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Professional education in radiology: Potential positions for graduates in Rio de Janeiro resonance services linked to the Unified Health System

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ABSTRACT

Nuclear magnetic resonance (NMR) is an advanced technology for medical diagnosis, allowing the non-invasive study of internal organs using magnetic fields. The main components of MRI equipment include the main magnet, gradient coils, radiofrequency coils, computer and image processing. This equipment is fundamental for diagnostic imaging and it is essential to know its territorial distribution in order to benefit the population and guide future radiology professionals. The study analyzed the distribution of MRI equipment operating in the state of Rio de Janeiro, especially those affiliated with the SUS, in order to identify job opportunities for graduates of professional radiology courses.

Keywords: Magnetic resonance imaging, Diagnostic imaging, Radiology.

INTRODUCTION

With the advancement of medical technology, equipment is used that makes it possible to study organs and systems in a non-invasive way. One of these pieces of equipment is nuclear magnetic resonance, or simply NMR (HAGE; IWASAKI, 2009).

NMR is a diagnostic method that creates high-resolution images to study internal organs through the use of a magnetic field (OTADUY; LEITE, 2024). The main components of an NMR equipment are: main magnet, gradient coils, radiofrequency coils, computer, and image processing (POSSES, 2024).

MRI equipment is of paramount importance in diagnostic imaging. Thus, knowing its territorial distribution is of great value not only for the population that benefits from this service, but also for students of professional education in radiology and their graduates, as it is a guide for potential future opportunities in the world of work.

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OBJECTIVE

The objective of this study was to analyze the distribution of magnetic resonance imaging equipment operating in the state of Rio de Janeiro, identifying those associated with the Unified Health System (SUS), with a view to understanding potential future jobs for graduates of professional education in radiology.

METHODOLOGY

The method used in the study was descriptive research, which involved the collection of information at a quantitative level.

At first, a survey was carried out on the CNES website until mid-June 2024, regarding Magnetic Resonance Imaging diagnostic equipment in the state of Rio de Janeiro, as shown in figures 1 and 2:

Figure 1: CNES page with MRI equipment in Rio de Janeiro.

Ministério da Saúde

CNESNet
Secretaria de Atenção à Saúde
DATASUS

Cadastro Nacional de Estabelecimentos de Saúde

Home | Institucional | Serviços | Relatórios | Consultas

Indicadores - Equipamentos
Estado - RJ
Tipo Equipamento - Equipamentos de Diagnostico por Imagem - Ressonancia Magnetica

CNES	Estabelecimento	Município	Existentes	em Uso	SUS
7973306	ALTA BARRA SHOPPING	RIO DE JANEIRO	1	1	N
9304061	ALTA LEBLON DIAGNOSTICOS	RIO DE JANEIRO	1	1	N
9119957	AMBULATORIO SAO LUIZ GONZAGA	RIO DE JANEIRO	1	1	N
7557817	ANATO SCAN CENTER DIAGNOSTICOS POR IMAGEM	RIO DE JANEIRO	1	1	N
5159636	ASSOCIACAO DE APOIO A TERCEIRA IDADE CENTRO	RIO DE JANEIRO	2	2	N
5329167	ASSOCIACAO DE APOIO A TERCEIRA IDADE TIJUCA 1	RIO DE JANEIRO	2	2	N
5160375	BRONSTEIN MED DIAG VILA VALQUEIRE	RIO DE JANEIRO	1	1	N
3383067	BRONSTEIN MEGA COPACABANA	RIO DE JANEIRO	1	1	N
6987516	BRONSTEIN POLO I	RIO DE JANEIRO	1	1	N
9309160	BRONSTEIN SHOPPING BANGU	RIO DE JANEIRO	1	1	N
2282291	CAMIL	BOM JESUS DO ITABAPOANA	1	1	N
3113205	CASA DE PORTUGAL	RIO DE JANEIRO	1	1	N
3019527	CASA DE SAUDE NOSSA SENHORA DE FATIMA N IGUACU S A	NOVA IGUACU	1	1	N
9305289	CASA DE SAUDE SANTA THEREZINHA S A	RIO DE JANEIRO	1	1	N
2271443	CASA DE SAUDE SAO JOSE	RIO DE JANEIRO	1	1	N
7222645	CDPI CLINICA DE DIAGNOSTICO POR IMAGEM TIJUCA	RIO DE JANEIRO	1	1	N
6292631	CDT SCAN	TERESOPOLIS	1	1	S
3274365	CEDI	MACAE	1	1	N
3274373	CEDI CENTRO DE DIAGNOSTICO	MACAE	1	1	N
3274381	CEDI CENTRO DE DIAGNOSTICOS	MACAE	1	1	N
6265944	CEDIMAGEM	RESENDE	1	1	N
7069499	CEDIMAGEM RIO	RIO DE JANEIRO	1	1	N
5483549	CENTRO CARDIODIAGNOSTICO DE MACAE	MACAE	1	1	N
3179397	CENTRO DA IMAGEM	CABO FRIO	2	2	S
9246975	CENTRO DE DIAGNOSTICO AVANCADO	BELFORD ROXO	1	1	S

