution of radiologists physicians by gender, Brazil – 2019



Source: Scheffer M. et. al., O perfil do médico especialista em Radiologia e Diagnóstico por Imagem, 2019. (The profile of the specialist physician in Radiology and Diagnostic Imaging, 2019).

In the older age groups (> 60 years), the number of professionals is predominantly male, while the largest female representation in the specialty is among young people (≤ 29 years) (46.5%), in line with the increasing female participation in Medicine in the country.

Table 5

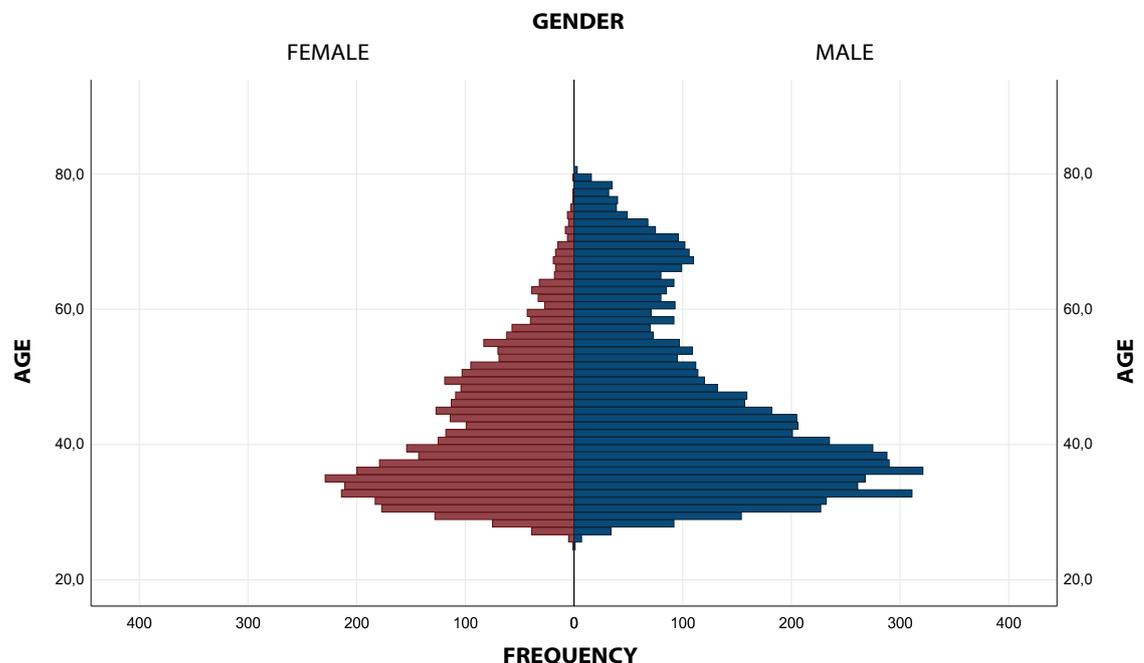
Distribution of radiologist physicians by age and sexgender, Brazil – 2019

Age group	Female		Male		Total
	Number	%	Number	%	
≤ 29 years	259	46.5	293	53.5	552
30 – 34 years	998	43.5	1,234	56.5	2,232
35 – 39 years	889	36.5	1,466	63.5	2,355
40 – 44 years	647	34.5	1,123	65.5	1,770
45 – 49 years	684	43.4	846	56.6	1,530
50 – 54 years	567	43.2	715	56.8	1,282
55 – 59 years	399	40.6	574	59.4	973
60 – 64 years	235	27.8	598	72.2	833
65 to 69 years	116	15.2	637	84.8	753
≤ 70 years	44	7.2	544	92.8	588
Total	4,838	37.5	8,030	62.5	12,868

Source: Scheffer M. et. al., O perfil do médico especialista em Radiologia e Diagnóstico por Imagem, 2019. (The profile of the specialist physician in Radiology and Diagnostic Imaging, 2019).

Figure 2

Distribution of radiologist physicians by age and sexgender, Brazil – 2019



Source: Scheffer M. et. al., O perfil do médico especialista em Radiologia e Diagnóstico por Imagem, 2019. (The profile of the specialist physician in Radiology and Diagnostic Imaging, 2019).

Of the total of 10,327 physicians with RDI degrees, 37.1% (3,836) of the specialists are women, and 62.9% (6,491) are men (Table 6, Figure 3). For this title, most professionals of both genders are concentrated in the age group between 30 and 49 years and the average age for both genders is 44.7 years (± 12.4). The number of men is higher in all age groups. The largest female representation (46.3%) is among young people (≤ 29 years), followed by the 30-34 and 50-54 age groups (44.1% each). And the largest male representation ($>70\%$) is among professionals of the largest age groups (>60 years), reaching the apex among physicians over 70 years (93.6%).

Table 6

Distribution of radiology and diagnostic imaging specialists according to age and gender, Brazil – 2019

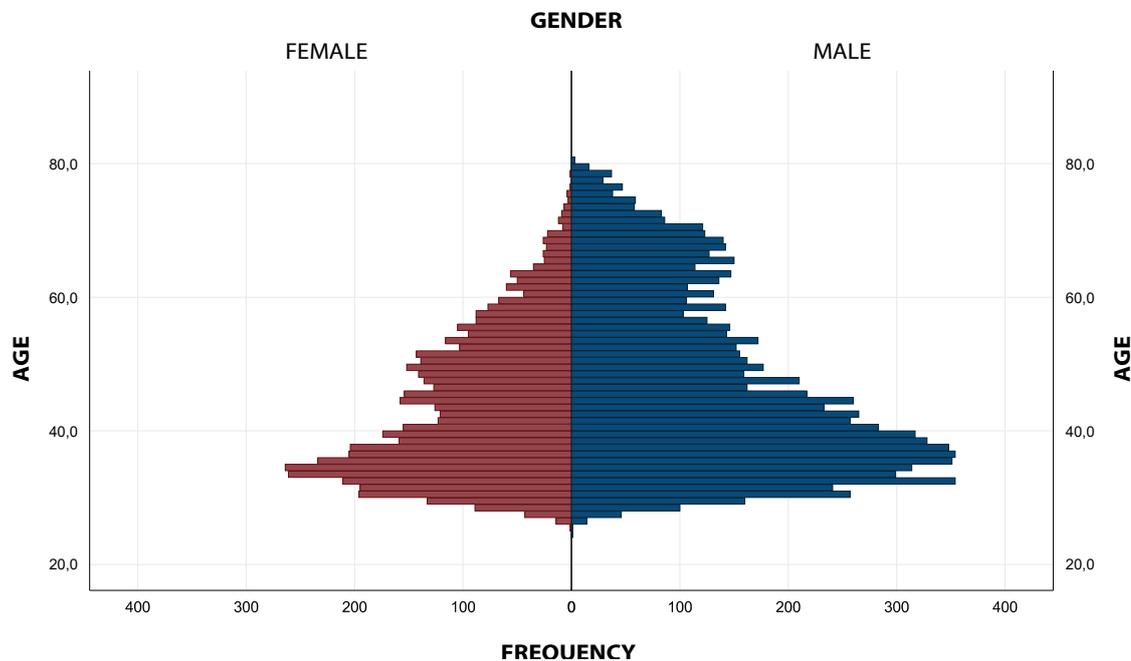
Age group	Female		Male		Total
	Number	%	Number	%	
≤ 29 years	248	46.3	288	53.7	536
30 – 34 years	914	44.1	1,159	55.9	2,073
35 – 39 years	776	37.1	1,314	62.9	2,090
40 – 44 years	519	35.7	933	64.3	1,452
45 – 49 years	509	43.4	664	56.6	1,173
50 – 54 years	379	44.1	481	55.9	860
55 – 59 years	243	40.8	352	59.2	595
60 – 64 years	141	26.9	384	73.1	525
65 to 69 years	76	14.1	463	85.9	539
≤ 70 years	31	6.4	453	93.6	484
Total	3,836	37.1	6,491	62.9	10,327

Source: Scheffer M. et. al., O perfil do médico especialista em Radiologia e Diagnóstico por Imagem, 2019. (The profile of the specialist physician in Radiology and Diagnostic Imaging, 2019).

