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Trends and outcomes of breast surgical procedures in the Brazilian Unified Health System: a nationwide analysis (2015–2025)

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ABSTRACT

Introduction: Breast-related surgical care represents an important component of the Brazilian Unified Health System (SUS), but nationwide evidence on hospital activity and outcomes remains limited. **Objective:** This study aimed to analyze temporal trends, procedure distribution, in-hospital mortality, length of stay, and hospitalization reimbursement values between 2015 and 2025. **Methods:** This nationwide retrospective ecological study used aggregated Hospital Information System (SIH)/SUS data, in which records represent hospital admissions rather than unique patients. Admissions were identified through selected SIGTAP codes—the SUS Management System for the Table of Procedures, Medicines, Orthoses, Prostheses, and Special Materials—and classified as breast-conserving, mastectomy, reconstructive, or gender-affirming procedures. Isolated axillary lymphadenectomy codes were also screened but excluded from the primary analysis because these procedures are classified outside breast/oncologic surgery subgroups in SIGTAP and are compatible with non-breast diagnoses (e.g., cutaneous melanoma); they are described separately in Supplementary Table S1. Because some remaining codes—including the predominant breast-conserving procedure (sector resection/quadrantectomy)—are not exclusive to malignant breast disease, the analysis describes breast-related surgical admissions rather than a confirmed breast cancer cohort. Temporal trends were assessed using log-linear regression for the full period and for pre-specified sub-periods (2015–2019, 2020–2025, and 2021–2025). Mortality between mastectomy and breast-conserving admissions was described using absolute and relative frequencies, with the chi-square (χ^2) test and unadjusted relative risk reported as secondary, exploratory analyses. **Results:** A total of 361,534 admissions were included in the primary analysis; an additional 4,275 admissions associated with isolated axillary lymphadenectomy were screened but excluded because of limited specificity for breast disease. Breast-conserving procedures accounted for 243,931 admissions (67.5%), mastectomy for 99,863 (27.6%), reconstructive procedures for 17,408 (4.8%), and gender-affirming mastectomies for 332 (0.1%). Overall, 224 in-hospital deaths occurred (0.062%). Crude in-hospital mortality was 0.033% for breast-conserving admissions (approximately 3.3 deaths per 10,000) and 0.143% for mastectomy admissions (approximately 14.3 deaths per 10,000); as a secondary, exploratory comparison, this corresponded to an unadjusted relative risk of 4.31 (95% confidence interval [95%CI] 3.28 to 5.66; χ^2=131.65; p<0.001), which should be interpreted cautiously given case-mix heterogeneity between groups. Admissions were essentially stable from 2015 to 2019 (annual percent change [APC]=−0.63%; 95%CI −1.35 to 0.09; p=0.070), decreased by 29.8% in 2020, and increased significantly from 2020 to 2025 (APC=+8.10%; 95%CI 2.36 to 14.16; p=0.017), without a significant linear trend across the full period (APC=−0.80%; 95%CI −3.81 to 2.31; p=0.573). For the complete screened cohort of 365,809 admissions, mean length of stay was 1.5 days, and total approved hospitalization reimbursement value was R$ 574.1 million. **Conclusions:** Breast-conserving procedures predominated among breast-related surgical admissions. Crude in-hospital mortality was higher for mastectomy than for breast-conserving admissions; because clinical indication, tumor stage, comorbidities, and other confounders were not available in the SIH/SUS dataset used for this analysis, this difference should be interpreted descriptively and not as a causal effect of the surgical procedure. These findings characterize hospital activity while acknowledging important limitations of administrative, diagnosis-blind data.

KEYWORDS: breast neoplasms; mastectomy; breast-conserving surgery; hospital mortality; Brazil.

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INTRODUCTION

Breast cancer is the most frequently diagnosed malignancy among women worldwide and remains a major contributor to cancer-related morbidity, mortality, and healthcare burden[1]. In Brazil, it is the most common malignant neoplasm among women, excluding nonmelanoma skin cancer, and represents an important challenge for the Brazilian Unified Health System (Sistema Único de Saúde (SUS)[2].

Breast cancer management is multimodal and may involve surgery, systemic therapy, and radiotherapy according to tumor characteristics, disease extent, and patient-related factors[3,4]. Surgery remains a central component of treatment and may include breast-conserving procedures, mastectomy, axillary surgery, and breast reconstruction[3,4]. The selection of the surgical approach depends on tumor size and location, disease extent, patient clinical characteristics and preferences, and the feasibility of adjuvant treatment[3,4].

