2024 International Nuclear Atlantic Conference – INAC 2024
Escola de Guerra Naval, Rio de Janeiro, RJ, May 6 - 10, 2024

ISBN: 978-65-594-1256-3

Computed Tomography: Current Brazilian Scenario

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1. Introduction

In recent years, computed tomography (CT) has become increasingly important in diagnostic radiology worldwide. The introduction of dual-energy CT and photon-counting computed tomography (PCCT) in clinical use has further expanded diagnostic possibilities with improved image quality without increasing patient dose (1). Iterative algorithms and deep learning reconstructions also enhance image quality by reducing noise (2, 7). Efforts to optimize CT procedures are still necessary, as per findings by UNSCEAR 2020. Despite accounting for only 10% of all examinations, CT scans contribute the highest percentage (62.6%) to the overall collective dose. The estimated annual number of CT scans is about 400 million, with an 80% increase in frequency and a 70% increase in collective dose (3).

Currently, Brazil has not established diagnostic reference levels. The limited number of studies conducted in the country does not accurately reflect the situation. Organization websites such as the Unique Public Health System (DATASUS), the National Register of Health Establishments (CNES), and the National Supplementary Health Agency (a private health system) provide official information about CT procedures, including updated data on the number of CT equipment available and the annual number of procedures performed (4).

It is evident from the distribution of CT equipment and population percentages in each region that this imaging modality is concentrated primarily in the Midwest and Southern regions region. The publication of GM/MS ordinance law no.1631/GM on October 1, 2015, established that at least one CT scanner should be available in the public healthcare system for every 100,000 inhabitants or 75 kilometers (5).

According to UNSCEAR 2020, developed countries have a quarter of the world's population and have, on average, 1,332 CT for 1000 inhabitants. Underdeveloped and developing countries have the most significant part of the population, 27% and 49%, respectively. The CTs performed in the first were 20 procedures per 1000 inhabitants and the latter 332, showing the disparity caused by the lack of resources (3, 9).

According to the data from OECD reports, Brazil lags in healthcare investment compared to other countries in US dollars per capita. Being suppressed by countries like Argentina, the United States, and Turkey as of the last report. The high frequency of CT procedures requires implementing patient dose assessment and optimization programs (9, 10). This article uses the national health system database to evaluate the distribution of CT scanners and the frequency of CT procedures in Brazil from 2016 to 2020.

2. Methodology

2.1 Data Collection: For the present study, the data was obtained on the following official websites: *Instituto Brasileiro de Geografia e Estatística* – IBGE (Brazilian Institute of Geography and Statistics), Department of Informatics of the SUS (DATASUS), National Register of Health Establishments (CNES) and by the Ambulatory Information System of the SUS (SIASUS).

a) **IBGE:** This database supplies federal, state, and municipal government bodies, institutions, and the public with geoscience and socioeconomic statistics.

b) **DATASUS:** The website objectively analyses healthcare situations, evidence-based decision-making, and public health action programs. In addition, there are available data on access to services, quality of care, health care for the population, hospital and ambulatory department network records, and demographic and socioeconomic information. A preview of the demographic census conducted by the IBGE in 2022 is available on the institute's website.

c) **CNES:** The CNES comprises the data of health facilities in terms of physical area, human resources, equipment, professionals, ambulatory department, and hospital services. It constitutes an essential tool for health planning, regulation, evaluation, control, teaching, and research.

d) **Data Analysis:** Statistical analysis shows the growth rates of CT scanners/population and procedure frequency, the equipment's geographical distribution, and the impact on the number of CT procedures in each region. Furthermore, it permits a comparison of the published in the latest UNSCEAR report and OECD database.

3. Results and Discussion

Distribution of CT scanners in Brazilian regions

As of December 2022, 6,473 CT scanners were available in Brazilian healthcare facilities. From 2016 to 2022, the CT scanner growth rate was approximately 55%, with an annual average of 7.62%. The highest growth rate was in 2022. The SUS saw a 55% increase in CT scanner installations (Figure 1).

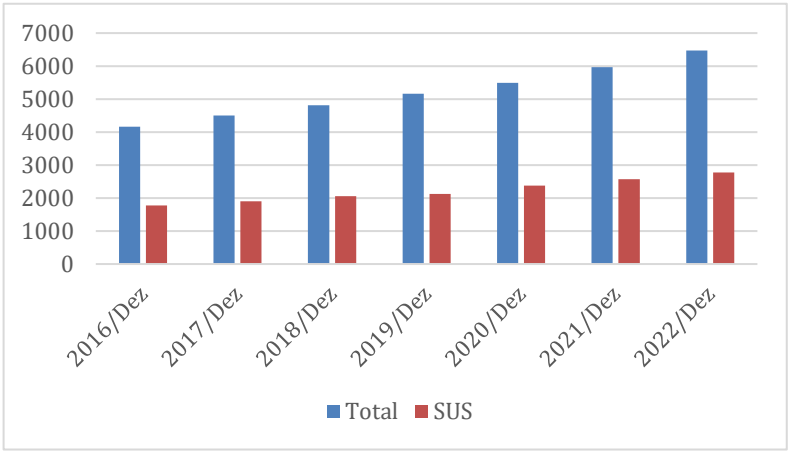

Figure 1: National CT scanners grew between 2016 and 2022 in all healthcare providers and SUS