In the profile of specialists in Diagnostic Imaging with exclusively acting in ultrasound (US), of the 3,598 physicians, 39.2% (1,410) of the specialists are women, and 60.8% (2,188) are men (Table 7). The average age for both sexes is 53.5 years (± 10.8). For this title, most women are in the 45-59 age group and men in the 50-69 age group (Figure 4). In addition, female representation is higher than male among doctors under 34 and in the 45-49 age group.

Figure 3

Distribution of medical specialists in Radiology and Diagnostic Imaging by age and sexgender, Brazil - 2019.



Source: Scheffer M. et. al., O perfil do médico especialista em Radiologia e Diagnóstico por Imagem, 2019. (The profile of the specialist physician in Radiology and Diagnostic Imaging, 2019).

Table 7

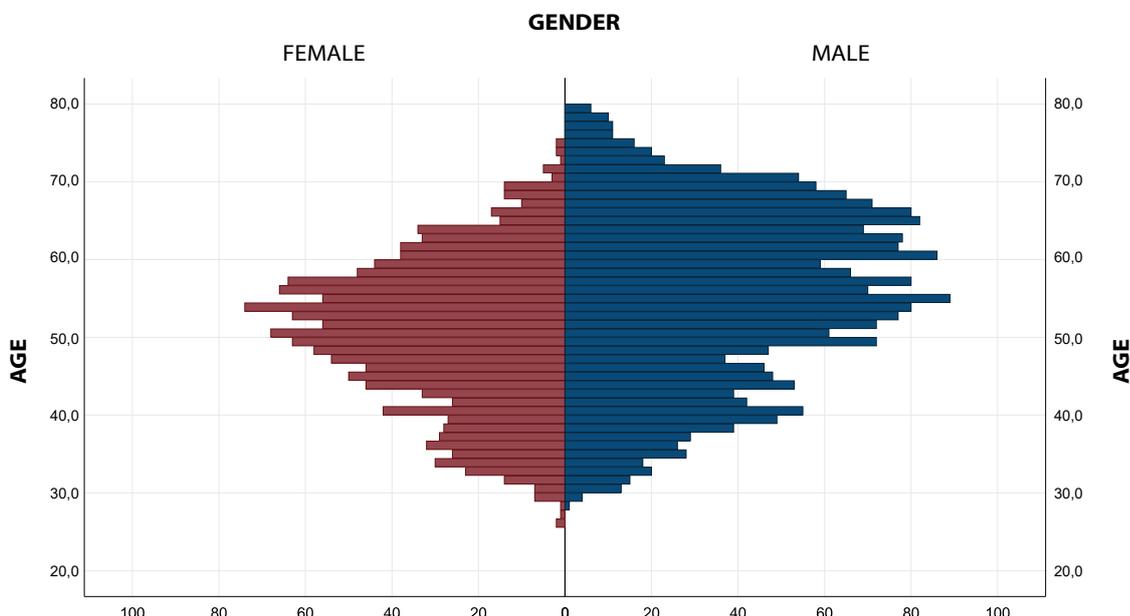
Distribution of Imaging Diagnostic specialist Physicians with exclusive expertise in General Ultrasound by aAge and Sexgender, Brazil - 2019

Age group	Female		Male		Total
	Number	%	Number	%	
≤ 29 years	11	68.8	5	31.3	16
30 - 34 years	88	52.7	79	47.3	167
35 - 39 years	128	45.1	156	54.9	284
40 - 44 years	174	45.1	212	54.9	386
45 - 49 years	242	51.6	227	48.4	469
50 - 54 years	294	47.0	331	53.0	625
55 - 59 years	247	43.2	325	56.8	572
60 - 64 years	152	30.3	350	69.7	502
65 to 69 years	61	16.2	316	83.8	377
≤ 70 years	13	6.5	17	93.5	200
Total	1,410	39.2	2,188	60.8	3,598

Source: Scheffer M. et. al., O perfil do médico especialista em Radiologia e Diagnóstico por Imagem, 2019. (The profile of the specialist physician in Radiology and Diagnostic Imaging, 2019).

Figure 4

Age distribution of specialists in Diagnostic Imaging, who work exclusively in General Ultrasound, according to age and sexgender, Brazil - 2019



Source: Scheffer M. et. al., O perfil do médico especialista em Radiologia e Diagnóstico por Imagem, 2019. (The profile of the specialist physician in Radiology and Diagnostic Imaging, 2019).

Considering the RIAR (Interventional Radiology and Angioradiology) specialists, which currently has 324 professional specialists working in the country, only 8.6% of the professionals are women, while 91.4% are men (Table 8; Figure 5). The largest number of women is concentrated in the 35-39 age group (11 physicians), and men, 35-44 years old. The average age for both sexgenders is 51.8 years (± 10.9). To enroll in an RIAR program, the doctor must have completed a Radiology or Surgery residency program, which helps explain the lower presence of under-29s.

Regarding the nature of the undergraduate school, 63.5% (8,083) of radiologists graduated in medicine from public schools, and 36.5% (4,642) from private schools (Figure 6). Considering the distribution of undergraduate medical courses in 2018, 35% of the vacancies spots were offered by public schools and 65% by private schools.

Table 8

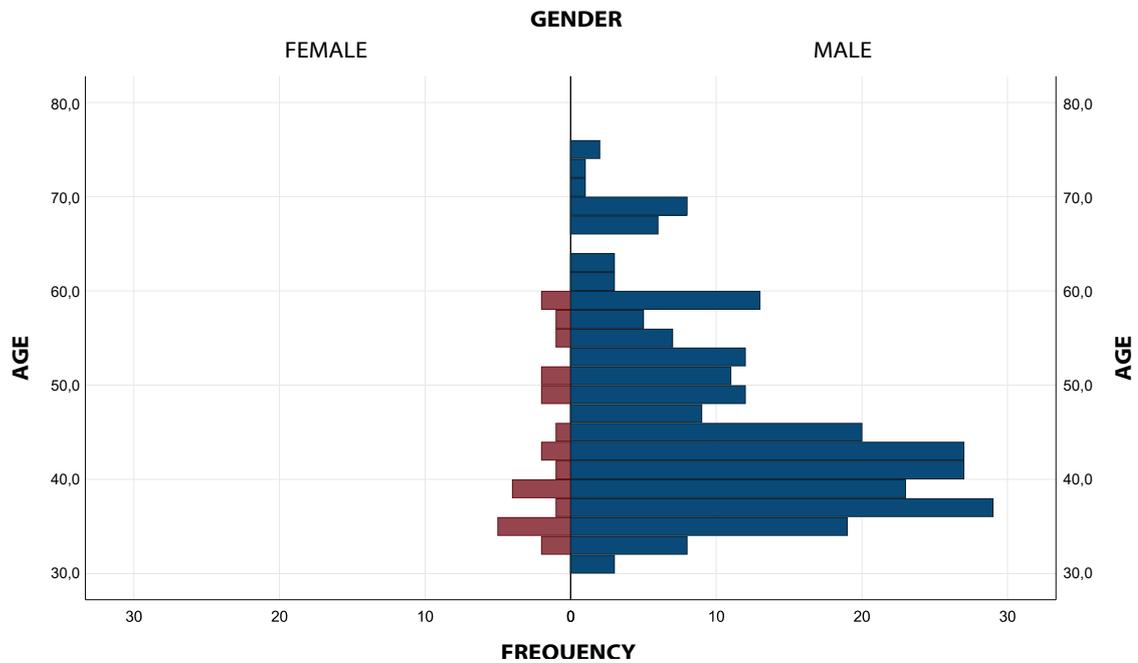
Distribution of Imaging Diagnostic Physicians with exclusive expertise in Interventional Radiology and Angioradiology by Age and Sexgender, Brazil – 2019