Over recent decades, the surgical management of breast cancer has progressively shifted from more extensive procedures toward breast-conserving approaches whenever oncologically appropriate[5–7]. Randomized trials and long-term follow-up studies have demonstrated comparable survival outcomes between breast-conserving surgery followed by radiotherapy and mastectomy in appropriately selected patients with early-stage breast cancer[5,6,8]. Current clinical guidelines therefore recommend breast-conserving surgery as a standard therapeutic option when adequate tumor resection and appropriate adjuvant radiotherapy can be achieved[3,4].

The COVID-19 pandemic caused substantial disruptions in cancer care worldwide, including the postponement of elective procedures, delays in diagnostic and referral pathways, and reorganization of hospital resources[9,10]. These disruptions may have affected the volume and temporal distribution of breast surgical care, making nationwide evaluations of hospital activity before, during, and after the pandemic particularly relevant[9,10].

Therefore, this study aimed to analyze temporal trends, procedure distribution, in-hospital mortality, length of stay, and hospitalization reimbursement values associated with breast-related surgical hospitalizations recorded in the SUS between 2015 and 2025.

METHODS

This nationwide retrospective ecological study was based on secondary, publicly available data obtained from the Hospital Information System of the Brazilian Unified Health System (Sistema de Informações Hospitalares do SUS (SIH/SUS), available through the Department of Informatics of the Unified Health System (Departamento de Informação e Informática do Sistema Único de Saúde (DATASUS)[11]. Hospital admissions associated with breast-related surgical procedures recorded in Brazil between January 2015 and December 2025 were analyzed according to the place of hospitalization.

Data were extracted on April 25, 2026, using TabNet Win32 3.3, from the SIH/SUS module "Hospital Procedures of SUS – by place of hospitalization – Brazil." Queries were performed by year of admission and by main procedure, using the Sistema de Gerenciamento da Tabela de Procedimentos, Medicamentos e Órteses, Próteses e Materiais Especiais do SUS (SIGTAP) codes described below. Extracted indicators included the number of hospital admissions, in-hospital deaths, mean length of hospital stay, approved hospitalization reimbursement values, and state of hospitalization. Because SIH/SUS records from recent months may be subject to processing updates before final consolidation, admissions from 2025 were analyzed as available at the extraction date and should be interpreted with this caveat in mind.

The unit of analysis was the hospital admission authorized through an Authorization for Hospital Admission (AIH; Autorização de Internação Hospitalar) in which one of the selected surgical procedures was recorded as the main procedure. Therefore, the number of records represents hospital admissions rather than unique patients, because the same patient may have had more than one admission during the study period[11].

Procedures were identified using the SUS Management System for the Table of Procedures, Medicines, Orthoses, Prostheses, and Special Materials (Sistema de Gerenciamento da Tabela de Procedimentos, Medicamentos e Órteses, Próteses e Materiais Especiais do SUS (SIGTAP)[12]. The following surgical codes were screened:

- 0406020213, radical bilateral axillary lymphadenectomy;
- 0406020221, radical unilateral axillary lymphadenectomy;
- 0410010057, radical mastectomy with lymphadenectomy;
- 0410010065, simple mastectomy;
- 0410010090, postmastectomy breast reconstruction with prosthetic implant;
- 0410010111, sector resection/quadrantectomy;
- 0410010120, sector resection/quadrantectomy with axillary lymph node dissection;
- 0410010197, bilateral simple mastectomy under the gender-affirming care program;
- 0410010219, total postmastectomy breast reconstruction;
- 0416120024, radical mastectomy with axillary lymphadenectomy in oncology;
- 0416120032, simple mastectomy in oncology; and
- 0416120059, segmentectomy/quadrantectomy/sector resection of the breast in oncology.

The complete list of screened codes, official SIGTAP descriptions, analytical classification, and available admission/death counts is presented in Supplementary Table S1.

Diagnostic procedures, including breast nodule biopsy or excision and breast anatomopathological examination, were

excluded because the study was restricted to hospital admissions in which a breast-related surgical procedure was recorded as the main procedure. The SIH/SUS database does not provide the individual clinical indication associated with each hospitalization.

