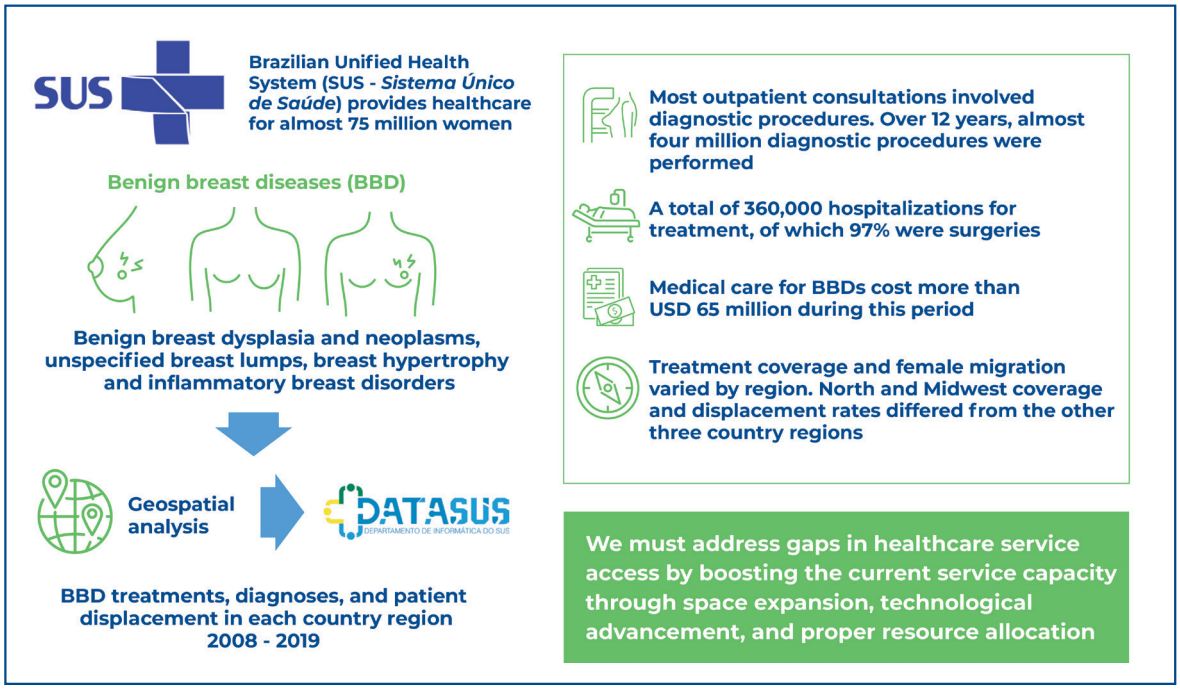
einstein
Official Publication of the Instituto Israelita de Ensino e Pesquisa Albert Einstein

ORIGINAL ARTICLE

Brazil's benign breast disease care profile and geospatial analysis



Authors

Dayan Sansone, Daniela Farah, Afonso Celso Pinto Nazario, Marcelo Cunio Machado Fonseca

Correspondence

E-mail: mcmf1964@gmail.com

DOI

DOI: 10.31744/einstein_journal/2025AO1132

In Brief

We conducted a quantitative and geospatial analysis of coverage and displacement for the diagnosis and treatment of benign breast illnesses in Brazil's Unified Health System between 2008 and 2019. The results showed that treatment coverage and female displacement differed by region. The North and Midwest have different coverage and displacement rates compared with the other three major regions of the country. These findings demonstrate the importance of addressing gaps in healthcare service access, irrespective of their source, by enhancing the service capacity of existing institutions and ensuring that the healthcare system appropriately allocates resources.

Highlights

- Most outpatient consultations comprised diagnostic procedures.
- In the past 12 years, medical care for benign breast diseases has cost >USD 65 million.
- Women from North and Midwest Brazil had higher diagnosis and treatment displacement rates.

How to cite this article:

Sansone D, Farah D, Nazario AC, Fonseca MC. Brazil's benign breast disease care profile and geospatial analysis. einstein (São Paulo). 2025;23:eAO1132.

einstein
Official Publication of the Instituto Israelita de Ensino e Pesquisa Albert Einstein

e-ISSN: 2317-6385

ORIGINAL ARTICLE

Brazil's benign breast disease care profile and geospatial analysis

Dayan Sansone[1,2], Daniela Farah[2], Afonso Celso Pinto Nazario[1], Marcelo Cunio Machado Fonseca[1,2]

[1] Department of Gynecology, Universidade Federal de São Paulo, São Paulo, SP, Brazil.
[2] Department of Gynecology, Health Technologies Assessment Center, Universidade Federal de São Paulo, São Paulo, SP, Brazil.

DOI: 10.31744/einstein_journal/2025AO1132

ABSTRACT

Objective: To quantitatively and geospatially analyze coverage and displacement for the diagnosis and treatment of benign breast diseases in the Brazilian Unified Health System between 2008 and 2019. **Methods:** Datasets from the Brazilian Ministry of Health were used to survey medical care for benign breast diseases in Brazil from 2008 to 2019. These data allowed for the determination of benign breast disease treatments, diagnoses, and patient displacement in each region of the country. **Results:** Most outpatient consultations were for diagnostic procedures. Approximately 4 million diagnostic procedures and 360,000 hospitalizations for treatment, of which 97% were surgeries, were conducted in this 12-year period. During this period, medical care for benign breast diseases cost more than USD 65 million. The treatment coverage and displacement rates of the female population differed by country region, with the North and Midwest showing patterns different from those of the other three major regions. **Conclusion:** Addressing disparities in healthcare service access, regardless of their source, by increasing the service capacity of existing facilities and ensuring correct resource allocation by the healthcare system is crucial.

Keywords: Breast diseases; Breast neoplasms; Incidence; Strategy planning; Hospitalization; Demography; Epidemiology; Public health; Unified Health System; Primary healthcare; Healthcare costs; Health expenditures; Brazil

INTRODUCTION

Universal healthcare systems, such as the Brazilian Unified Health System (SUS - *Sistema Único de Saúde*), face ongoing issues in countries of continental proportions and significant social and geographical inequities. Decentralization is a critical component in the implementation of SUS logistics. Primary care, supported by decentralization, ensures universal access to a wide range of services, including coordination for more complex treatments such as medical hospital care. Dealing with the increasing demand amidst rapid and frequent technological developments is challenging for a robust public healthcare system such as SUS.[1]

Although population aging and lifestyle changes further affect female nonreproductive health, healthcare systems, particularly in developing countries, are ill-prepared to cope with this "new" concern.[2,3] This concern is particularly relevant for Brazil because according to the Brazilian Institute of Geography and Statistics (IBGE - *Instituto Brasileiro de Geografia e Estatística*) 2010 Census, the country has 98 million women[4] and only 25% receive any form of supplementary healthcare, leaving nearly 75 million women reliant solely on the SUS.[5]

How to cite this article:
Sansone D, Farah D, Nazario AC, Fonseca MC. Brazil's benign breast disease care profile and geospatial analysis. einstein (São Paulo). 2025;23:eAO1132.

Associate Editor:
Julio Cesar Rosa e Silva
Faculdade de Medicina de Ribeirão Preto, Universidade de São Paulo, Ribeirão Preto, SP, Brazil
ORCID: https://orcid.org/0000-0001-6930-1328

Corresponding author:
Marcelo Cunio Machado Fonseca
Rua Napoleão de Barros, 632 - Vila Clementino
Zip code: 04024-002 - São Paulo, SP, Brazil
Phone: (55 11) 98422-8329
E-mail: mcmf1964@gmail.com

Received on:
Mar 27, 2024

Accepted on:
Sep 18, 2024

Conflict of interest:
none.

Benign breast diseases (BBDs) encompass several diagnoses, including fibroadenomas, cysts, fibrocystic disorders, papillomas, and ductal epithelial proliferation.[6-8] The conditions deemed as BBDs by the International Classification of Diseases (ICD)-10[9] include benign breast dysplasia (N60), inflammatory breast disorders (N61), breast hypertrophy (N62), unspecified breast lumps (N63), other breast diseases (N64), benign neoplasms (D24), and breast neoplasms with uncertain or unknown behavior (D48.6).

Benign breast diseases are common and can potentially increase the risk of developing breast cancer.[6,10] Some studies have reported a 4- to 5-fold higher risk in patients with BBDs and atypia and a 1.5-2-fold greater risk in those without atypia.[11] However, determining the prevalence and incidence of BBDs is challenging because these conditions receive little clinical attention,[12] and the lack of a standardized histological classification system hinders diagnosis.[6] The cumulative incidence of biopsy-proven BBDs ranges from 10 to 20%.[13]

Spatial epidemiology, which combines geography and public health, uses geospatial analytical tools to answer disease-related questions. It provides a valuable tool for strategic planning in public administration[14] by contextualizing health events, aiding the understanding of the socio-environmental processes involved in their occurrence, and assisting in overcoming the significant challenge of adapting service demand to supply. Therefore, this study was a quantitative, descriptive, and exploratory analysis of BBD care in the SUS from 2008 to 2019. We considered the number, cost, and spatial distribution of procedures, hospitalizations, and patient migration for BBD diagnosis and treatment.

OBJECTIVE

This study aimed to analyze the management of benign breast diseases within the Brazilian Unified Health System, focusing on the number and geospatial distribution of procedures, costs, hospitalizations, and patient migration for benign breast disease diagnosis and treatment.

METHODS

All evaluated data are available in the Department of Informatics of the Brazilian Unified Health System (DATASUS - *Departamento de Informação e Informática do Sistema Único de Saúde*) databases.[15] The Hospital Information System (SIH - *Sistema de Informações Hospitalares*) supplied hospital data, and the Outpatient Information System (SIA) provided outpatient data. DATASUS data were downloaded in. dbf format using the file transfer protocol via FileZilla software and then connected to DATASUS at ftp://ftp.datasus.gov.br. Institutional Review Board approval was not required as this study used publicly available secondary data.