Age group	Female		Male		Total
	Number	%	Number	%	
≤ 29 years	0	0.0	0	0.0	0
30 – 34 years	5	14.7	29	85.3	34
35 – 39 years	11	12.2	79	87.8	90
40 – 44 years	3	3.8	75	96.2	78
45 – 49 years	3	8.8	31	91.2	34
50 – 54 years	3	8.1	34	91.9	37
55 – 59 years	3	11.1	24	88.9	27
60 – 64 years	0	0.0	6	100.0	6
65 to 69 years	0	0.0	14	100.0	14
≤ 70 years	0	0.0	4	100.0	4
Total	28	8.6	296	91.4	324

Source: Scheffer M. et. al., O perfil do médico especialista em Radiologia e Diagnóstico por Imagem, 2019. (The profile of the specialist physician in Radiology and Diagnostic Imaging, 2019).

Figure 5

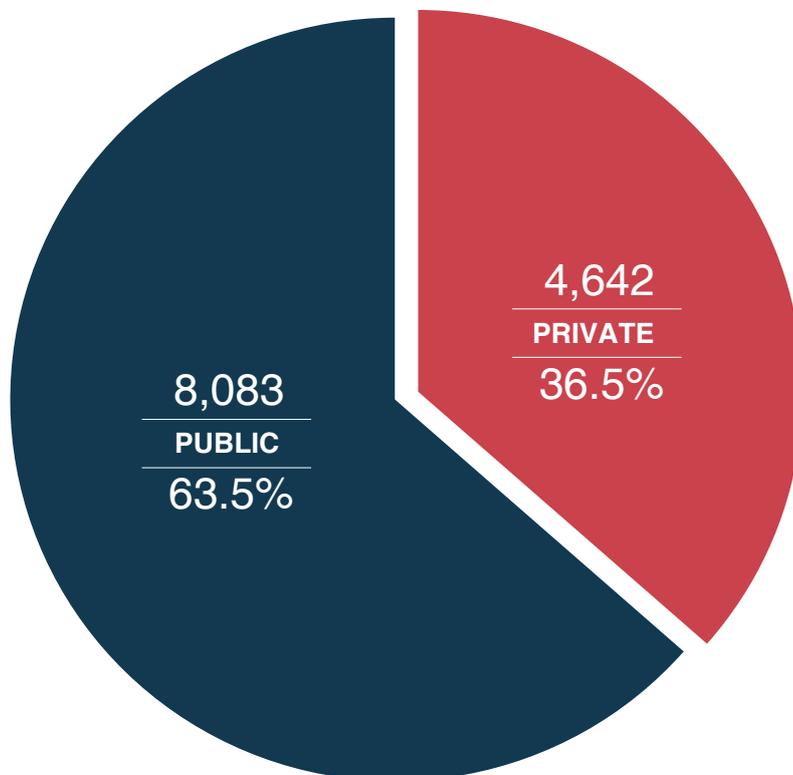
Distribution of Imaging Diagnostic Physicians with exclusive expertise in Interventional Radiology and Angioradiology by aAge and Sexgender, Brazil – 2019



Source: Scheffer M. et. al., O perfil do médico especialista em Radiologia e Diagnóstico por Imagem, 2019. (The profile of the specialist physician in Radiology and Diagnostic Imaging, 2019).

Figure 6

Radiologists physicians according graduation school nature of Medicine, Brazil – 2019



Source: Scheffer M. et. al., O perfil do médico especialista em Radiologia e Diagnóstico por Imagem, 2019. (The profile of the specialist physician in Radiology and Diagnostic Imaging, 2019).

The existence of a field of practice defined imaging area and strong consistent hospitaimaging curriculuml content at undergraduate level, more present in public schools that have teaching hospitals, may be a determining factor in the choice of specialization.

Medical Residency and specialized formation

The training of specialists in Radiology and Diagnostic Imaging is highlighted below. The purpose is to outline the general characteristics of the training system, as well as to point out potentialities and gaps in the distribution and offering of Medical Residency programs and vacancies spots, which is the main mode of training of medical specialists in Brazil.

The study also notes the distribution of programs and vacancies spots for improvement in services, as well as the different training modalities offered by institutions recognized by the Brazilian College of Radiology and Diagnostic Imaging.

There are two ways for a physician to obtain the title of Specialist in Radiology and Diagnostic Imaging: 1) complete one of the Radiology and Imaging Diagnostic Residency programs recognized by the Ministry of Education and Culture (MEC); 2) obtain the title via CBR, which requires the certificate of the three-year compulsory Radiology and Image Diagnosis Improvement Course in official vacancies positions of services accredited by the CBR or have a statement of training in the area, for a minimum of six years, with weekly duration, attested by the institution's technical director and two full members of the CBR.

Most physicians who complete MEC-recognized residency programs provide CBR title proof, also because of the importance of recognized peer titling nomination. The bearer of the title of specialist in RDDI will be able to work in all areas of imaging diagnosis.

Thus, we will describe below the medical residency in Radiology and Diagnostic Imaging, the improvement in Radiology and Diagnostic Imaging; and obtaining the title of specialist in Radiology and Diagnostic Imaging.

The Medical Residency in Radiology and Diagnostic Imaging

In 2018, Brazil had 1,393 physicians enrolled and specializing in 151 programs of Medical Residency (RM) in Radiology and Diagnostic Imaging Residency accredited by CNRM/MEC (Table 9).

In the same period, the number of vacancies positions requested by the programs and authorized by CNRM was 1,728, that is, 331 vacancies positions (approximately 20%), although accredited, were not filled or occupied (Table 12). Position Vacancies are idle for various reasons, from non-allocation of scholarships, infrastructure problems, absence of preceptors, dropouts, among other situations.

About the Medical Residency

The Medical Residency (RM) is the graduate teaching for physicians, in the form of a specialization course, characterized by in-service training, under the responsibility of health institutions, university or not, accredited by CNRM under the guidance of medical professionals of high ethical and professional qualifications. The Medical Residency programs in Radiology and Diagnostic Imaging have a minimum duration of three years. RM in the field may add one or more years to specialized training. The entrance in accredited Medical Residency programs through selective processes and public calls. The resident doctor is guaranteed monthly scholarship (in 2017 the amount, periodically updated by law, was BRL3,330.00) in special training regime in service of 60 hours per week. Residency grants are funded by various sources. The Ministry of Education and Culture (MEC) funds the scholarships of federal university hospitals, and the Ministry of Health also allocates resources to scholarships. States, municipalities, philanthropic and private hospitals (these in smaller numbers) also fund RM grants in their own services. Most CNRM-accredited Medical Residency programs are, therefore, linked to public services of the Unified Health System (SUS).