For descriptive and comparative analyses, admissions were classified according to the main surgical procedure. The primary analysis comprised four categories:

- breast-conserving procedures — sector resection/quadrantectomy (0410010111), sector resection/quadrantectomy with axillary lymph node dissection (0410010120), and segmentectomy/quadrantectomy/sector resection of the breast in oncology (0416120059);
- mastectomy procedures — radical mastectomy with lymphadenectomy (0410010057), simple mastectomy (0410010065), radical mastectomy with axillary lymphadenectomy in oncology (0416120024), and simple mastectomy in oncology (0416120032);
- reconstructive procedures — postmastectomy breast reconstruction with prosthetic implant (0410010090) and total postmastectomy breast reconstruction (0410010219); and
- gender-affirming bilateral simple mastectomy (0410010197), reported separately because its clinical indication differs from those of the other categories.

Two additional codes identified by the initial screening—radical bilateral axillary lymphadenectomy (0406020213) and radical unilateral axillary lymphadenectomy (0406020221), together comprising 4,275 admissions—were excluded from the primary analysis. These codes are classified within the vascular surgery subgroup of SIGTAP rather than within a breast or oncologic surgery subgroup, and, per the official SIGTAP procedure–diagnosis compatibility table[12], they are compatible with several non-breast diagnoses, including cutaneous melanoma of the trunk and upper limb (International Classification of Diseases, 10th Revision [ICD-10] C43.5–C43.6), other malignant neoplasms of the skin of the trunk (C44.5), and secondary malignant neoplasm of axillary lymph nodes (C77.3), in addition to malignant breast neoplasms (C50.1–C50.9). Because the aggregated SIH/SUS query used in this study does not allow linkage between the principal procedure and the principal diagnosis recorded in each AIH, admissions using these codes could not be restricted to those with a diagnosis confirming breast disease and were therefore judged insufficiently specific for inclusion in the primary analysis. These admissions are described separately, together with the complete list of screened codes, in Supplementary Table S1.

The most frequent procedure retained in the primary analysis, sector resection/quadrantectomy (0410010111), is compatible — per the same SIGTAP table — with both malignant and benign breast diagnoses (e.g., ICD-10 D24 and N60.0–N60.9). Because SIH/SUS does not permit linkage to the principal diagnosis, admissions using this code could not be restricted to confirmed malignancy; consequently, the primary analysis should not be interpreted as exclusively comprising patients with malignant breast neoplasms. This limitation, common to procedure-based (diagnosis-blind) case identification in SIH/SUS, is addressed further in the Discussion.

The variables extracted were the annual number of hospital admissions, procedure category, in-hospital deaths, mean length of hospital stay, approved hospitalization reimbursement value, and state of hospitalization. In SIH/SUS, approved reimbursement values correspond to the amount authorized for payment to the hospital through the AIH and do not necessarily reflect the real economic cost incurred by the institution; these values were reported in nominal Brazilian reais and were not adjusted for inflation, and the mean value per admission was calculated as the total approved amount divided by the total number of admissions. Mean length of stay was obtained directly from the SIH/SUS TabNet aggregated indicator, representing the ratio between total inpatient-days and total admissions for the selected records. Because a breakdown of reimbursement values and length of stay excluding isolated axillary lymphadenectomy admissions was not available, these two outcomes are reported for the complete screened cohort of 365,809 admissions rather than for the primary analysis population; this scope is noted wherever the outcomes are presented.

In-hospital mortality was defined as death occurring during the corresponding hospital admission. The in-hospital mortality rate was calculated by dividing the number of in-hospital deaths by the total number of admissions in each procedure category and was expressed as a percentage and as the number of deaths per 10,000 admissions.

Categorical variables were summarized using absolute and relative frequencies. Continuous variables were presented as means based on the measures available in the SIH/SUS database. Geographic distributions were evaluated descriptively, for the complete screened cohort, using absolute numbers of hospital admissions by state. Population-normalized rates and formal statistical comparisons of regional access, service availability, or geographic inequality were not performed.

Temporal trends in the annual number of admissions in the primary analysis were assessed using log-linear regression, both for the complete 2015–2025 period and for pre-specified subperiods reflecting the pandemic disruption: 2015–2019 (pre-pandemic), 2020–2025 (from the pandemic nadir through recovery), and 2021–2025 (post-pandemic recovery alone).