Source: CNES, 2024.

Figure 2: Data of the establishment that has MRI machines in Rio de Janeiro.

Estabelecimento de Saúde

Identificação

CADASTRADO NO CNES EM: 11/10/2021 ULTIMA ATUALIZAÇÃO EM: 31/5/2024 DATA DE ATUALIZAÇÃO LOCAL: 26/4/2024

Veja onde se localiza: | Exibir Ficha Reduzida por Competência | Exibir Ficha Reduzida Atual

Nome:			CNES:	CNPJ:
ALENA BARRA			0909319	38299625000179
Nome Empresarial:			**CPF:**	**Personalidade:**
ALENA SERVICOS MEDICOS E MEDICINA DIAGNOSTICA LTDA			--	JURÍDICA
Logradouro:			**Número:**	**Telefone:**
AV DAS AMERICAS			13685	2198798265
Complemento:	**Bairro:**	**CEP:**	**Município:**	**UF:**
LOJA B1 B2	BARRA DA TIJUCA	22790701	RIO DE JANEIRO - IBGE - 330455	RJ
Tipo Estabelecimento:	**Sub Tipo Estabelecimento:**	**Gestão:**		**Dependência:**
CLINICA/CENTRO DE ESPECIALIDADE	OUTROS	MUNICIPAL		INDIVIDUAL
Número Alvará:	**Órgão Expedidor:**		**Data Expedição:**	
09/97/051168/2023	SMS		01/05/2023	
Horário de Funcionamento:				
Sempre aberto				

Módulos:

Básico	Conjunto	Ambulatorial	Hospitalar	Mantenedora	Profissionais
Habilitações	Regras Contratuais	Contrato de Gestão	Incentivos	Equipes	Residência Terapeutica
Telessaúde	Org. Parceiras	Ger/Adm (Terceiro)			

Source: CNES, 2024.

Secondly, a spreadsheet was prepared with the following directions: establishment, business name, neighborhood, municipality, state, management of the establishment (municipal or state), existing and in-use equipment, and whether they are in operation in the SUS, as shown in figure 3:

Figure 3: Illustration of the spreadsheet with all the RM equipment installed in RJ.