Residence Contents

As it happens in radiology residency programs in European countries and the United States, in Brazil these programs also include rotations among the diverse area of activity. The physician should acquire skills in general and contrast radiology, ultrasound, mammography, computed tomography, bone densitometry, magnetic resonance imaging, interventional radiology, examination techniques, and urgencies and emergencies. These skills should be developed in a training program that corresponds to at least 80% of the planned each year, complemented by theoretical-complementary activities whose workload can vary from 288 to 576 annual hours. Some programs may even offer training in angio-radiology and endovascular surgery, vascular Doppler ultrasonography, neuroradiology, and interventional radiology in an optional fourth or fifth year of the residency program. Nuclear Medicine training must be done separately in one of the country's three-year accredited nuclear medicine residency programs.

The formation in the world

Radiology Residency Programs in different countries vary in the duration, content and scope of practice of future specialists. In Egypt and India, for example, the duration is three years, with the possibility of an additional year for subspecialization. In the United States and Canada, the programs last four years, while in countries such as New Zealand and Australia they last five years, during which general radiology training usually takes place during the first four years, followed by fifth year of training in a subspecialty. In Europe, the length of the residence period ranges from two to six years, averaging five years, followed by one year of improvement in 55% of countries (12 of 22 countries surveyed). The United Kingdom requires two years' prior clinical experience for training in a residency program. Despite the considerable variation in the content of programs between countries, training generally adopts a rotation scheme between radiology's different areas of activity.

Table 9

Distribution of Medical Residence in Radiology and Diagnostic Imaging in 2018, according to number of programs and of authorized vacancies positions, filled and idle, Brazil - 2019

State	Program	Vacancies Positions			% of Idle vacancies positions
		Authorized	Filled	Idle	
Acre	0	0	0	0	0.0
Alagoas	3	21	19	2	9.5
Amapá	0	0	0	0	0.0
Amazonas	1	9	5	4	44.4
Bahia	4	42	38	4	9.5
Ceará	5	48	35	13	27.1
Distrito Federal	6	63	52	11	17.5
Espírito Santo	4	36	24	12	33.3
Goiás	3	30	30	0	0.0
Maranhão	3	24	17	7	29.2
Mato Grosso	2	12	3	9	75.0
Mato Grosso do Sul	1	6	6	0	0.0
Minas Gerais	18	162	124	38	23.5
Pará	3	33	25	8	24.2
Paraíba	1	3	3	0	0.0
Paraná	16	126	82	44	34.9
Pernambuco	5	66	68	2	3.0
Piauí	2	12	12	0	0.0
Rio de Janeiro	15	180	147	33	18.3
Rio Grande do Norte	1	12	12	0	0.0
Rio Grande do Sul	16	144	103	41	28.5
Rondônia	0	0	0	0	0.0
Roraima	0	0	0	0	0.0
Santa Catarina	6	48	32	16	33.3
São Paulo	35	642	547	95	14.8
Sergipe	1	9	9	0	0.0
Tocantins	0	0	0	0	0.0
Brazil	151	1,728	1,393	339	19.6

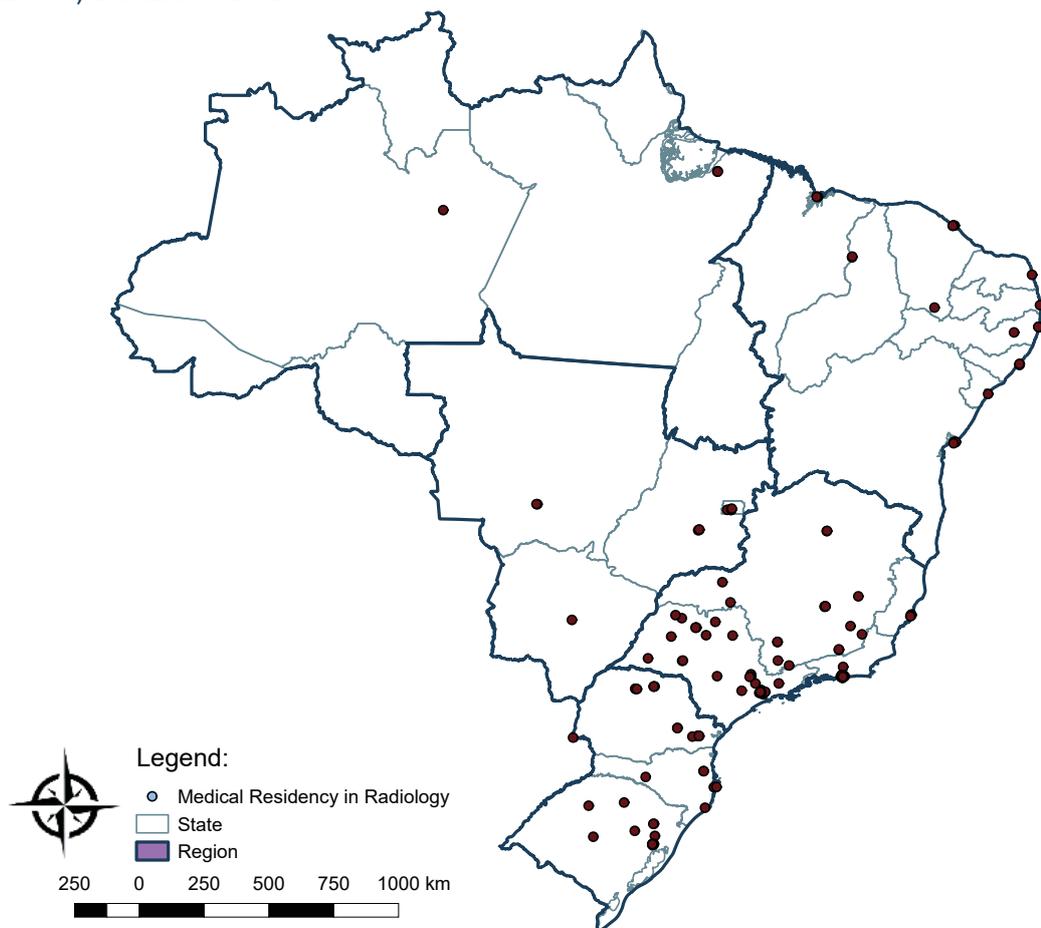
Source: CNRM/2018; Scheffer M. et. al., O perfil do médico especialista em Radiologia e Diagnóstico por Imagem, 2019. (The profile of the specialist physician in Radiology and Diagnostic Imaging, 2019).

Inequalities in geographical distribution of Medical Residency programs in Radiology and Imaging Diagnosis are striking (Figure 7). While the South and Southeast states concentrate 110 out of 151 programs, which corresponds to 72.7% of the total, the Midwest, North and Northeast regions together have only 41 residency programs, which corresponds to 27.3% of national

total. Inequalities are most evident when comparing the Southeast region, which has 72 programs, with the North region, where five states (Rondônia, Acre, Roraima, Amapá and Tocantins) do not have any Medical Residence program.