The annual percent change (APC) was calculated as $(e^{\beta}-1) \times 100$, where β represents the regression coefficient for each period, and was presented with the corresponding 95% confidence interval (95%CI). The 2019-to-2020 change was additionally expressed as a simple percentage reduction. This sub-period approach was used, in addition to the single overall-period estimate, to characterize the pre-pandemic trend, the magnitude of the pandemic-related

disruption, and the pattern of recovery separately, since a single regression spanning a period with a large transient disruption may not adequately capture these distinct phases.

Crude in-hospital mortality was described using absolute and relative frequencies for each procedure category in the primary analysis. As a secondary, exploratory analysis, Pearson's chi-square (X^2X^2) test was used to assess whether the proportion of in-hospital deaths differed between admissions associated with mastectomy procedures and those associated with breast-conserving procedures, and the magnitude of the association was expressed as an unadjusted relative risk (RR), using breast-conserving admissions as the reference group, with the corresponding 95%CI. Because sector resection/quadrantectomy—the largest single contributor to the breast-conserving category—is not exclusive to malignant breast disease, this reference group may not be clinically equivalent to the mastectomy group, and the RR should be interpreted as descriptive rather than as a robust epidemiological effect estimate. Reconstructive and gender-affirming procedures were evaluated descriptively only, because they represent distinct clinical indications and had few or no events.

Statistical significance was defined as $p<0.05$. All statistical analyses were performed using R software, version 4.3.1 (R Foundation for Statistical Computing, Vienna, Austria).

The SIH/SUS database does not provide individual-level information regarding the clinical indication for surgery, patient age, tumor stage, histological or molecular subtype, comorbidities, clinical severity, previous treatments, postoperative complications, or other potential confounding factors. Consequently, multivariable or risk-adjusted analyses could not be performed. The associations observed between procedure category and in-hospital mortality should therefore not be interpreted as causal effects of the surgical procedures.

Because this study exclusively used aggregated, anonymized, and publicly available secondary data without the possibility of individual identification, evaluation by a Research Ethics Committee and individual informed consent were not required, in accordance with Resolution No. 510/2016 of the Brazilian National Health Council[13]. The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations[14].

RESULTS

Screening identified 365,809 hospital admissions associated with breast-related surgical procedures recorded in the SUS between 2015 and 2025. Of these, 4,275 admissions (1.2%) corresponded to isolated axillary lymphadenectomy codes that are not specific to breast disease (see Methods) and were excluded from the primary analysis, which therefore comprised 361,534 admissions. In the primary analysis, the annual number of admissions was essentially stable from 2015 to 2019, ranging from 34,972 to 36,014. In 2020, the number decreased to 24,549, representing a 29.8% reduction compared with 2019. Hospital activity subsequently increased to 25,537 admissions in 2021, 30,925 in 2022, 33,955 in 2023, and 36,711 in 2024, followed by 33,422 admissions in 2025 (Figure 1B).

Log-linear regression was used to quantify the average annual change in the number of admissions in the primary analysis and to determine whether the temporal trend was statistically significant, both overall and within pre-specified sub-periods. Across the complete 2015–2025 period, the annual percent change was –0.80% (95%CI –3.81 to 2.31; p=0.573), indicating no statistically significant overall trend. When analyzed by sub-period, admissions were essentially stable from 2015 to 2019 (APC=–0.63%; 95%CI –1.35 to 0.09; p=0.070). From the pandemic nadir in 2020 through 2025, admissions increased significantly (APC=+8.10%; 95%CI 2.36 to 14.16; p=0.017); when the post-pandemic period was evaluated alone, from 2021 to 2025, the increase was no longer statistically significant (APC=+7.35%; 95%CI –2.23 to 17.88; p=0.095). Therefore, despite the absence of a significant linear trend across the full 11-year period, the sub-period analysis indicates a stable pre-pandemic baseline, a marked disruption in 2020, and a significant recovery through 2025, driven largely by the rebound from the pandemic nadir (Figure 1B).

In the primary analysis, breast-conserving procedures represented the largest category, accounting for 243,931 admissions (67.5%). Mastectomy procedures accounted for 99,863 admissions (27.6%), reconstructive procedures for 17,408 (4.8%), and gender-affirming bilateral simple mastectomy for 332 (0.1%) (Table 1; Figure 1A). The 4,275 admissions associated with isolated axillary lymphadenectomy, excluded from the primary analysis, are described in Supplementary Table S1.