The study population included all women registered in these databases from 2008 to 2019 with any BBD described in the ICD-10, including benign breast dysplasia (N60), inflammatory breast disorders (N61), breast hypertrophy (N62), unspecified breast lumps (N63), other breast diseases (N64), benign neoplasms (D24), and breast neoplasms with uncertain or unknown behavior (D48.6). The expense values for outpatient procedures and admissions are presented in US dollars (USD). The conversion rate was calculated as the mean annual exchange rate (Table 1S, Supplementary Material).[16]

We constructed new tables from the DATASUS database using a Python application specifically designed to extract data from the .dbf files of DATASUS. We used IBGE mesoregions to create a spatial cutout grouping of multiple municipalities and divided Brazil into 137 territories[17] (Figure 1S, Supplementary Material).

We used R software (R Foundation for Statistical Computing, Vienna, Austria) to construct the displacement and migration graphics. Distances between municipalities were calculated using their centroids, and graphics were created using the 'circlize' package. All other calculations and analyses were performed in Microsoft Excel (Microsoft Corporation, Redmond, WA, USA). The *t*-test and Kruskal-Wallis and Dunn's *post-hoc* tests were used to analyze data. A p-value of 5% was used to determine differences in treatment coverage and migration between Brazilian regions.[18] The QGIS georeferencing tool was used to create maps, and population data were obtained from the IBGE 2010 census.[4]

RESULTS

Over 12 years of outpatient and inpatient care in the SUS, all six BBD-related ICD records were continuous. On average, 362,000 treatments were conducted annually in the outpatient setting, including 94.96% diagnostic procedures costing USD 5.42 million. Between 2008 and 2019, 4,349,877 BBD-related procedures were performed at a total cost of USD 65,029,686.11 (Table 2S, Supplementary Material).

The most commonly performed procedure was bilateral breast ultrasonography, with an average of 158,926.4 procedures annually at a cost of USD 1,669,811.58. Mammography was the second most common procedure, with an annual average of

73,755.80 procedures and an average yearly cost of USD 1,732,184.75. Notably, mammograms were conducted more often throughout the first 2 years of the study (569,019 in 2008 and 313,439 in 2009) (Figure 1A and Table 3S, Supplementary Material). A total of 138,038 clinical and surgical procedures were undertaken, accounting for 3.2% of the total costs. These procedures included dressing, drainage, sedation, and consultations.

Over 12 years of inpatient care, 363,112 hospitalizations were conducted at a total cost of USD 88,999,026.43 (Table 4S, Supplementary Material). Patients stayed in the hospital for an average of 1.69 days. Intensive care unit (ICU) admissions were necessary in only 847 hospitalizations, with an average stay of 2.93 days per admission. Most hospitalizations (96.78%) were surgical, mainly sectorectomies or quadrantectomies. More than 191,000 hospitalizations, costing USD 37 million, were conducted over the 12 years (Figure 1B and Table 5S, Supplementary Material). The second most common procedure was breast abscess drainage, which was performed almost 40,000 times over the 12 years.

Benign breast diseases accounted for 0.26% of all hospitalizations in the SUS over the 12 years, corresponding to 0.15% of all financial resources expended. These admissions cost only 0.09% of the total hospital ward bed payments and 0.004% of the ICU bed payments per day. BBDs used 0.08% of the resources for outpatient procedures, accounting for 0.01% of all procedures performed under the SUS (Table 6S, Supplementary Material).

The mean ages of outpatients (46.86 years) (Figure 2S, Supplementary Material) and hospitalized patients (38.57 years; Figure 3S, Supplementary Material) significantly differed (*t*-test, $p<0.000$).

Spatial distribution: inpatient care

Hospitalizations were concentrated in a few mesoregions, with 51.73% occurring in 13 of 137 Brazilian mesoregions. Hospitalizations for BBD were more common in the metropolitan regions of São Paulo (50,278; 13.65%), Rio de Janeiro (18,723; 5.08%), Belo Horizonte (14,603; 4.02%), Fortaleza (14,024; 3.81%), and Recife (13,253; 3.60%) (Figure 2A). Hospitalization

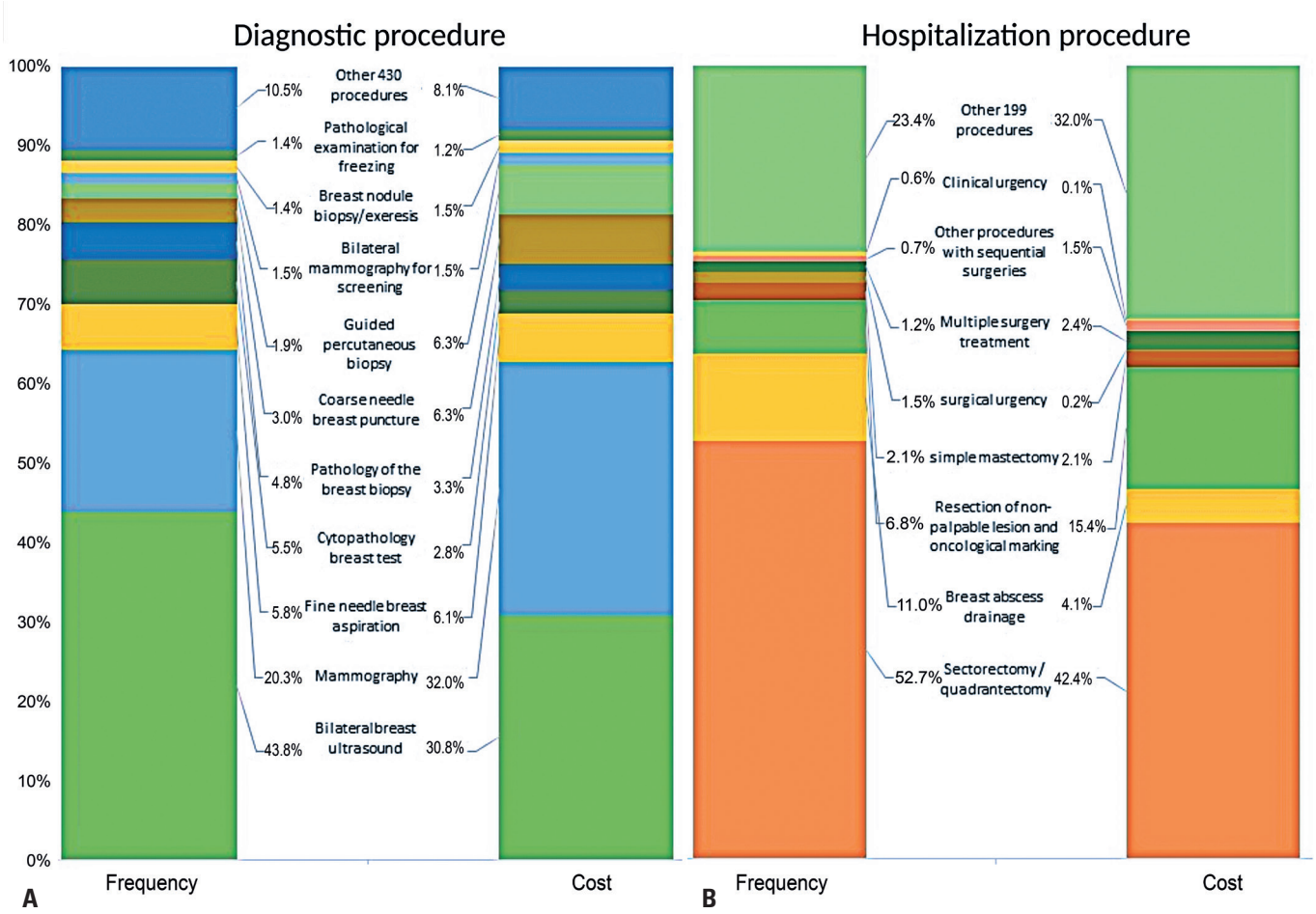


Figure 1. Diagnostic procedure and hospitalization frequency and costs. A) Diagnostic procedure; B) hospitalization

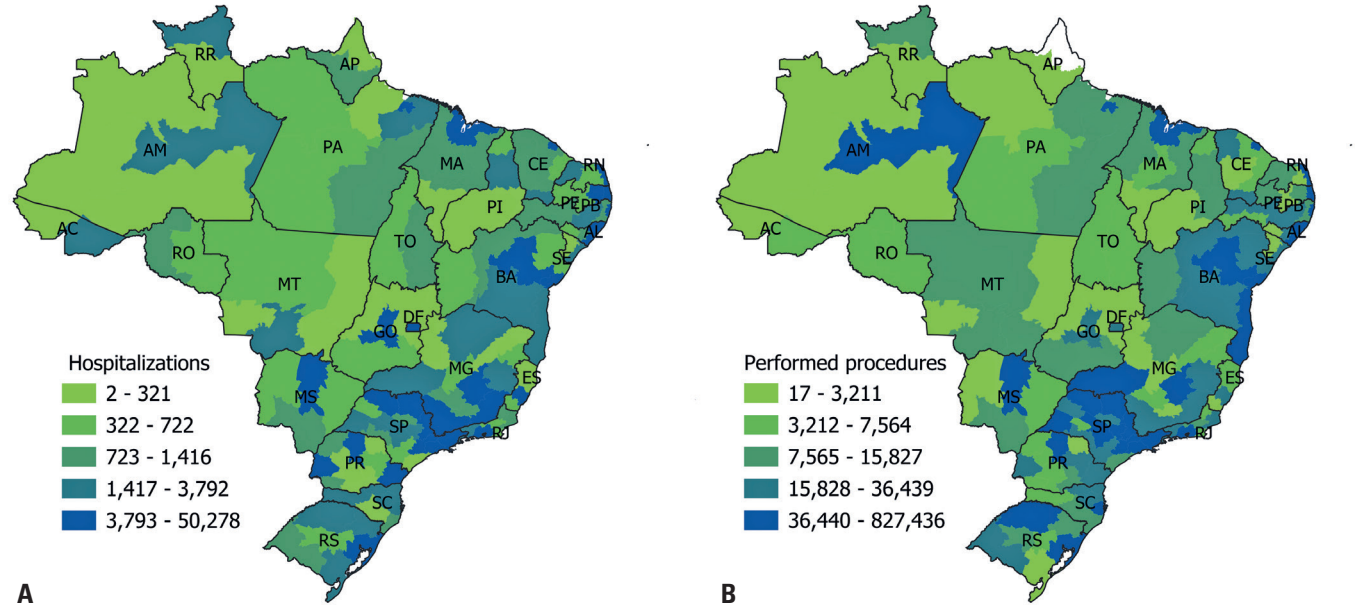


Figure 2. Patient care for benign breast diseases per Brazilian mesoregion. A) Inpatient care; B) outpatient care

coverage (*i.e.*, the number of hospitalizations per 100,000 inhabitants) significantly differed among the five major Brazilian regions (Kruskal-Wallis, p=0.0495) (Table 7S, Supplementary Material). The Northern region had fewer hospitalizations (105.9 per 100,000 people) than those of the Southeast region (158.7 per 100,000 inhabitants) (Dunn's test, p=0.02). The Southeast region had higher hospitalizations than did the Midwest region (113.2 per 100,000 inhabitants) (Dunn's test, p=0.03). However, the Northeast (155.1 per 100,000 inhabitants) and South (152.9 per 100,000 inhabitants) showed no significant differences from the other regions (Dunn's test, p=0.08, p=0.47, p=0.88, p=0.08 and p=0.09, p=0.88, p=0.64, and p=0.09, respectively) (Table 8S, Supplementary Material).