Figure 7

Medical Residency Programs in Radiology and Diagnostic Imaging in 2018, Brazil - 2019

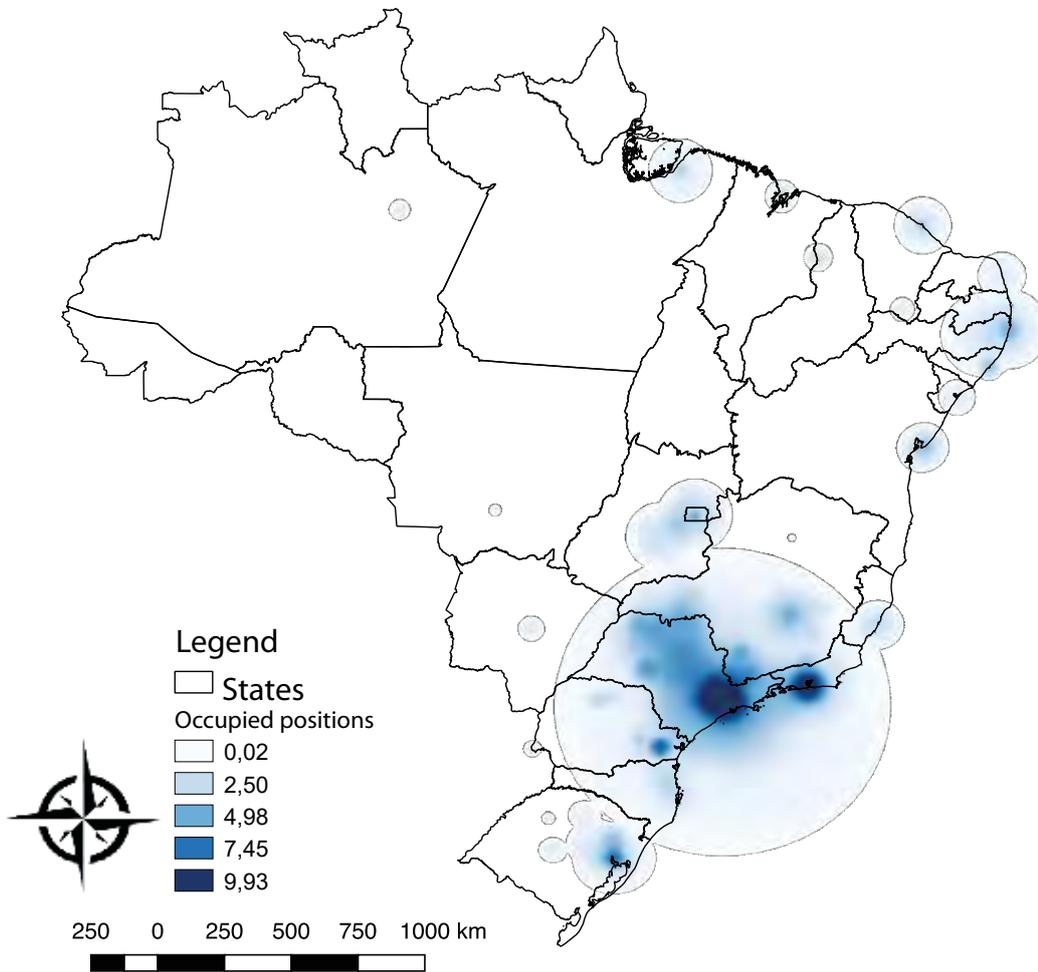


Source: CNRM/2018; Scheffer M. et. al., O perfil do médico especialista em Radiologia e Diagnóstico por Imagem, 2019. (The profile of the specialist physician in Radiology and Diagnostic Imaging, 2019).

Like medical residency programs, current residents, represented here by the term “filled vacanciespositions”, are also unevenly distributed across the national territory (Figure 8). The Southeast region has 842 residents, equivalent to 60.5% of the total in national level. The South region, 217 residents, or 15.6% of the total. The Northeast concentrates 211 residents (15.1%), and the Midwest, 91 (6.5%). The North has the lowest number of residents - 30 (2.1%) - all located in the states of Pará and Amazonia. Together, South and Southeast gather more than three quarters of all medical residency vacanciespositions in the country.

Figure 8

Occupied positionvacancies in Medical Residency programs in Radiology and Diagnostic Imaging in 2018, Brazil - 2019

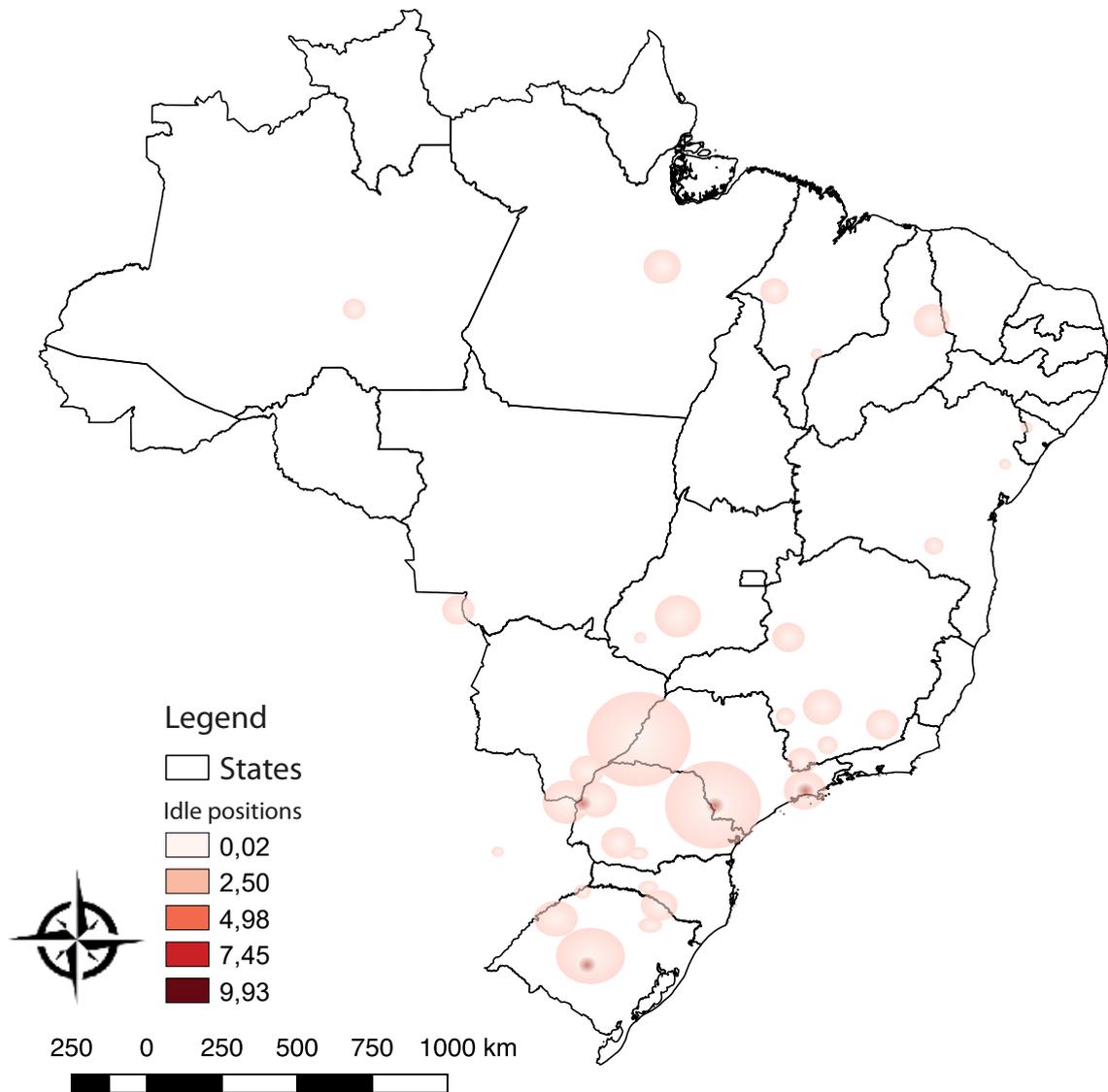


Source: CNRM/2018; Scheffer M. et. al., O perfil do médico especialista em Radiologia e Diagnóstico por Imagem, 2019. (The profile of the specialist physician in Radiology and Diagnostic Imaging, 2019).