Among the 361,534 admissions included in the primary analysis, 224 in-hospital deaths were recorded, corresponding to an in-hospital mortality rate of 0.062% (approximately 6.2 deaths per 10,000 admissions). Crude in-hospital mortality was 0.033% for breast-conserving admissions (81 deaths among 243,931 admissions; approximately 3.3 deaths per 10,000) and 0.143% for mastectomy admissions (143 deaths among 99,863 admissions; approximately 14.3 deaths per 10,000). No in-hospital deaths were recorded among admissions for reconstructive procedures or gender-affirming bilateral simple mastectomies (Table 2). Among the 4,275 admissions excluded from the primary analysis, 52 in-hospital deaths were recorded (1.216%); because these admissions could not be confirmed as breast-related (Methods), this figure is reported descriptively in Supplementary Table S1 and is not interpreted as a breast surgical outcome.

As a secondary, exploratory analysis, Pearson's chi-square (χ^2) test showed a statistically significant association between procedure category (mastectomy *versus* breast-conserving) and in-hospital death (χ^2=131.65; degrees of freedom [df]=1; p<0.001),

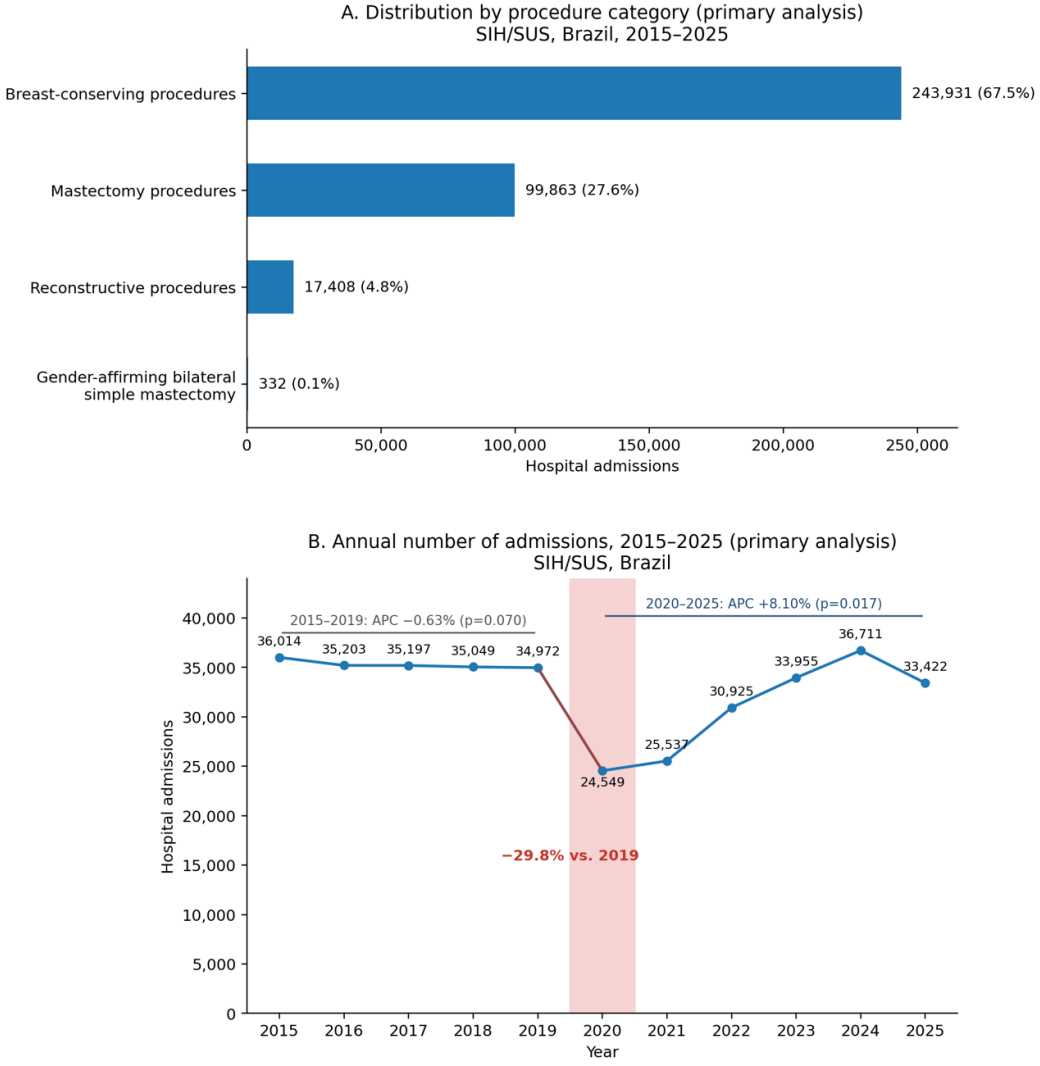
corresponding to an unadjusted RR of 4.31 (95%CI 3.28 to 5.66) (Table 2). This estimate is statistically valid, but its epidemiological interpretation is limited: because sector resection/quadrantectomy, which is not exclusive to malignant disease, accounted for 62.6% of the breast-conserving admissions used as the reference group, this group may include a relevant proportion of non-oncologic admissions, and the two groups cannot be assumed clinically equivalent. The RR is therefore reported for completeness but should not be interpreted as a robust or causal measure of comparative surgical risk; the absolute rates presented above are considered the primary descriptive result for this comparison.