Spatial distribution: outpatient care

Only 9 of the 137 mesoregions accounted for 50.15% of outpatient care. The metropolitan areas of São Paulo (827,436; 19.02%), Salvador (395,682; 9.10%), Rio de Janeiro (202,536; 4.66%), Vale do Paraíba Paulista (161,253; 3.71%), and Central North Bahia (153,541; 3.53%) had the highest number of visits (Figure 2B).

Outpatient care coverage, *i.e.*, the number of outpatient procedures per 100,000 inhabitants, differed across the five major Brazilian regions (Kruskal-Wallis test; p=0.0060) (Table 9S, Supplementary Material). Procedural coverage in the North region (924.8 per 100,000 inhabitants) was much lower than in the Northeast (1,737.7 per 100,000 inhabitants) (Dunn's test, p=0.01), Southeast (1,947.2 per 100,000 inhabitants) (Dunn's test, p<0.00), and South (1,679.6 per 100,000 inhabitants) (Dunn's test, p=0.01) regions. Procedural coverage in the Midwest (1,039.6 per 100,000 inhabitants) was lower than that in the Southeast region (Dunn's test, p=0.02) (Table 10S, Supplementary Material).

Migrations: inpatient care

Several patients travel to other cities for BBD treatment, and some treatments require patients to travel between cities, mesoregions, federation units, or even regions.

Patients traveled to another mesoregion for 10.72% of hospitalizations. Depending on the patient's origin, the migration rate ranged from 6.53 to 16.21% (Table 11S, Supplementary Material). The greatest distance traveled for admission was in the Northern region. Hospitalization displacement requirements differed across the five major Brazilian regions (Figure 4S, Supplementary Material) albeit not significantly (Kruskal-Wallis test, p=0.331) (Figure 5S, Supplementary Material).

Similar to outpatient care, hospitalizations showed disparities in the origin and destination of migration. The South and Southeast regions received more people for hospital admissions than they sent, and the North, Northeast, and Midwest regions sent more patients than they received (Figure 3). Figures 6S-10S in the

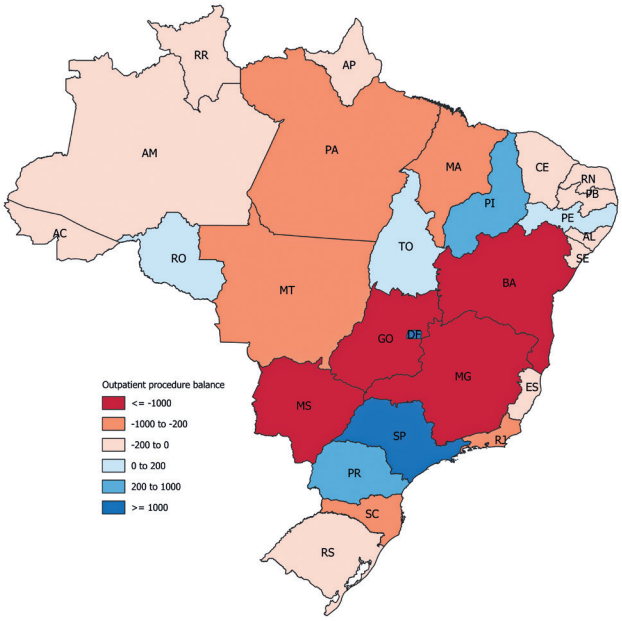


Figure 3. Balance of inflow and outflow of patient migration for outpatient procedures

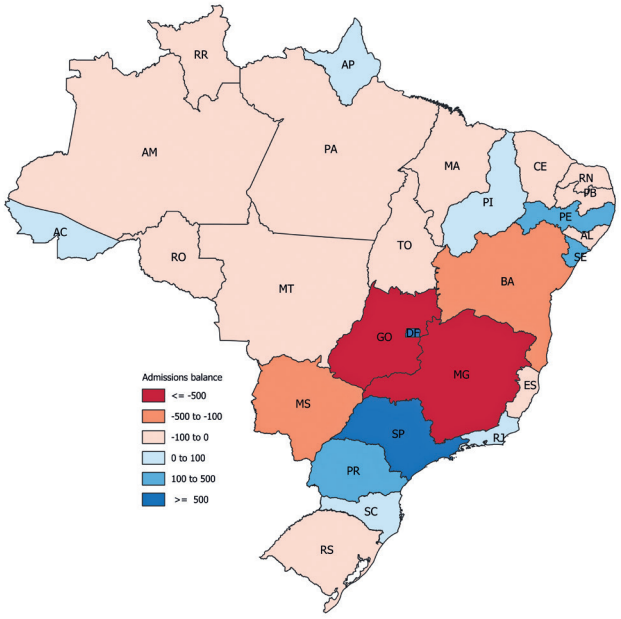


Figure 4. Balance of inflow and outflow of patient migration for hospitalization

Supplementary Material show the migration graphs for all services conducted beyond the original mesoregion of the patient.

Migrations: outpatient care

Considering the total number of procedures, 5.92% of the patients required travel to different mesoregions. The migration rates varied considerably, with the Southeast having the lowest rate at 2.94% and the Midwest having the highest at 14.58% (Table 12S, Supplementary Material). Travel requirements varied across the country (Figure 11S, Supplementary Material), but with no significant differences (Kruskal-Wallis, p=0.172) (Figure 12S, Supplementary Material).

Although migration between regions did not differ, the origins and destinations of migration differed. The North, Northeast, and Midwest regions showed a negative balance, as more patients left their mesoregions for procedures than those arriving. Conversely, the South and Southeast regions experienced a positive balance, with more patients entering for treatment than leaving. The red areas in figure 4 indicate a high outflow of patients, whereas the blue regions show an increased inflow. Figures 13S-17S, Supplementary Material, depict migration for outpatient care between mesoregions.

Migrations: distance traveled

Analysis of the distances traveled by patients for outpatient procedures and hospitalization outside their home regions showed that the distance varied significantly. The average distance was 314.4 km for hospitalizations and 378.8 km for outpatient visits. The North and Midwest regions had the highest mean distances traveled for hospitalization and outpatient procedures. The distances traveled for in- and outpatient procedures significantly differed between regions (Kruskal-Wallis, p<0.000 and 0.002, respectively) (Figure 18S and Table 13S, Supplementary Material).

Regarding the distance to reach hospitals, the North (mean, 774.7 km) and Midwest (mean, 388.0 km) regions did not differ significantly (Dunn's test, p=0.48). However, these two regions accounted for the most distance than the other three regions (Northeast, mean, 226.9 km; Southeast, mean, 181.8 km; South, mean, 239.1 km) (Dunn's showed p<0.00 for the three regions compared with the Northern region and p<0.01 compared with the central-west region) (Figure 19S, Supplementary Material).

Concerning outpatient care, the North (mean, 823.8 km) and Midwest (mean, 434.2 km) regions were similar in terms of distance traveled (Dunn's test, p=0.96). Nevertheless, their distances were significantly higher than those of the Southeast (mean, 240.6 km) (Dunn's test, p<0.0021 for North and Midwest) and South (mean, 213.6 km) (Dunn's test, p<0.0021 for North

and Midwest) regions. The Northeast region (mean, 350.3 km) did not significantly differ from any other region (Dunn's test, p=0.12 *versus* North, p=0.055 *versus* Midwest, p=0.06 *versus* Southeast, p=0.18 *versus* South). The distances traveled in the Southeast and South regions were similar (Dunn's test p=0.88) (Table 14S, Supplementary Material).

DISCUSSION

Understanding BBDs is critical for planning prevention strategies, alleviating associated symptoms, and ruling out malignant neoplasms with similar clinical presentations. Consequently, outlining BBD prevention strategies and simultaneously alleviating associated symptoms is possible.

Our results demonstrated that most patients in outpatient clinics underwent diagnostic procedures, as more than 95% of the procedures were diagnostic. An approximately 60% decline in the number of procedures was observed from 2008 to 2010, 2 years after the start of our analysis. This decrease resulted from the reduction in the number of mammograms. After 2009, this procedure was no longer considered in the SUS databases for BBD diagnosis, reappearing only in 2015 and in minimal numbers.

Notably, drug dispensing is among the therapeutic measures listed in the SIA databases, accounting for a significant proportion of outpatient therapeutic procedures for most diseases. Outpatient treatment and clinical and surgical procedures accounted for only 3.2% of all the procedures performed (138,000 in 12 years). This phenomenon is unusual in the SUS. However, most medications used to treat BBDs, such as danazole, bromocriptine, tamoxifen, vitamin E, medroxyprogesterone acetate, progesterone, and gonadotropin-releasing hormone,[19-25] are not registered for this use in Brazil or have not yet been listed among the drugs supplied by the SUS for BBDs. In both cases, the outcome is the same; the SUS did not provide medication for BBD treatment. Our analysis revealed that outpatient procedures for diagnostic purposes were overrepresented.