The present study also looked at the total number of vacancies positions authorized by CNRM, how many were no longer occupied or filled. It is a picture of the intended or potential, but not implemented or exploited capacity, of the offer of vacanciespositions by the MR programs in Radiology and Diagnostic Imaging.

Figure 9

Idle Vacancies positions in Medical Residency programs in Radiology and Diagnostic Imaging in 2018, Brazil – 2019

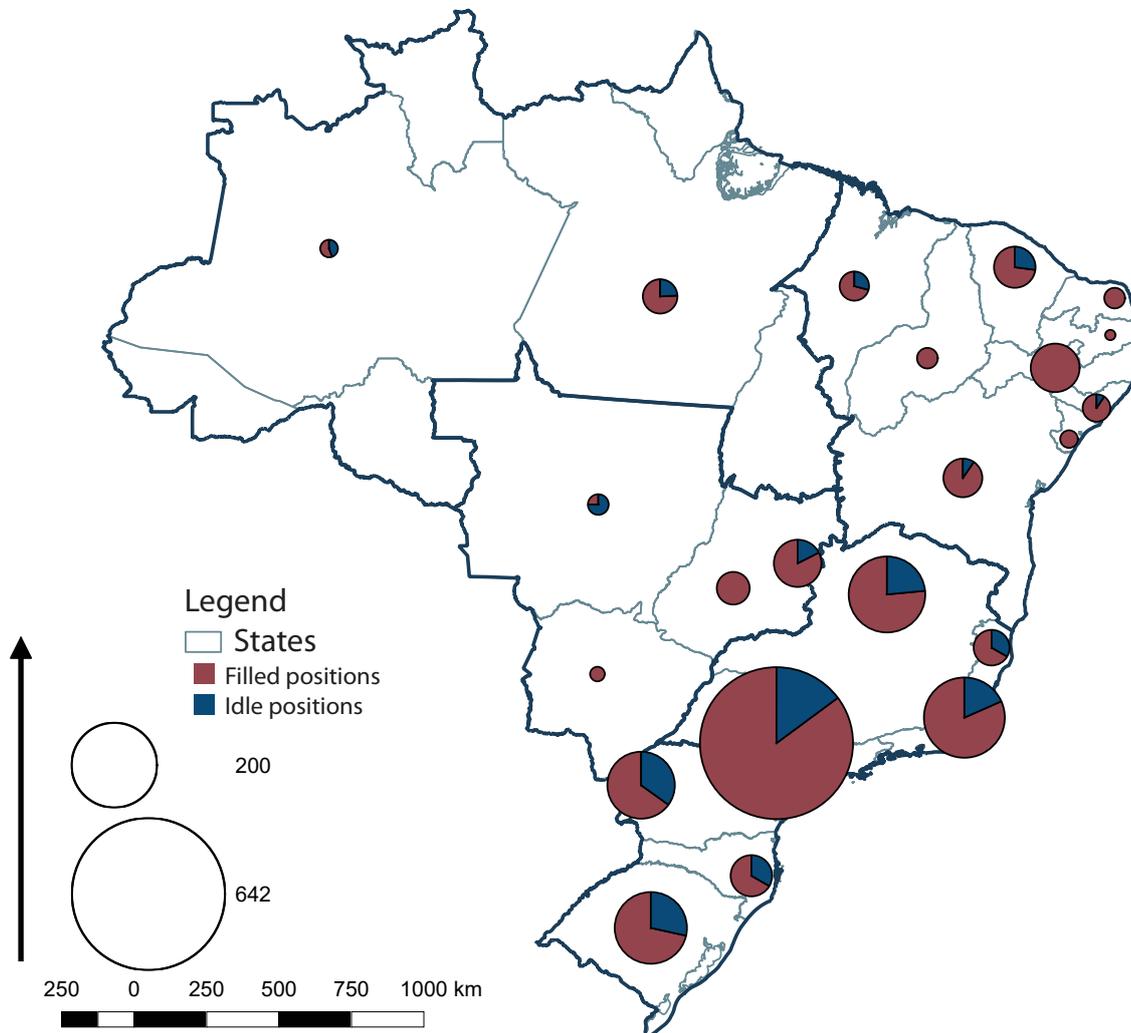


Source: CNRM/2018; Scheffer M. *et. al.*, O perfil do médico especialista em Radiologia e Diagnóstico por Imagem, 2019. (The profile of the specialist physician in Radiology and Diagnostic Imaging, 2019).

Although 19.6% of the vacancies positions requested by the programs and authorized by the CNRM were not occupied, the percentage of unoccupied vacancies positions is below the national percentage in 2017 (40%), which includes all specialty programs. The states with the highest percentage of unoccupied Radiology and Diagnostic Imaging vacancies positions are Mato Grosso (75%), Amazonas (44%), Paraná (34.9%), Santa Catarina and Espírito Santo (33.3% each). Goiás, Mato Grosso do Sul, Piauí, Sergipe, Paraíba and Rio Grande do Norte do not have idle vacancies positions (Figures 9 and 10).

Figura 10

Vacancies Positions filled and idle in Medical Residency programs of Radiology and Diagnostic Imaging in the year 2018, Brazil - 2019



Source: CNRM/2018; Scheffer M. et. al., O perfil do médico especialista em Radiologia e Diagnóstico por Imagem, 2019. (The profile of the specialist physician in Radiology and Diagnostic Imaging, 2019).

By analyzing the vacancies positions occupied by residents according to the year in the course (R1 to R3), it is observed that practically all Brazilian states, except Bahia, had an increase or maintenance in the number of vacancies positions in R1 in relation to the number of vacanciespositions in R2 (Table 10). The states that presented the largest increase in the number of jobs occupied in R1 in relation to those in R2 were Maranhão, Mato Grosso do Sul, Pernambuco and Rio de Janeiro. Analyzing the relationship of vacancies positions filled in R1 with the vacancies positions of R2 and R3 can help to understand the evolution of vacanciespositions, becoming a useful tool for planning and projection of the number of specialists that the health system can count on in the future.

Table 10

Distribution of vacancies positions occupied in Medical Residency programs of Radiology and Diagnostic Imaging in 2018 according the year of course, Brazil – 2019

State	R1	R2	R3	Total
Acre	0	0	0	0
Alagoas	7	6	6	19
Amapá	0	0	0	0
Amazonas	2	2	1	5
Bahia	12	13	13	38
Ceará	13	12	10	35
Distrito Federal	26	16	10	52
Espírito Santo	10	7	7	24
Goiás	15	9	6	30
Maranhão	8	4	5	17
Mato Grosso	1	1	1	3
Mato Grosso do Sul	4	2	0	6
Minas Gerais	47	39	38	124
Pará	9	9	7	25
Paraíba	3	0	0	3
Paraná	37	24	21	82
Pernambuco	32	17	19	68
Piauí	4	3	5	12
Rio de Janeiro	70	41	36	147
Rio Grande do Norte	12	0	0	12
Rio Grande do Sul	47	28	28	103
Rondônia	0	0	0	0
Roraima	0	0	0	0
Santa Catarina	14	12	6	32
São Paulo	225	176	146	547
Sergipe	3	3	3	9
Tocantins	0	0	0	0
Brazil	601	424	368	1,393

Source: CNRM/2018; Scheffer M. et. al., O perfil do médico especialista em Radiologia e Diagnóstico por Imagem, 2019. (The profile of the specialist physician in Radiology and Diagnostic Imaging, 2019).