The most frequently recorded individual procedure was sector resection/quadrantectomy (SIGTAP 0410010111), with 152,581 admissions. This was followed by segmentectomy/quadrantectomy/sector resection of the breast in oncology (0416120059), with

Table 1. Distribution of breast-related surgical hospital admissions, primary analysis. Hospital Information System of the Brazilian Unified Health System (SIH/SUS), Brazil, 2015–2025.

Procedure category	Admissions	Percentage (%)
Breast-conserving procedures	243,931	67.5
Mastectomy procedures	99,863	27.6
Reconstructive procedures	17,408	4.8
Gender-affirming bilateral simple mastectomy	332	0.1
Total (primary analysis)	361,534	100.0

Isolated axillary lymphadenectomy admissions (n=4,275) were screened but excluded from the primary analysis because these codes are not specific to breast disease (see Methods). They are described separately in Supplementary Table S1, together with the complete screened total of 365,809 admissions.



APC: annual percent change; SIH/SUS: Hospital Information System of the Brazilian Unified Health System.

Figure 1. (A) Distribution of breast-related surgical hospital admissions according to procedure category (primary analysis; isolated axillary lymphadenectomy excluded — see Methods and Supplementary Table S1) and (B) annual number of breast-related surgical hospital admissions, 2015–2025, primary analysis, in the Brazilian Unified Health System.

77,946 admissions, and radical mastectomy with axillary lymphadenectomy in oncology (0416120024), with 70,269 admissions.

Within the primary analysis, radical mastectomy with axillary lymphadenectomy in oncology accounted for the largest number of in-hospital deaths among individual procedures, with 84 events, followed by segmentectomy/quadrantectomy/sector resection of the breast in oncology, with 59 deaths. Among the codes excluded from the primary analysis, radical unilateral axillary lymphadenectomy accounted for 50 of the 52 deaths recorded for isolated axillary procedures (Supplementary Table S1). No inferential comparisons were performed between individual procedure codes because of differences in their clinical indications and the limited number of events in some categories.

For the complete screened cohort of 365,809 admissions (Methods), the mean length of hospital stay was 1.5 days. Total approved hospitalization reimbursement value during the study period was R$ 574,065,301.91, corresponding to a mean of R$ 1,569.30 per admission (total value divided by the total number of admissions). These financial and length-of-stay outcomes were analyzed descriptively and were not disaggregated by procedure category; no inferential comparison between categories was performed.

The largest absolute numbers of admissions, considering the complete screened cohort, were recorded in São Paulo (89,469), Minas Gerais (36,493), Rio de Janeiro (30,548), Bahia (26,526), and Rio Grande do Sul (25,083). These findings represent absolute hospital admission counts. Because population-normalized rates and formal regional comparisons were not calculated, no statistical inferences regarding regional access, availability of specialized services, or geographic inequality were made.

DISCUSSION

This nationwide study analyzed 361,534 hospital admissions for breast-related surgical procedures recorded in the SUS between 2015 and 2025, after excluding 4,275 admissions associated with isolated axillary lymphadenectomy that could not be confirmed as breast-related (Methods). Breast-conserving procedures accounted for approximately two-thirds of admissions, whereas mastectomy procedures represented slightly more than one-quarter of the total (Table 1; Figure 1A). Overall, in-hospital mortality in the primary analysis was low, at 0.062%, and was higher for mastectomy than for breast-conserving admissions in both absolute (14.3 *versus* 3.3 deaths per 10,000 admissions) and relative terms; because of case-mix heterogeneity within the reference group, this comparison is presented as a secondary, descriptive finding rather than a central result (Table 2). A marked reduction in surgical activity occurred in 2020, followed by a significant increase from the pandemic nadir through 2025, although no significant linear trend was observed across the full 11-year period when analyzed as a single segment (Figure 1B).