CnesNet - Cadastramento Nacional de Estabelecimentos de Saúde

Ressonância Magnética

Estabelecimento	Nome empresarial	Bairro	Município	UF	ão do estabelecim	ipamentos existe	ipamentos em (	SUS
ALTA BARRA SHOPPING	DIAGNOSTICOS DA AMERICA S A	BARRA DA TIJUCA	RIO DE JANEIRO	RJ	Municipal	1	1	N
ALTA LEBLON DIAGNOSTICOS	DIAGNOSTICOS DA AMERICA S A	LEBLON	RIO DE JANEIRO	RJ	Municipal	1	1	N
AMBULATORIO SAO LUIZ GONZAGA	IACAO DOS ANTIGOS ALUNOS DOS PADRES JESU	BOTAFOGO	RIO DE JANEIRO	RJ	Municipal	1	1	N
ANATO SCAN CENTER DIAGNOSTICOS POR IMAGEM	SCAN CENTER DIAGNOSTICOS POR IMAGEM LT	TIJUCA	RIO DE JANEIRO	RJ	Municipal	1	1	N
ASSOCIACAO DE APOIO A TERCEIRA IDADE CENTRO	ASSOCIACAO DE APOIO A TERCEIRA IDAD	CENTRO	RIO DE JANEIRO	RJ	Municipal	2	2	N
ASSOCIACAO DE APOIO A TERCEIRA IDADE TIJUCA 1	ASSOCIACAO DE APOIO A TERCEIRA IDADE	TIJUCA	RIO DE JANEIRO	RJ	Municipal	2	2	N
BRONSTEIN MED DIAG VILA VALQUEIRE	DIAGNOSTICOS DA AMERICA S A	VILA VALQUEIRE	RIO DE JANEIRO	RJ	Municipal	1	1	N
BRONSTEIN MEGA COPACABANA	DIAGNOSTICOS DA AMERICA S A	COPACOBANA	RIO DE JANEIRO	RJ	Municipal	1	1	N
BRONSTEIN POLO I	DIAGNOSTICOS DA AMERICA S A	MADUREIRA	RIO DE JANEIRO	RJ	Municipal	1	1	N
BRONSTEIN SHOPPING BANGU	DIAGNOSTICOS DA AMERICA S A	BANGU	RIO DE JANEIRO	RJ	Municipal	1	1	N
CAMIL	DIAGNOSTICOS DA AMERICA S A	CENTRO	OM JESUS DO ITABAPOAN	RJ	Municipal	1	1	N
CASA DE PORTUGAL	CASA DE PORUGAL	RIO COMPRIDO	RIO DE JANEIRO	RJ	Municipal	1	1	N
A DE SAUDE NOSSA SENHORA DE FATIMA N IGUACU	UDE E MAT NOSSA SENHORA DE FATIMA DE NO	CENTRO	NOVA IGUACU	RJ	Municipal	1	1	N
CASA DE SAUDE SANTA THEREZINHA S A	CASA DE SAUDE SANTA THEREZINHA S A	TIJUCA	RIO DE JANEIRO	RJ	Municipal	1	1	N
CASA DE SAUDE SAO JOSE	SSOCIACAO CONGREGACAO DE SANTA CATARIN	HUMAITA	RIO DE JANEIRO	RJ	Municipal	1	1	N
DPI CLINICA DE DIAGNOSTICO POR IMAGEM TIJUC	DPI CLINICA DE DIAGNOSTICO POR IMAGEM LTD	TIJUCA	RIO DE JANEIRO	RJ	Municipal	1	1	N
CDT SCAN	CENTRO DIAGNOSTICO E TERAPEUTICO S S LTDA	VALE PAREISO	TERESOPOLIS	RJ	Municipal	1	1	S
CEDI	ULTRA SOM MEDICO MACAE LTDA	CENTRO	MACAE	RJ	Municipal	1	1	N
CEDI CENTRO DE DIAGNOSTICO	TOMOGRAFIA MACAE LTDA	CENTRO	MACAE	RJ	Municipal	1	1	N
CEDI CENTRO DE DIAGNOSTICOS	EXAMES RADIOLOGICOS IRMAOS ALEXANDRE LTDA	CENTRO	MACAE	RJ	Municipal	1	1	N
CEDIMAGEM	RM DIAGNOSTICO POR IMAGEM LTDA	CENTRO	RESENDE	RJ	Municipal	1	1	N
CEDIMAGEM RIO	EDIMAGEM RIO DIAGNOSTICO POR IMAGEM LTD	BOTAFOGO	RIO DE JANEIRO	RJ	Municipal	1	1	N
CENTRO CARDIODIAGNOSTICO DE MACAE	RADIOLAB CARDIOLOGIA E LABORATORIO LTDA	CENTRO	MACAE	RJ	Municipal	1	1	N

Source: Author's collection, 2024.