Regarding the geographical distribution of occupied vacancies positions in the same state (Table 11), about 72% of occupied vacancies positions are in the capitals, and in the North and Northeast regions, practically all vacancies positions are concentrated in the capitals. In other regions, although better distributed, more than 50.0% of vacancies positions are still concentrated in the capitals, except Santa Catarina, where 71.8% of residents are in the interior of the state.

Table 11

Distribution of vacancies positions occupied in Medical Residency programs of Radiology and Diagnostic Imaging in 2018, according the place of course, Brazil – 2019

State	Capital		Countryside	
	Number	%	Number	%
Acre	0	0.0	0	0.0
Alagoas	19	100.0	0	0.0
Amapá	0	0.0	0	0.0
Amazonas	5	100.0	0	0.0
Bahia	38	100.0	0	0.0
Ceará	29	82.9	6	17.1
Distrito Federal	52	100.0	0	0.0
Espírito Santo	12	50.0	12	50.0
Goiás	30	100.0	0	0.0
Maranhão	17	100.0	0	0.0
Mato Grosso	3	100.0	0	0.0
Mato Grosso do Sul	6	100.0	0	0.0
Minas Gerais	64	51.6	60	48.4
Pará	25	100.0	0	0.0
Paraíba	3	100.0	0	0.0
Paraná	45	54.9	37	45.1
Pernambuco	68	100.0	0	0.0
Piauí	12	100.0	0	0.0
Rio de Janeiro	130	88.4	17	11.6
Rio Grande do Norte	12	100.0	0	0.0
Rio Grande do Sul	61	59.2	42	40.8
Rondônia	0	0.00	0	0.0
Roraima	0	0.0	0	0.0
Santa Catarina	9	28.1	23	71.9
São Paulo	357	65.3	190	34.7
Sergipe	9	100.0	0	0.0
Tocantins	0	0.0	0	0.0
Brazil	1,006	72.2	387	27.8

Source: CNRM/2018; Scheffer M. et. al., O perfil do médico especialista em Radiologia e Diagnóstico por Imagem, 2019. (The profile of the specialist physician in Radiology and Diagnostic Imaging, 2019).

Improvement in Radiology and Diagnostic Imaging

In addition to the medical residency programs previously described, the present study also surveyed the institutions that offer improvement in Radiology and Diagnostic Imaging. In 2018, 183 institutions recognized by the Brazilian College of Radiology and Diagnostic Imaging offered places for improvement in three distinct categories: (i) improvement in Radiology and Diagnostic Imaging (RDI - three-year duration); (ii) improvement in General Ultrasonography (US - two years duration); and (iii) Fellow (Table 12), understood as a complementation or subspecialization program.

The choice of Radiology Medical Residency by recent graduates

In Brazil, in a survey conducted by the Faculdade de Medicina da Universidade de São Paulo (School of Medicine of the University of São Paulo) with 4,600 recent graduates in Medicine across the country, Radiology was appointed as the first option of Medical Residency by 4.5% of respondents, the eighth specialty in order of preference, shortly after Pediatrics, Gynecology and Obstetrics, Medical Clinics, Dermatology, General Surgery, Anesthesiology and Psychiatry, in that order. These eight combined specialties, including Radiology, are the preference of 57.4% of recent graduates, among the 55 recognized medical specialties in Brazil.

In the world, the choice for residency in radiology is linked to multiple factors. Interviews conducted with 488 area-resident physicians, with an average age of 30.8 (\pm 3.2), conducted between 2016 and 2017 in the United States, identified that the most career-appealing aspects refer to the intellectual challenge (n = 187, 38 %), followed by image-related components (n = 100, 20%), procedures (n = 96, 20%), and individual characteristics and lifestyle (n = 69, 14%). Questionnaires applied to approximately 1,200 undergraduate students from 141 North American medical schools also pointed to intellectual challenge as the most appealing choice of radiology, while less contact with the patient, compared to the practice of other specialties, was pointed out as the main factor for not choosing this specialty.

Table 12

Distribution of improvement programs and vacancies positions in Radiology and Diagnostic Imaging (RDI), General Ultrasound (US) and Fellow in institutions recognized by the Brazilian College of Radiology and Diagnostic Imaging in 2018, Brazil - 2019

	Vacancies Positions			
	Institutions	EDI	US	FELLOW
Acre	0	0	0	0
Alagoas	2	2	5	3
Amapá	0	0	0	0
Amazonas	0	0	0	0
Bahia	6	7	13	6
Ceará	5	11	0	16
Distrito Federal	9	11	0	23
Espírito Santo	4	4	0	11
Goiás	7	8	0	10
Maranhão	3	8	0	1
Mato Grosso	0	0	0	0
Mato Grosso do Sul	3	4	0	2
Minas Gerais	11	25	4	18
Pará	4	6	0	25
Paraíba	1	4	0	0
Paraná	11	17	7	22
Pernambuco	2	7	0	10
Piauí	2	7	0	2
Rio de Janeiro	30	60	0	102
Rio Grande do Norte	0	0	0	0
Rio Grande do Sul	14	28	9	23
Rondônia*	0	0	0	0
Roraima	0	0	0	0
Santa Catarina	6	17	0	13
São Paulo	62	155	59	270
Sergipe	1	2	0	0
Tocantins	0	0	0	0
Brazil	183	383	97	557

*In Rondônia there is currently an improvement program whose accreditation was completed after data analysis, so it is not listed in these results.

Source: Scheffer M. et. al., O perfil do médico especialista em Radiologia e Diagnóstico por Imagem, 2019. (The profile of the specialist physician in Radiology and Diagnostic Imaging, 2019).

Like medical residency programs, the institutions that offer them are unevenly distributed across the country. Of the 183 recognized institutions, 107 (58.4%) are in the Southeast region, 62 of them in the state of São Paulo, and another 30 in the state of Rio de Janeiro. The North region has the smallest number of institutions - only four - all located in the state of Pará. The South region has 31 institutions (16.9%) and the Northeast has 19 (12%). The Midwest region has 19 (10.3%) institutions.

The 183 institutions together offer 1,037 improvement/residency vacancies/positions named “aperfeiçoandos” (AP), of which 557 are categorized as Fellow, while 383 vacancies/positions are intended for improvement AP in RDI and 97 in US. The vacancies/positions categorized as Fellow, which are the most numerous, are heavily concentrated in the Southeast region - approximately half of them are available in the state of São Paulo. The remaining RDI and US1 improvement AP vacancies/positions are equally concentrated in the Southeast, and are practically nonexistent in the Northern region.