The southeast region has 45.8% of the CT scanners, while the northern has 6.73% (Figure 2). According to DATASUS, only 19% of municipalities have at least one CT scanner. In the period evaluated, the Midwest Region had the highest growth rate (85%). The annual growth rates in the North, Northeast,

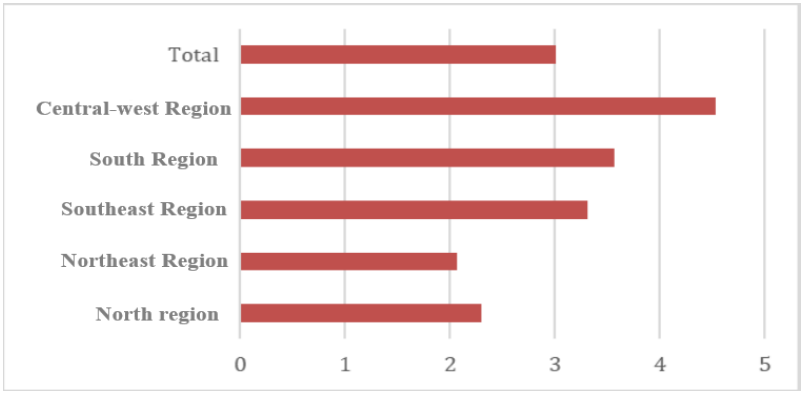

Figure 2: Number of CT scanners per 100,000 inhabitants in the different regions of Brazil.

Southeast, South, and Midwest regions were 10%, 8.28%, 6.69%, 6.64%, and 10.8 %, respectively. On average, the national territory has three scanners per 100,000 inhabitants. However, the North and Northeast have lower rates, and all regions have the minimum scanners required (Figure 2).

Between January 2016 and December 2022, more than 45 million CT procedures were performed, and there was a 50.8% increase in scans during the studied period. Comparing all medical imaging diagnostic procedures performed in Brazil, computed tomography exams in the ambulatory system corresponded to 0.62% (SIASUS).
The number of procedures per 1000 inhabitants grew 89%, and an annual growth rate of 11.19%. The most significant growth occurred between 2020 to 2021 (Figure 3). Observing annual growth rates of CT procedures; the Midwest region had the highest rate (17%), and the Southeast region had the lowest annual growth (10%). Brazil's national territory had an 11.19% annual growth rate. CT scans corresponded to 0.61% of all imaging diagnostic procedures in the studied period.

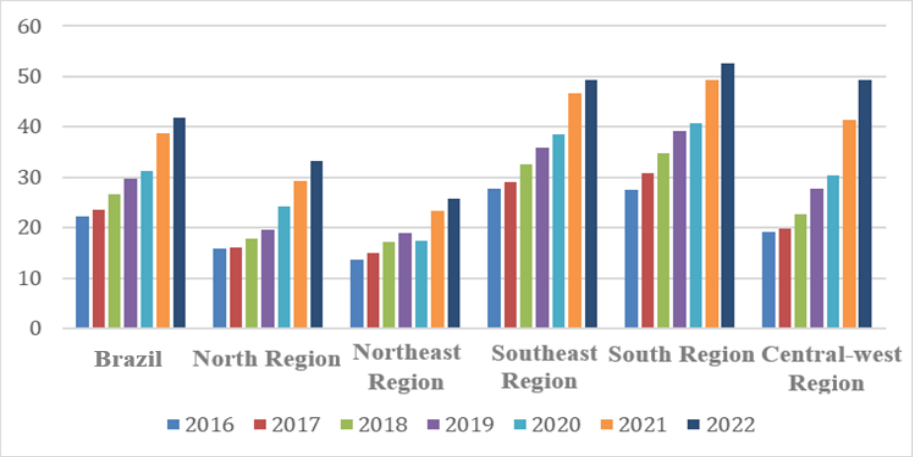

Figure 3: Number of CT exams per 1000 inhabitants from 2016 to 2022.

Based on OECD and UNSCEAR data, Brazil has fewer CT scanners per 1 million inhabitants than Australia, the United States, and South Korea. In the period of this study, the frequency of CT procedures per 1000 population increased in Brazil (89%), and several countries. Fast growth in CT procedures is concerning, which requires monitoring patient doses due to the potential for high patient doses, which could pose a potential health risk. It also compared the population-weighted examinations per 1000 population between Brazil's UNSCEAR numbers, 51, and against DATASUS which is approximately 42.

4. Conclusions

Recent data shows that in Brazil, there has been a significant increase in the number of CT scans performed in the past few years, both in absolute numbers and in frequency relative to the country and region's population. However, there is still an uneven distribution of access to this technology across the country, leading to unequal quality of healthcare services.

Acknowledgments

The authors thank the financial support of *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* (CAPES).

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