In contrast, the BBD treatments reported by DATASUS were primarily surgical, *e.g.*, sectorectomies and quadrantectomies, and involved hospitalization. Surgeries were conducted at a similar frequency across the 12 years. When it is unknown whether a patient has a malignant or benign tumor, surgery to remove a non-palpable breast lesion marked using breast oncological techniques (the third most common and second most expensive procedure in our analysis) is frequently performed in a hospital setting to rule out the possibility of breast cancer. SIH includes this technique among those permitted for patients with BBDs listed in the ICD-10. As a result, some hospitalizations may have occurred for diagnosis rather than treatment of a previously diagnosed BBD.

The age of women treated for BBD in the SUS was consistent with that reported in literature.[26] The in- and outpatient age distributions showed two peaks: one at 19 years and the other at 45 years. The initial peak in the age distribution graph of outpatients is more subtle. Changes in the anatomical and histological structures of the breast throughout the initial reproductive years and at the start of menopause may explain these peaks.[27,28] We hypothesize that the therapeutic procedures for BBD treatment were conducted in younger women. In contrast, the procedures performed on older females in the second peak aimed to rule out potential malignant tumors.

The spatial distribution of BBD treatments and diagnoses in the Brazilian territory is uneven. Brazil's three most populated regions (Southeast, Northeast, and South) had a higher average number of hospitalizations per inhabitant, with approximately 150 hospitalizations per 100,000 inhabitants. In contrast, the Midwest and North regions had approximately 110 hospitalizations per 100,000 inhabitants. This discrepancy was also observed for outpatient procedures, as the former regions had over 1,800 procedures per 100,000 residents, while the latter had only approximately 1,000 procedures per 100,000 residents. This difference in coverage, which is 30-40% lower in the North and Midwest regions, may be due to the disparity in healthcare services and patient migration from these regions.

The lower number of diagnostic procedures performed in more depopulated areas suggests the possibility that BBDs are underdiagnosed. This underdiagnosis would result in even lower treatment coverage than in other regions because many patients still require a diagnosis. Inequity in services across territories forces patients to migrate from one area to another.

Several hospitalizations and outpatient procedures occur far from the patient's homes due to the lack of comprehensive clinical-medical infrastructure in each city. This arrangement is expected and planned in an integrated healthcare system such as the SUS, especially in a vast country such as Brazil. Patients often have to leave their towns and mesoregions for diagnosis and treatment, sometimes traveling to another federal unit or region to receive medical care. However, migration from a mesoregion for BBD diagnosis, which is not a high-complexity procedure, is uncommon.

Patients from other mesoregions accounted for 6.15% of all procedures performed, requiring an average travel distance of 378 km for these basic procedures. Less populated areas have a higher requirement for patient displacement, revealing spatial variability in healthcare provision. The Midwest region had the highest patient migration rate, with 14.58% of procedures performed in a mesoregion other than that of the patient's origin. It is important to note that intra-mesoregion mobility was not considered in this analysis.

The need to migrate for hospitalization was consistent with outpatient treatment, albeit at a slightly higher rate (>10%). This need is not surprising, given that the diagnostic complexity of BBD (ultrasound, mammography, and punctures) is lower than the treatment complexity, which is typically surgical in Brazil.

Although Brazil has mechanisms to deal with population displacement in these situations,[29] distances greater than 1,000 km are typical in the North and Midwest regions. The need for long journeys to diagnose BBD potentially reveals an imperfection in the healthcare system. Women from poorer and more depopulated areas have to travel long distances because they lack sufficient healthcare infrastructure in their mesoregions for low-complexity procedures.

The SUS expenditure for BBD diagnosis and treatment was minimal. BBD-related expenditures have negligible impact on a healthcare system with a structure as substantial as the SUS, with millions of dollars spent annually. In the 12 years, BBDs represented less than one-thousandth of the money spent on SUS outpatient clinics and hospitalizations. This low representation most likely occurs because after diagnosing a non-malignant breast disease, treatment usually aims to control and treat symptoms and educate patients. As previously stated, the SUS does not provide drugs for the treatment of BBD. Therefore, although BBDs require fewer systemic resources, access to adequate therapies is limited.

Differentiating BBDs from malignant neoplasms is critical for both patients and healthcare systems. Because of this distinction, Brazilian databases have revealed that surgeries, such as sectorectomies and quadrantectomies, are more prevalent, whereas access to pharmacological therapies for BBDs is limited. A public and universal healthcare system, such as the SUS, expects patients to migrate for diagnosis or treatment. This expectation has generated procedures for dealing with patient migration in these instances. When these displacements for low- and medium-complexity procedures such as BBD diagnosis and treatment occur, the system needs improvement such that women from less economically favored and more depopulated areas do not travel long distances to receive medical assistance.

The strategies for system improvement are undeniably complex. However, some elements deserve consideration, such as preventing and treating non-communicable diseases and ensuring access to tests and treatments for conditions such as BBDs. This effort is critical because non-communicable diseases accounted for 7 of the 10 global leading causes of death in 2019. Therefore, addressing disparities in access to healthcare services, regardless of their source, is critical. This can be achieved by expanding the primary care network to incorporate population health services, including outpatient clinics, basic health units, and emergency care.

Furthermore, the service capacities of existing facilities must be enhanced through spatial expansion and technological advancement. Similarly, the correct allocation of resources by the healthcare system must be ensured by training management professionals and capacitating frontline healthcare workers in the science, technology, and information fields. This set of actions is only a proposal to accelerate access to tests and medicines for the entire population and boost the quantity and quality of healthcare, particularly for those experiencing poverty. However, their execution is complex.

CONCLUSION

Service deficiencies and significant disparities in coverage within populated areas underscore the need to enhance the healthcare network, encompassing outpatient clinics, basic health units, and emergency care. Additionally, augmenting the service capacity of existing facilities through spatial expansion and technological advancement is essential.

AUTHORS' CONTRIBUTION

Dayan Sansone: conceptualization, data curation, formal analysis, methodology, writing - original draft, writing - review, and editing. Daniela Farah: formal analysis, project administration, visualization, writing, review, and editing. Afonso Celso Pinto Nazario: methodology, resources, validation, writing - original draft, writing - review, and editing. Marcelo Cunio Machado Fonseca: conceptualization, data curation, formal analysis, methodology, project administration, supervision, validation, visualization, writing - original draft, writing - review, and editing.

AUTHORS´ INFORMATION

Sansone D: http://orcid.org/0000-0002-2924-4936
Farah D: http://orcid.org/0000-0002-9727-9460
Nazario AC: http://orcid.org/0000-0002-0601-4388
Fonseca MC: http://orcid.org/0000-0003-0803-3715

REFERENCES

1. Paim J, Travassos C, Almeida C, Bahia L, Macinko J. The Brazilian health system: history, advances, and challenges. Lancet. 2011;377(9779):1778-97.
2. World Health Organization (WHO) Women and health: today's evidence tomorrow's agenda. Geneva: WHO; 2009.
3. Langer A, Fleck F. The new women's health agenda. Bull World Health Organ. 2013;91(9):628-9.
4. Instituto Brasileiro de Geografia e Estatística (IBGE). Censo 2010. Rio de Janeiro: IBGE [citado 2019 Set 30]. Disponível em: https://censo2010.ibge.gov.br/
5. Agência Nacional de Saúde Suplementar (ANS). Dados e Indicadores do setor. São Paulo: ANS; [citado 2019 Set 30]. Disponível em: http://www.ans.gov.br/perfil-do-setor/dados-e-indicadores-do-setor
6. Dyrstad SW, Yan Y, Fowler AM, Colditz GA. Breast cancer risk associated with benign breast disease: systematic review and meta-analysis. Breast Cancer Res Treat. 2015;149(3):569-75.
7. Miltenburg DM, Speights VO Jr. Benign breast disease. Obstet Gynecol Clin North Am. 2008;35(2):285-300.
8. Elias S, Facina G, de Araujo Neto JT. Mastologia Condutas Atuais. Manole; 2016. 724 p. (Série Mastologia).
9. Organização Mundial Da Saúde. CID-10 classificação estatística internacional de doenças e problemas relacionados a saúde. São Paulo: EDUSP; 1997.
10. Santen RJ. Benign Breast Disease in Women. In: Feingold KR, Anawalt B, Boyce A, Chrousos G, Dungan K, Grossman A, et al. Endotext. South Dartmouth (MA): MDText.com, Inc.; 2000 [cited 2019 Sep 30]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK278994/
11. Silvera SA, Rohan TE. Benign proliferative epithelial disorders of the breast: a review of the epidemiologic evidence. Breast Cancer Res Treat. 2008;110(3):397-409.
12. Rohan TE, Hartwick W, Miller AB, Kandel RA. Immunohistochemical detection of c-erbB-2 and p53 in benign breast disease and breast cancer risk. J Natl Cancer Inst. 1998;90(17):1262-9.
13. Friedenreich C, Bryant H, Alexander F, Hugh J, Danyluk J, Page D. Risk factors for benign proliferative breast disease. Int J Epidemiol. 2000;29(4):637-44.
14. Cavalcante MP, de Oliveira C, Simão FB, Lima PR, Monteiro PS. Análise geoespacial: um estudo sobre a dengue. Acta Paul Enferm. 2013;26(4):360-8.
15. Brasil. Ministério da Saúde. Banco de dados do Sistema Único de Saúde - DATASUS. Brasília (DF): Ministério da Saúde; [citado 2024 Maio 22]. Disponível em: http://www2.datasus.gov.br/DATASUS/index.php?area=0901
16. Ipeadata. Dados macroeconômicos e regionais. Brasília (DF): Ipeadata; [citado 2022 Ago 20]. Disponível em: http://www.ipeadata.gov.br/Default.aspx
17. Instituto Brasileiro de Geografia e Estatística (IBGE). Divisão do Brasil em mesorregiões e microrregiões geográficas. Rio de Janeiro: IBGE; 1990.
18. Dunn OJ. Multiple Comparisons Using Rank Sums. Technometrics. 1964;6(3):241-52.
19. Fentiman IS, Caleffi M, Brame K, Chaudary MA, Hayward JL. Double-blind controlled trial of tamoxifen therapy for mastalgia. Lancet. 1986;1(8476):287-8.
20. Messinis IE, Lolis D. Treatment of premenstrual mastalgia with tamoxifen. Acta Obstet Gynecol Scand. 1988;67(4):307-9.
21. O'Brien PM, Abukhalil IE. Randomized controlled trial of the management of premenstrual syndrome and premenstrual mastalgia using luteal phase-only danazol. Am J Obstet Gynecol. 1999;180(1 Pt 1):18-23.
22. Millet AV, Dirbas FM. Clinical management of breast pain: a review. Obstet Gynecol Surv. 2002;57(7):451-61.
23. Blommers J, de Lange-De Klerk ES, Kuik DJ, Bezemer PD, Meijer S. Evening primrose oil and fish oil for severe chronic mastalgia: a randomized, double-blind, controlled trial. Am J Obstet Gynecol. 2002;187(5):1389-94.
24. Hamed H, Caleffi M, Chaudary MA, Fentiman IS. LHRH analogue for treatment of recurrent and refractory mastalgia. Ann R Coll Surg Engl. 1990;72(4):221-4.
25. Mansel RE, Goyal A, Preece P, Leinster S, Maddox PR, Gateley C, et al. European randomized, multicenter study of goserelin (Zoladex) in the management of mastalgia. Am J Obstet Gynecol. 2004;191(6):1942-9.
26. Rungruang B, Kelley JL 3rd. Benign breast diseases: epidemiology, evaluation, and management. Clin Obstet Gynecol. 2011;54(1):110-24.
27. Hughes LE, Mansel RE, Webster DJ. Aberrations of normal development and involution (ANDI): a new perspective on pathogenesis and nomenclature of benign breast disorders. Lancet. 1987;2(8571):1316-9.
28. Pearlman MD, Griffin JL. Benign breast disease. Obstet Gynecol. 2010;116(3):747-58.
29. Brasil. Ministério da Saúde. Secretária de Atenção à Saúde. PortariaNº 55, 24 de fevereiro de 1999. Dispõe sobre a rotina do Tratamento Fora de Domicilio no.Sistema Único de Saúde - SUS, com inclusão dos procedimentos específicos na tabela de procedimentos do Sistema de Informações Ambulatoriais do SIA/SUS e dá outras providências. Brasília (DF): Ministério da Saúde; 1990 [citado 2024 Out 30]. Disponível em: https://bvsms.saude.gov.br/bvs/saudelegis/sas/1999/prt0055_24_02_1999.html