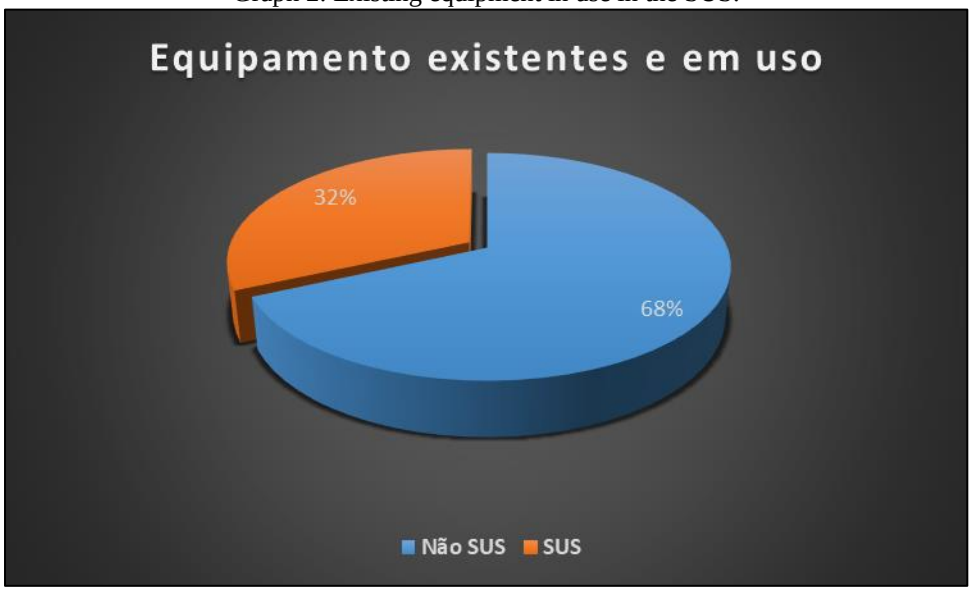
RESULTS

After fragmenting the data collected, providing the quantity of MRI equipment, it was found that there are 425 devices in the entire state of RJ, among these, 406 are operational and 19 are not in operation, shown in graph 1:

Graph 1: Total MRI equipment in the state of Rio de Janeiro.

Among the MRI machines that are in operation, it was divided by those linked to the SUS, thus showing that only 32% are linked to the SUS, as shown in graph 2:

Graph 2: Existing equipment in use in the SUS.



As shown in table 1, the distribution of the 406 devices that are in use in the municipalities of the state of Rio de Janeiro and of the 32% that are linked to the SUS was as follows: Rio de Janeiro (195 devices in use, 39 by the SUS); Niterói (25 pieces of equipment in use, 3 by SUS); Nova Iguaçu (14 pieces of equipment in use, 8 by SUS); Campos dos Goytacazes (14 pieces of equipment in use, 5 by SUS); São Gonçalo (13 pieces of equipment in use, 4 by SUS); Duque de Caxias (11 pieces of equipment in use, 5 by SUS); Cabo Frio (9 pieces of equipment in use, 5 by SUS); Macaé (9 pieces of equipment in

use, none by SUS); Volta Redonda (9 pieces of equipment in use, 3 by SUS); Barra Mansa and Nova Friburgo (8 pieces of equipment in use, 7 by SUS); São João de Meriti and Itaguaí (6 pieces of equipment in use, none by SUS); Petrópolis (6 equipment in use; 2 by SUS); Magé (5 pieces of equipment in use, 3 by SUS); Teresópolis (5 pieces of equipment in use, 4 by SUS); Itaperuna (5 pieces of equipment in use, none by SUS); Itaboraí (5 equipment in use, 2 by SUS); Angra dos Reis and Três Rios (4 pieces of equipment in use; 2 by SUS); Saquarema (4 pieces of equipment in use, 1 by SUS); Rio da Ostras (4 pieces of equipment in use, none by SUS); Nilópolis (4 pieces of equipment in use, 3 by SUS); Resende and Araruama (3 pieces of equipment in use, 2 by SUS); Belford Roxo (3 pieces of equipment in use, 3 by SUS); Bom Jesus do Itabapoana, Rio Bonito, Queimados, Barra do Piraí, Maricá and Itaocara (2 pieces of equipment in use, 1 by SUS); Guapimirim (2 equipment in use; 2 by SUS); Carapebus, Cachoeiras de Macacu, Mesquita, Rio Claro, Paty do Alferes and Cordeiro (1 equipment. 1 by SUS); São Pedro da Aldeia, Paracambi; São Fidelis and Santo Antônio de Pádua (1 equipment, none by SUS).

Table 1: Distribution of equipment that is in use and linked to the SUS by municipalities in the state of Rio de Janeiro.