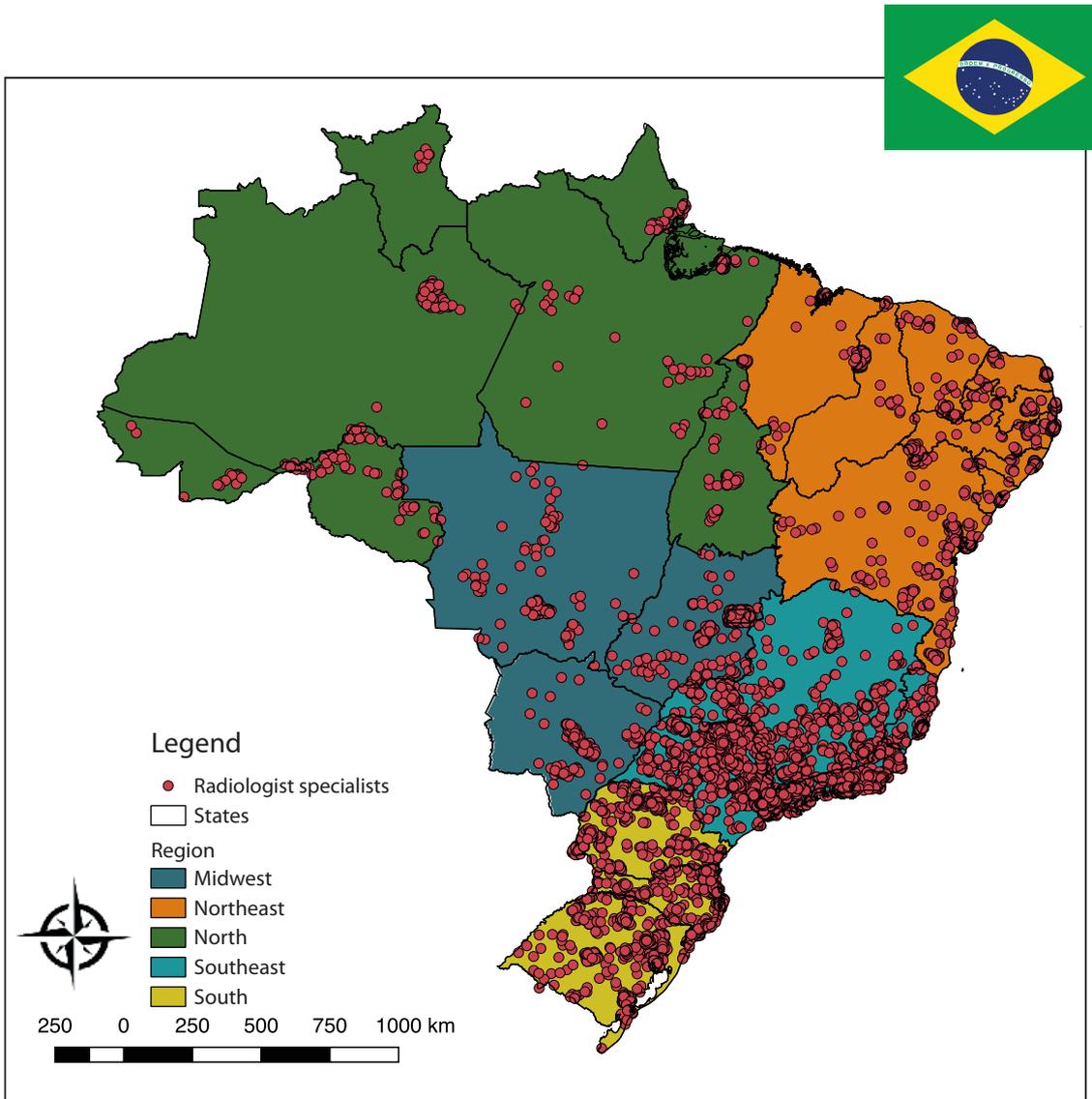
Atlas of Federation Units

The following Atlas provides maps and information on the distribution of radiologists in Brazil. In the maps, each physician is represented by a random point within the municipality of the professional's domicile.

For each Federation Unit, the number of physicians according to gender, age and specialization in Radiology and Diagnostic Imaging (RDI), General Ultrasonography (USG) and Interventional Radiology and Angioradiology (RIAR) is presented, as well as the areas of expertise or subspecialties.

There are also data from the specialists in the state capitals, the ratio of radiologists per 100,000 inhabitants, the distribution of Medical Residency vacancies positions and improvement programs.

It is noteworthy that, by methodological choice, radiologists registered in more than one CRM (the so-called secondary enrollment) are counted in each state where they keep their medical record active. Other titles of specialists held by radiologists are also listed in the Atlas.



Note: each physician is represented by a random point in their municipality of residence.

SPECIALTY INDEX

In Brazil	
Number of specialists	12,868 ¹ 14,217 ²
Population	208,494,900
% in relation to Brazil	100.0%
Density 100,000 / inhabitants	6.17 ¹ 6.82 ²
Male	8,030 (62.4%)
Female	4,838 (37.6%)
Male / female ratio	1.66

Age Number (%)	
≤ 29 years	552 (4.3%)
30 – 34 years	2,232 (17.3%)
35 – 39 years	2,355 (18.3%)
40 – 44 years	1,770 (13.8%)
45 – 49 years	1,530 (8.9%)
50 – 54 years	1,282 (10.0%)
55 – 59 years	973 (7.6%)
60 – 64 years	833 (6.5%)
65 to 69 years	753 (5.9%)
≤ 70 years	588 (4.6%)

Number of Titles (density 100,000/inhabitants)	
Radiology and Diagnostic Imaging	10,327 (4.95)
General Ultrasound	3,598 (1.72)
Interventional Radiology and Angioradiology	273 (0.13)

Number of Areas of expertise (density 100,000/inhabitants)	
Bone Densitometry	225 (0.10)
Vascular Doppler Ultrasound	82 (0.03)
Mammography	130 (0.06)
Neuroradiology	216 (0.10)
Ultrasonography in GO	220 (0.10)

Number of formation and training	
Medical residency	
Programs	151
Filled vacanciespositions	1,393
R1	601
R2	424
R3	368
AP (“aperfeiçoandos”)Improvement	
Institutions	183
VacanciesPositions	1,037
Radiology and Diagnostic Imaging	383
General Ultrasonography	97
Fellow	557

¹Considering the primary records;

²Considering the total records.

Other specialties	Number
Acupuncture	32
Allergy and Immunology	2
Anesthesiology	101
Angiology	123
Cardiology	25
Cardiovascular surgery	48
Hand Surgery	3
Head and Neck Surgery	3
Digestive System Surgery	12
General Surgery	330
Oncologic Surgery	2
Pediatric Surgery	3
Plastic surgery	3
Thoracic Surgery	1
Vascular surgery	125
Medical Clinic	350
Coloproctology	5
Dermatology	12
Endocrinology and Metabology	9
Endoscopy	10
Gastroenterology	19
Medical Genetics	2
Geriatrics	4
Gynecology and Obstetrics	813
Hematology and Hemotherapy	2
Homeopathy	9
Infectiology	4
Mastology	16
Emergency Medicine	0
Family and Community Medicine	36
Labor Medicine	119
Traffic Medicine	60
Sportive Medicine	8
Physical Medicine and Rehabilitation	2
Intensive Care Medicine	16
Forensic Medicine and Medical Expertise	17
Nuclear Medicine	124
Preventive and Social Medicine	21
Nephrology	10
Neurosurgery	14
Neurology	118
Nutrology	16
Ophthalmology	9
Clinical oncology	9
Orthopedics and Traumatology	151
Otorhinolaryngology	7
Pathology	19
Clinical Pathology / Laboratory Medicine	4
Pediatric	174
Pneumology	10
Psychiatry	14
Radiotherapy	25
Rheumatology	6
Urology	17



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