SUPPLEMENTARY MATERIAL

Brazil's benign breast disease care profile and geospatial analysis

Dayan Sansone, Daniela Farah, Afonso Celso Pinto Nazario, Marcelo Cunio Machado Fonseca

DOI: 10.31744/einstein_journal/2025AO1132

Table 1S. Conversion rate of reais (R$) to US dollar (US$) for each year

Year	R$	US$
2008	1.8338	1.00
2009	1.9968	1.00
2010	1.7594	1.00
2011	1.6742	1.00
2012	1.954	1.00
2013	2.1570	1.00
2014	2.3529	1.00
2015	3.3309	1.00
2016	3.4895	1.00
2017	3.1914	1.00
2018	3.6536	1.00
2019	3.9445	1.00

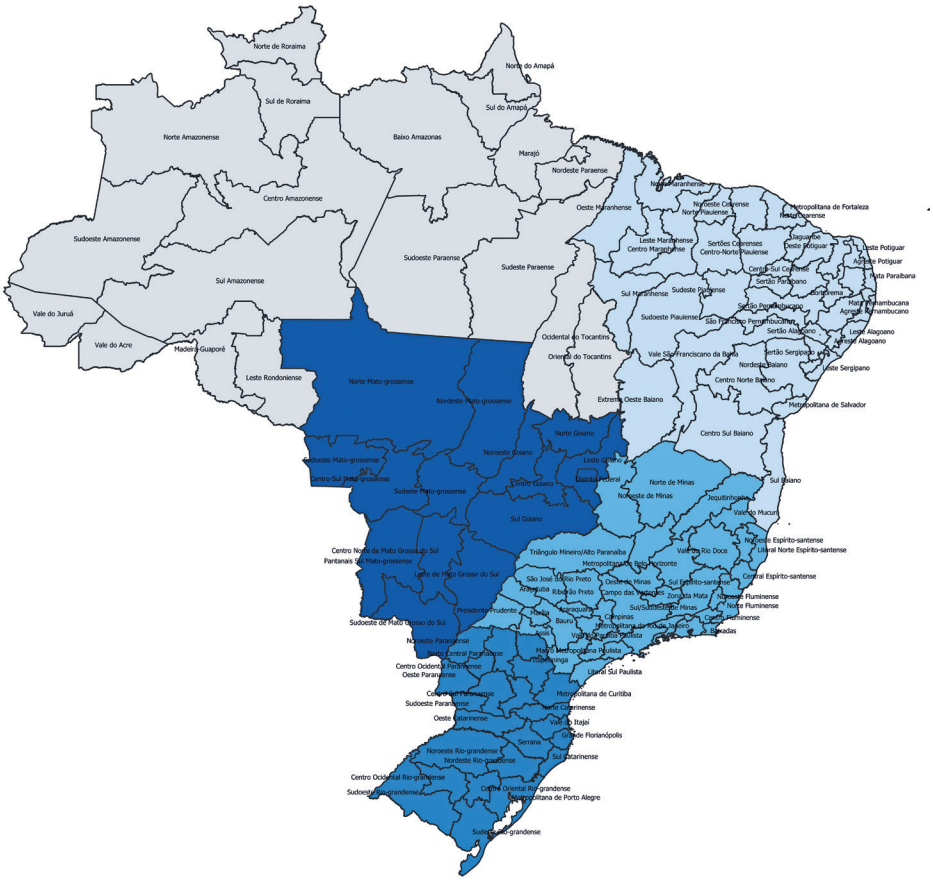


Figure 1S. Brazilian mesoregions

Table 2S. Quantity and costs of procedures performed for benign breast diseases from 2008 to 2019

Year	Number of procedures	Cost
2008	802,322	$16,958,670.82
2009	609,667	$11,112,251.64
2010	317,621	$5,083,760.26
2011	301,016	$5,282,644.62
2012	270,761	$4,100,461.05
2013	273,174	$3,688,900.30
2014	283,760	$3,555,971.44
2015	290,596	$2,655,401.62
2016	307,903	$2,709,765.57
2017	267,805	$2,713,396.18
2018	287,113	$3,388,914.39
2019	338,139	$3,779,548.22
Total	4,349,877	$65,029,686.11

Table 3S. Procedures performed for benign breast diseases from 2008 to 2019

Medical procedure	Number of procedures	Cost
Bilateral breast ultrasound	1,907,117	$20,037,738.90
Mammography	885,069	$20,786,217.06
Fine needle breast aspiration	254,134	$3,997,322.92
Cytopathology breast test	241,114	$1,806,025.89
Pathology of the breast biopsy	206,798	$2,160,831.30
Coarse needle breast puncture	129,633	$4,116,271.26
Guided percutaneous biopsy	82,791	$4,118,256.06
Bilateral mammography for screening	63,421	$988,649.49
Breast nodule biopsy/exeresis	61,799	$982,993.01
Pathological examination for freezing	60,787	$798,990.78
Other 430 procedures	457,060	$5,236,389.44

Table 4S. Hospitalizations, costs, hospital days, and hospital days in the intensive care unit for benign breast diseases from 2008 to 2019

Year	Number of hospitalizations	Hospitalizations cost	Hospital stay (days)	ICU stay (days)
2008	25,420	$4,887,265.92	44,165	66
2009	30,067	$5,905,011.30	50,043	122
2010	30,673	$7,025,856.19	51,474	211
2011	30,045	$7,450,050.73	51,545	88
2012	30,278	$6,836,233.80	51,529	188
2013	30,823	$10,825,103.27	53,504	149
2014	33,558	$12,381,807.51	56,524	232
2015	30,424	$6,928,507.96	52,729	264
2016	29,847	$6,424,589.64	51,657	250
2017	29,930	$7,413,236.31	51,914	264
2018	29,963	$6,395,640.77	54,165	327
2019	32,084	$6,525,723.04	56,588	319
Total	363,112	$88,999,026.43	625,837	2,480

ICU: intensive care unit.

Table 5S. Procedures performed during hospitalization for benign breast diseases from 2008 to 2019

Procedures	Number	Costs
Sectorectomy/quadrantectomy	191,312	$37,719,506.20
Breast abscess drainage	39,893	$3,683,968.37
Resection of non-palpable lesions and oncological marking	24,831	$13,736,555.07
Simple mastectomy	7,660	$1,826,036.10
Surgical urgency	5,332	$143,006.15
Multiple surgery treatment	4,387	$2,094,096.09
Other procedures with sequential surgeries	2,447	$1,292,340.80
Clinical urgency	2,223	$54,162.38
Other 199 procedures	85,027	$28,449,355.27

Table 6S. Out- and inpatient procedures and costs for benign breast diseases compared with total Brazilian Unified Health System costs from 2008 to 2019

	Total SUS	Total BBD	%
Outpatient			
Procedures performed	44,167,290,610	4,349,723	0.010
Cost of procedures	$81,441,940,667.15	$65,029,686.11	0.080
Inpatient			
Hospitalizations	139,630,238	363,112	0.260
Hospitalizations cost	$60,806,973,981.77	$88,999,026.43	0.146
ICU cost	$11,352,470,136.36	$432,586.79	0.004
Ward bed daily rates	705,489,619	625,837	0.089
ICU bed daily rates	55,733,662	2,480	0.004

ICU: intensive care unit; BBD: benign breast diseases; SUS: *Sistema Único de Saúde*.