Municipality	**Equip. in Use**	**SUS in use**
RIO DE JANEIRO	206	195
NITEROI	27	25
SAO GONCALO	15	13
NOVA IGUACU	14	14
CAMPOS DOS GOYTACAZES	14	14
DUQUE DE CAXIAS	12	11
MACAE	9	9
CABO FRIO	9	9
VOLTA REDONDA	9	9
BARRA MANSA	8	8
NOVA FRIBURGO	8	8
SAO JOAO DE MERITI	6	6
ITAGUAI	6	6
PETROPOLIS	6	6
TERESOPOLIS	5	5
RIO DAS OSTRAS	5	4
ITABORAI	5	5
MAGE	5	5
ITAPERUNA	5	5
NILOPOLIS	4	4
ANGRA DOS REIS	4	4
ARARUAMA	4	3
SAQUAREMA	4	4
TRES RIOS	4	4
RESENDE	3	3
RIO BONITO	3	2
BELFORD ROXO	3	3
BOM JESUS DO ITABAPOANA	2	2
BARRA DO PIRAI	2	2
QUEIMADOS	2	2
MARICA	2	2
ITAOCARA	2	2

GUAPIMIRIM	2	2
PARACAMBI	1	1
SAO FIDELIS	1	1
PATY DO ALFERES	1	1
CACHOEIRAS DE MACACU	1	1
RIO CLARO	1	1
SANTO ANTONIO DE PADUA	1	1
SAO PEDRO DA ALDEIA	1	1
MESQUITA	1	1
CORDEIRO	1	1
CARAPEBUS	1	1
TOTAL	**425**	**406**

FINAL CONSIDERATIONS

It is hoped that this document can facilitate the preparation of the article by the authors, as well as the review of the reviewers. (Demonstrate whether the proposed objectives have been achieved, and the final considerations of your research).

According to the results obtained, it was possible to quantify the MRI equipment in the state of Rio de Janeiro, with a total of 425 existing equipment, of which 406 are operational and 19 are inoperative. And that only 32% of the operating services are contracted to the SUS.

Of these equipments, 80% are concentrated in: **Rio de Janeiro (195), Niterói (25), Campos dos Goytacazes (15), São Gonçalo (10), Duque de Caxias (10), Nova Iguaçu (9), Volta Redonda (9), Cabo Frio (7), Macaé (6) and Angra dos Reis (5).**

Considering only those linked to the SUS, 78% are located in **Rio de Janeiro (39), Nova Iguaçu (7), Volta Redonda (5), Campos dos Goytacazes (4), São Gonçalo (4), Belford Roxo (4), Duque de Caxias (3), Cabo Frio (3), Nova Friburgo (3), Barra Mansa (3) and Itaboraí (3).**

It is worth mentioning that according to the Brazilian Institute of Geography and Statistics (IBGE) there are currently 92 municipalities in the state of RJ. Through the present research, it is noted that 57 municipalities do not have MR equipment, these are: **Aperibé, Areal, Armação dos Búzios, Arraial do Cabo, Bom Jardim, Cambuci, Cantagalo, Carapebus, Cardoso Moreira, Carmo, Casimiro de Abreu, Comendador Levy Gasparian, Conceição de Macabu, Duas Barras, Engenheiro Paulo de Frontin, Iguaba Grande, Italva, Itatiaia, Japeri, Laje do Muriaé, Macuco, Mangaratiba, Maricá, Mendes, Mesquita, Miguel Pereira, Miracema, Natividade, Paracambi, Paraíba do Sul, Paraty, Paty do Alferes, Pinheiral, Piraí, Porciúncula, Porto Real, Quatis, Quissamã, Rio Claro, Rio das Flores, Santa Maria Madalena, São Fidélis, São Francisco de Itabapoana, São João da Barra, São José de Ubá, São José do Vale do Rio Preto, São Pedro da Aldeia, São Sebastião do Alto, Sapucaia, Seropédica, Silva Jardim, Sumidouro, Tanguá, Trajano de Moraes, Valença, Varre-Sai and Vassouras.** The population of these municipalities totals approximately 1.9 million inhabitants who do not

have MR equipment, whether linked to the SUS or not, and it is necessary to travel to the nearest municipality.

One of the palliative solutions would be for the government to make mobile MRI equipment available circulating in cities that do not have service, mainly to serve the low-income population that cannot afford to pay for such an exam, since it costs in the range of R$ 850.00 depending on the part of the body to be studied.

It is hoped that the information expressed in this work can be useful and useful for users, students and professionals in the area, since, with knowledge about the distribution of such devices, it is possible to map opportunities not only for use, but also for the possibility of professional performance.

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