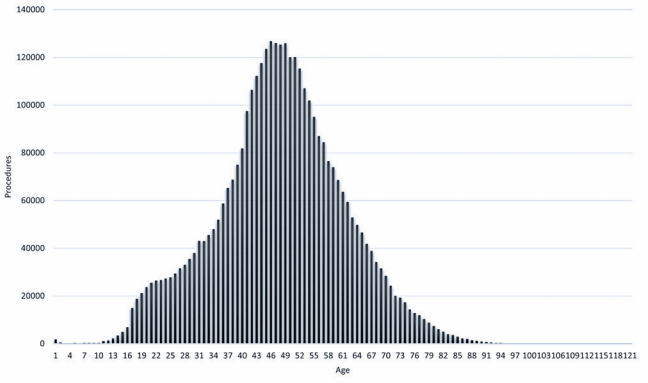


Figure 2S. Number of outpatient procedures performed for benign breast disease by patient age from 2008 to 2019

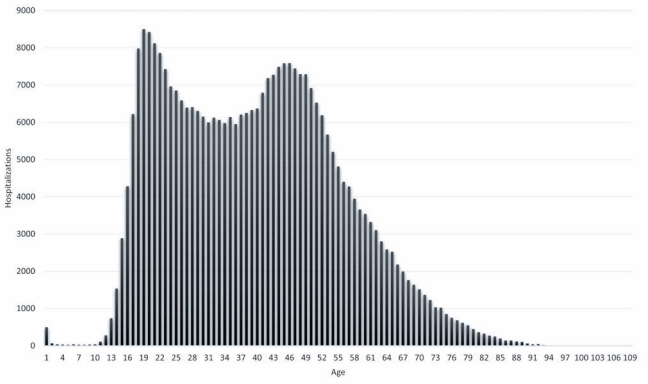


Figure 3S. Number of hospitalizations performed for benign breast disease by patient age from 2008 to 2019

Table 7S. Average hospitalizations per 100,000 inhabitants per benign breast disease in Brazilian regions from 2008 to 2019

Hospitalizations per 100,000 inhabitants	North	Northeast	Southeast	South	Midwest
Number of mesoregions	20	42	37	23	15
Minimum of hospitalizations	7.4	0.8	25.4	34.5	9.3
Maximum of hospitalizations	381.4	582.2	467.5	562.3	379.3
Average hospitalizations	105.9	155.1	158.7	152.9	113.2
Standard deviation	96.0	118.3	97.4	113.8	123.8

Table 8S. Dunn's test for differences in hospital coverage in the five major Brazilian regions from 2008 to 2019

	North	Northeast	Southeast	South	Midwest
North		0.08	0.02*	0.09	0.88
Northeast	0.08		0.47	0.88	0.08
Southeast	0.02*	0.47		0.64	0.03*
South	0.09	0.88	0.64		0.09
Midwest	0.88	0.08	0.03*	0.09	

* Significant differences between regions.

Table 9S. Average number of outpatient procedures performed per 100,000 inhabitants for benign breast disease in Brazilian regions from 2008 to 2019

Procedures per 100,000 inhabitants	North	Northeast	Southeast	South	Midwest
Number of mesoregions	20	42	37	23	15
Minimum of procedures	0.0	206.0	202.0	335.4	171.5
Maximum of procedures	3,251.0	8,721.2	6,741.3	5,730.5	3,595.5
Average of procedures	924.8	1,737.7	1,947.2	1,679.6	1,039.6
Standard deviation	903.6	1,644.3	1,544.9	1,299.7	888.2

Table 10S. Dunn's test for differences in outpatient procedure coverage in the five major Brazilian regions from 2008 to 2019

	North	Northeast	Southeast	South	Midwest
North		0.01*	0.00*	0.01*	0.58
Northeast	0.01*		0.43	0.90	0.07
Southeast	0.00*	0.43		0.58	0.02*
South	0.01*	0.90	0.58		0.09
Midwest	0.58	0.07	0.02*	0.09	

* Significant differences between regions.

Table 11S. Hospitalizations of patients with benign breast diseases outside their mesoregion of origin from 2008 to 2019

Origin of patients	Number of hospitalizations	Number of hospitalizations outside patient mesoregion	% of hospitalizations outside patient mesoregion
North	20,674	2,010	9.72
Northeast	106,356	16,557	15.57
Southeast	160,201	10,453	6.53
South	53,609	6,021	11.23
Midwest	27,390	4,440	16.21
Brazil	368,230	39,481	10.72

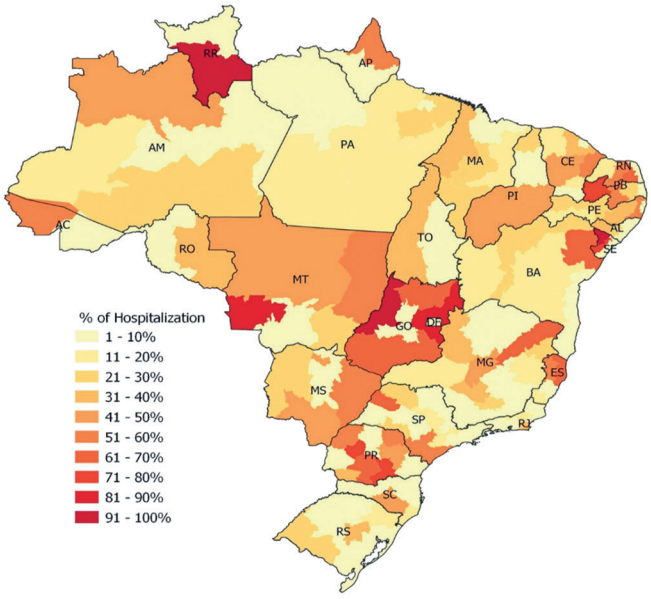


Figure 4S. Percentage of hospitalizations for benign breast diseases outside the patient's mesoregion from 2008 to 2019

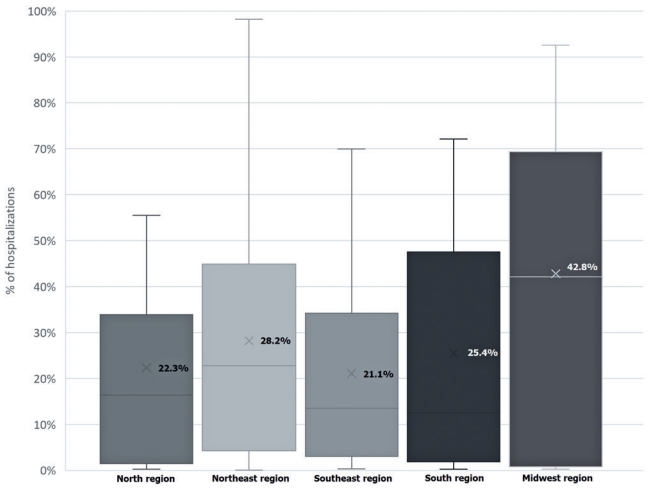


Figure 5S. Boxplot of the migration percentages out of the patient's mesoregion of origin for hospitalizations for benign breast diseases by Brazilian region from 2008 to 2019

* Figures 6S-10S show the migration graphs between the mesoregions for hospitalizations for benign breast diseases from 2008 to 2019 (the graphs are on a log2 scale for better visualization).

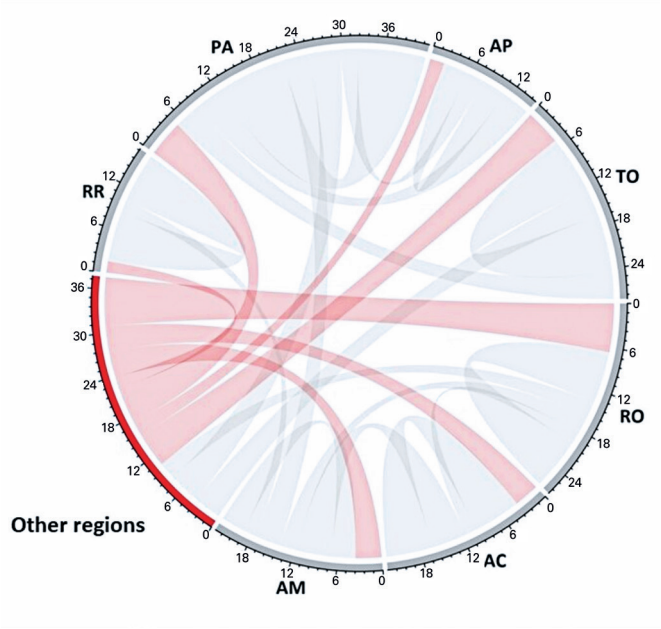
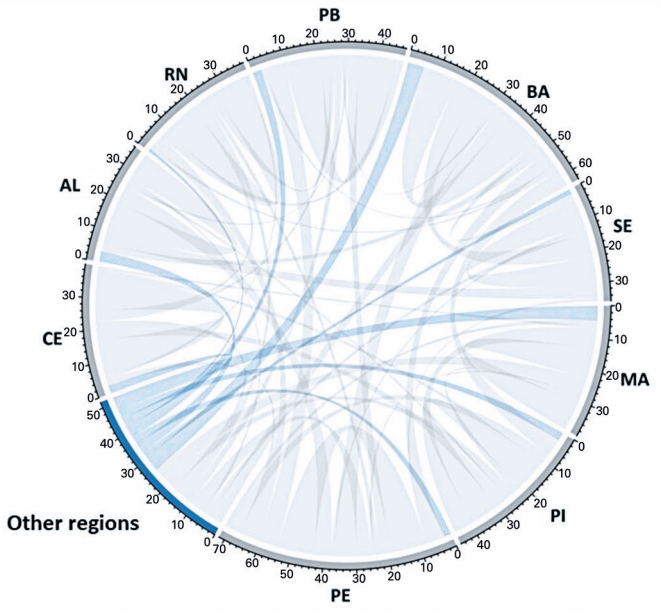
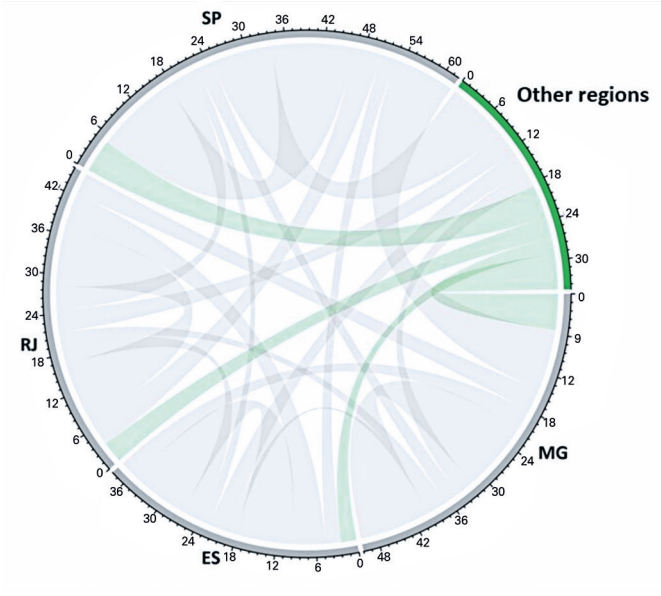


Figure 6S. Displacements from the North region (red: hospitalizations in other regions for patients coming from the North region; gray: migrations within the North region)



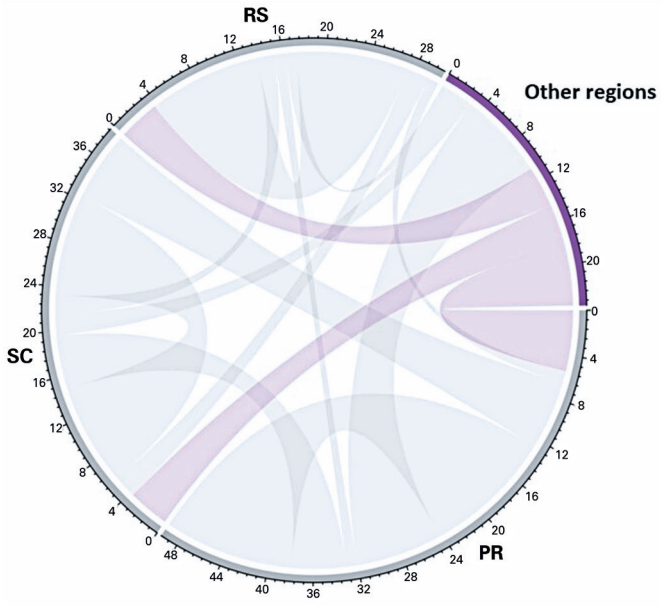
Northeast region states: CE-Ceará, AL-Alagoas, RN-Rio Grande do Norte, PB-Paraíba, BA-Bahia, SE-Sergipe, MA-Maranhão, PI-Piauí, PE-Pernambuco.

Figure 7S. Displacements from the Northeast region (blue: hospitalizations in other regions for patients coming from the Northeast region; gray: migrations within the Northeast region)



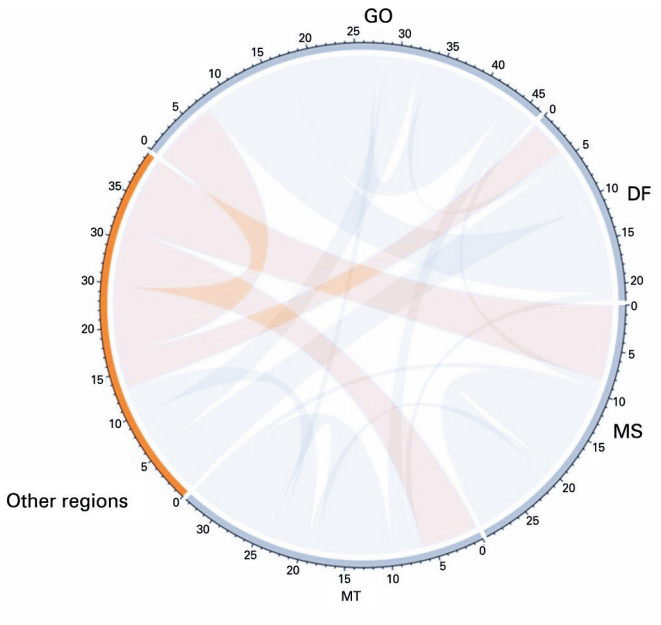
Southeast region states: MG-Minas Gerais, ES-Espírito Santo, RJ-Rio de Janeiro. SP-São Paulo.

Figure 8S. Displacements from the Southeast region (green: hospitalizations in other regions for patients coming from the Southeast region; gray: migrations within the Southeast region)



South region states: PR Paraná, SC Santa Catarina, and RS Rio Grande do Sul.

Figure 9S. Displacements from the South region (purple: hospitalizations in other regions for patients coming from the South region; gray: migrations within the South region)



Midwest states: GO Goiás, DF Distrito Federal, MS Mata Grosso do Sul, and MT Mato Grosso.

Figure 10S. Displacements from the Midwest region (orange: hospitalizations in other regions for patients coming from the Midwest region; gray: migrations within the Midwest region)

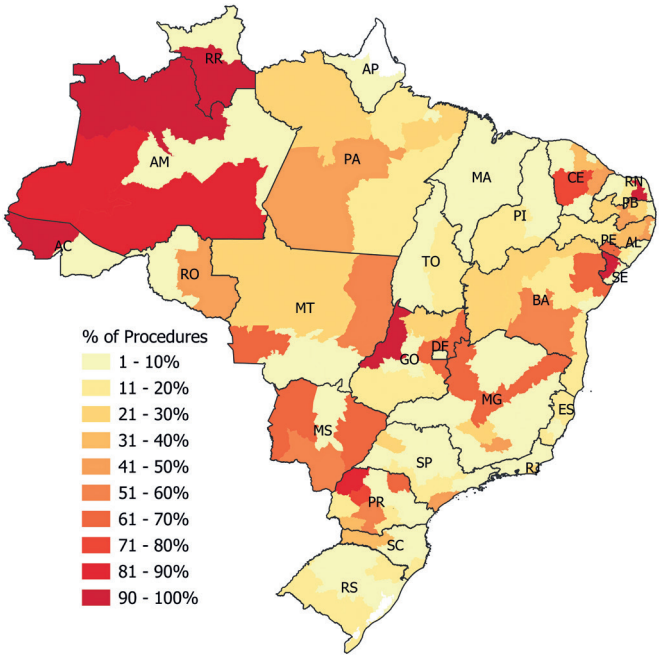


Figure 11S. Percentage of outpatient procedures for benign breast diseases outside the patient's mesoregion of origin from 2008 to 2019

Table 12S. Outpatient procedures performed for patients with benign breast disease outside their mesoregion of origin from 2008 to 2019

Origin of patients	Procedures performed	Procedures performed outside mesoregion of origin	% of procedures for which patients changed mesoregion
North	212,356	15,223	7.17
Northeast	1,402,264	124,610	8.88
Southeast	2,066,135	60,657	2.94
South	501,452	32,564	6.49
Midwest	167,156	24,377	14.58
Brazil	4,349,723	257,432	5.92

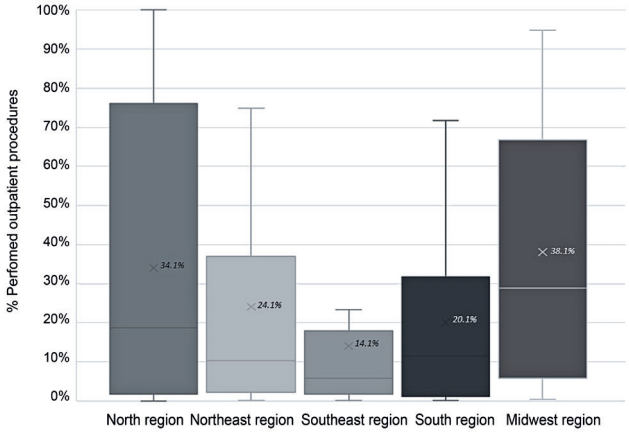
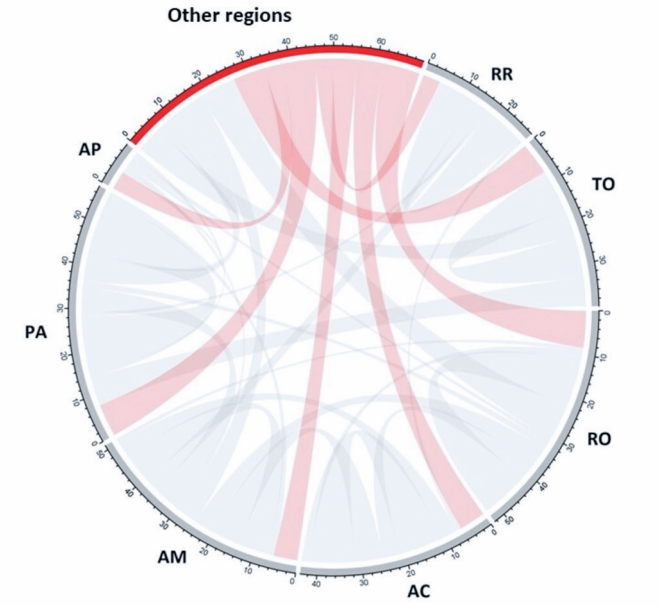


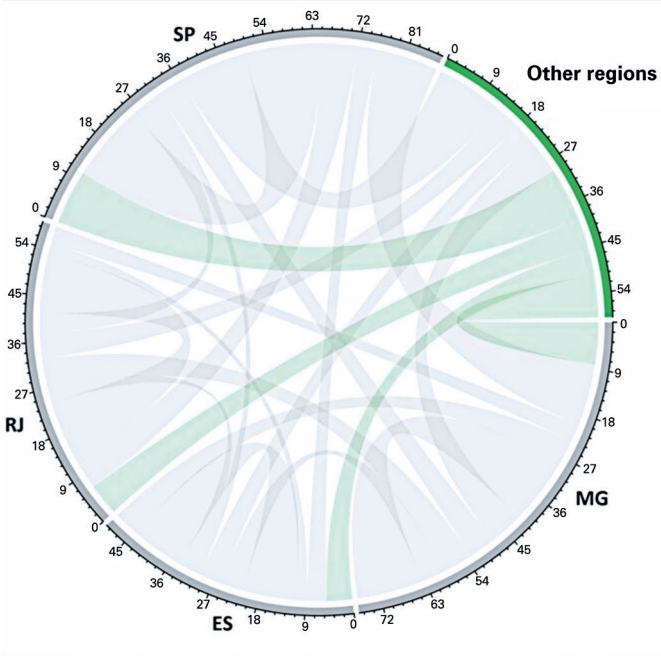
Figure 12S. Box plot of the migration percentages out of the patient's mesoregion of origin for outpatient procedures for benign breast diseases by Brazilian region from 2008 to 2019

* Figures 13S-17S show the migration graphs between mesoregions for outpatient procedures for benign breast diseases from 2008 to 2019 (the graphs are on a log2 scale for better visualization).



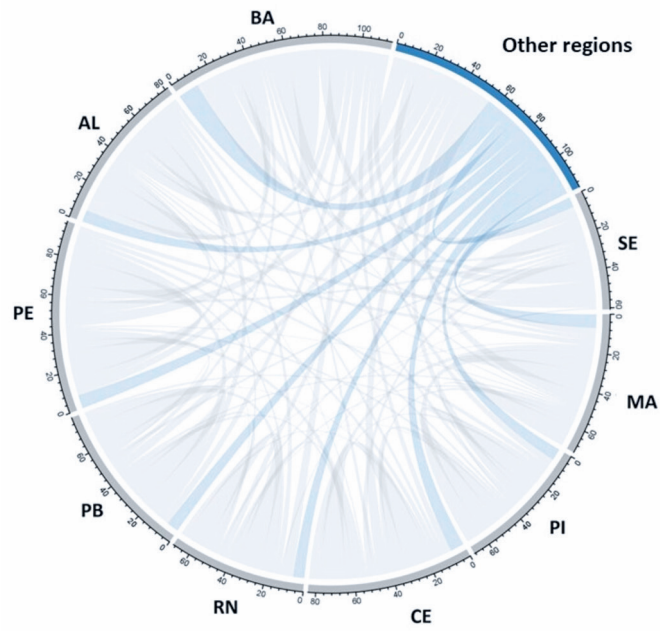
North region states: RR-Roraima, TO-Tocantins, RO-Rondônia, AC-Acre, AM-Amazonas, PA-Pará, AP-Amapá.

Figure 13S. Displacements from the North region (red: outpatient procedures in other regions for patients coming from the North region; gray: migrations within the North region)



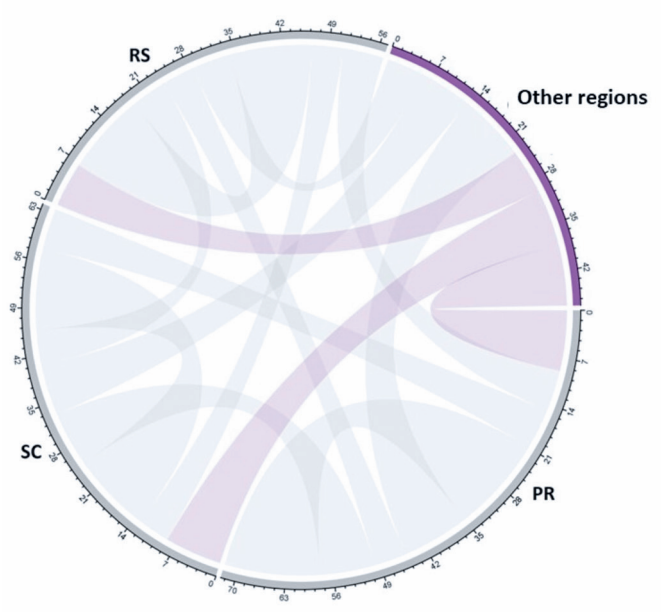
Southeast region states: MG-Minas Gerais, ES-Espírito Santo, RJ-Rio de Janeiro. SP-São Paulo.

Figure 15S. Displacements from the Southeast region (green: outpatient procedures in other regions for patients coming from the Southeast region; gray: migrations within the Southeast region)



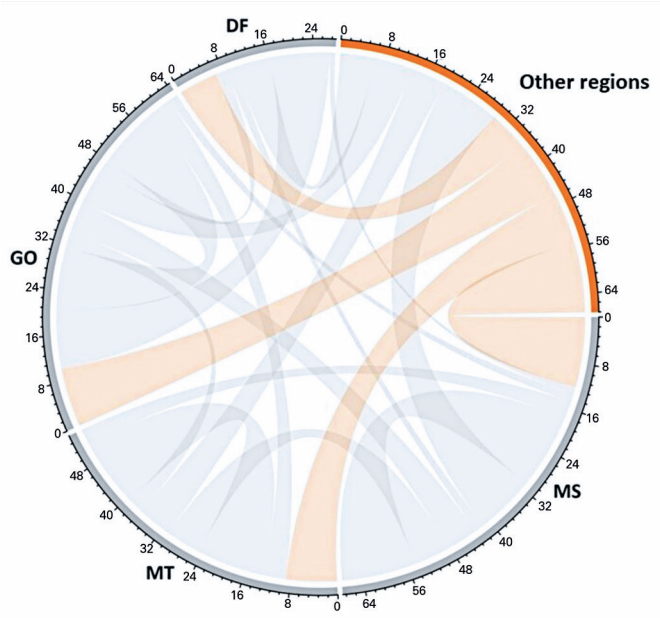
Northeast region states: SE-Sergipe, MA-Maranhão, PI-Piauí, CE-Ceará, RN-Rio Grande do Norte, PB-Paraíba, PE-Pernambuco, AL-Alagoas, BA-Bahia.

Figure 14S. Displacements from the Northeast region (blue: outpatient procedures in other regions for patients coming from the Northeast region; gray: migrations within the Northeast region)



South region states: PR Paraná, SC Santa Catarina, and RS Rio Grande do Sul.

Figure 16S. Displacements from the South region (purple: outpatient procedures in other regions for patients coming from the South region; gray: migrations within the South region)



Midwest region states: MS-Mata Grosso do Sul, MT-Mato Grosso, GO-Goiás, and DF-Distrito Federal.

Figure 17S. Displacements from the Midwest region (orange: outpatient procedures in other regions for patients coming from the Midwest region; gray: migrations within the Midwest region)

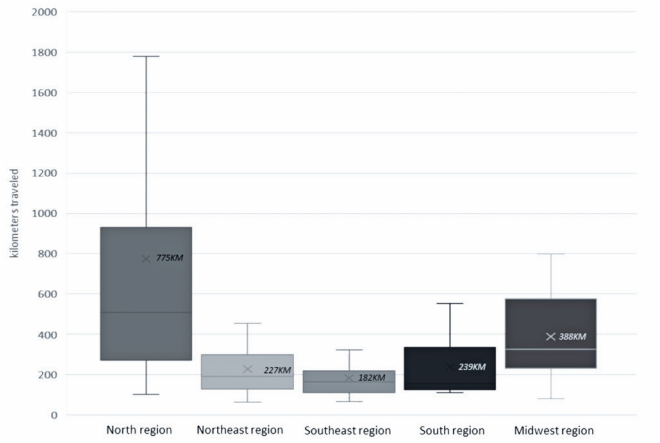


Figure 18S. Box plot of the distances covered by patients who migrated from their mesoregion of origin for hospitalization for benign breast diseases by Brazilian region from 2008 to 2019

Table 13S. Dunn's test for differences in distances covered for hospitalization in the five major Brazilian regions from 2008 to 2019

	North	Northeast	Southeast	South	Midwest
North		0.0000*	0.0000*	0.0004*	0.4835
Northeast	0.0000*		0.2349	0.9013	0.0038*
Southeast	0.0000*	0.2349		0.2586	0.0002*
South	0.0004*	0.9013	0.2586		0.0115*
Midwest	0.4835	0.0038*	0.0002*	0.0115*	

* Significant differences between regions.

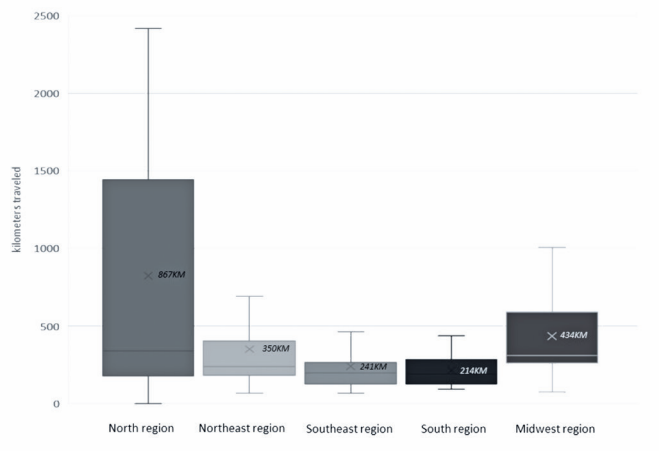


Figure 19S. Box plot of the distances covered by patients who migrated from their mesoregion of origin for outpatient procedures for benign breast diseases by Brazilian region from 2008 to 2019

Table 14S. Dunn's test for differences in distances covered for outpatient procedures in the five major Brazilian regions from 2008 to 2019

	North	Northeast	Southeast	South	Midwest
North		0.1256	0.002243*	0.003713*	0.9691
Northeast	0.1256		0.05535	0.06942	0.1804
Southeast	0.002243*	0.05535		0.8833	0.006377*
South	0.003713*	0.06942	0.8833		0.008459*
Midwest	0.9691	0.1804	0.006377*	0.008459*	

* Significant differences between regions.