The predominance of breast-conserving procedures observed in this study is consistent with the established role of breast-conserving surgery in appropriately selected patients with breast cancer. Randomized trials and long-term follow-up studies have demonstrated comparable survival outcomes between breast-conserving surgery followed by radiotherapy and mastectomy for early-stage disease[5,6,8]. Current clinical guidelines consequently recognize breast-conserving surgery as a standard therapeutic option when adequate tumor resection and appropriate adjuvant radiotherapy can be achieved[3,4]. Previous population-based studies have also documented a gradual transition from more extensive procedures toward breast-conserving approaches in several healthcare settings[7]. In the present analysis, breast-conserving procedures represented 67.5% of admissions in the primary analysis (Table 1; Figure 1A).

However, sector resection/quadrantectomy (0410010111), which accounted for the largest share of breast-conserving admissions in the primary analysis (152,581 of 243,931; 62.6%), is compatible—per the SIGTAP procedure–diagnosis compatibility table[12]—with both malignant and benign breast diagnoses, including fibroadenosis, breast cysts, and other benign dysplasias. Consequently, part of the admissions classified as breast-conserving procedures in this study may correspond to surgical

Table 2. In-hospital mortality according to breast-related surgical procedure category, primary analysis. Hospital Information System of the Brazilian Unified Health System (SIH/SUS), Brazil, 2015–2025.

Procedure category	Admissions	Deaths	In-hospital mortality (%)	Deaths/10,000 admissions
Breast-conserving procedures	243,931	81	0.033	3.3
Mastectomy procedures	99,863	143	0.143	14.3
Reconstructive procedures	17,408	0	0.000	0.0
Gender-affirming bilateral simple mastectomy	332	0	0.000	0.0
Total (primary analysis)	361,534	224	0.062	6.2

Isolated axillary lymphadenectomy admissions (4,275 admissions; 52 deaths; 1.216% crude mortality) were excluded from the primary analysis because these codes are not specific to breast disease and could not be confirmed as breast-related (see Methods and Discussion). They are reported descriptively in Supplementary Table S1 and are not included in this table.

treatment of benign breast disease rather than breast cancer, and the 67.5% figure should not be interpreted as the proportion of breast cancer patients treated with conservative surgery.

Nevertheless, the predominance of breast-conserving procedures should not be interpreted as direct evidence of earlier diagnosis, improved adherence to clinical guidelines, or changes in tumor stage. The SIH/SUS database does not provide information on the individual clinical indication for surgery, tumor stage, histological subtype, molecular profile, surgical margins, or receipt of radiotherapy. Therefore, the present findings describe the distribution of breast-related surgical hospital admissions within the SUS rather than the proportion of patients with breast cancer receiving a specific oncological treatment.

Mastectomy-related admissions presented higher crude in-hospital mortality than breast-conserving admissions, equivalent to approximately 14.3 *versus* 3.3 deaths per 10,000 admissions. In a secondary, exploratory analysis, this corresponded to an unadjusted RR of 4.31 (95%CI 3.28 to 5.66; χ^2=131.65; p<0.001) (Table 2). This estimate must be interpreted with particular caution, for two independent reasons. First, as in any unadjusted comparison, mastectomy and breast-conserving procedures are generally performed in different clinical contexts, and treatment selection may depend on tumor characteristics, disease extent, previous treatment, patient-related factors, and the feasibility of adjuvant therapy[3,4]. Because SIH/SUS does not provide information on age, comorbidities, cancer stage, clinical severity, treatment indication, or postoperative complications, adjustment for potential confounding factors was not possible. Second, and specifically for this comparison, the reference group is not fully clinically equivalent to the mastectomy group: sector resection/quadrantectomy, which is compatible with benign breast diagnoses, contributed 62.6% of breast-conserving admissions. For these reasons, the RR is reported for completeness but should not be treated as a robust epidemiological effect estimate or as evidence of inferior safety or effectiveness of either procedure; the absolute crude rates are considered the more informative descriptive comparison.

As detailed in Methods, the 4,275 admissions associated with isolated axillary lymphadenectomy codes were excluded from the primary analysis because these codes are not specific to breast disease and are compatible with non-breast diagnoses, including cutaneous melanoma and secondary axillary lymph node metastases from other primary sites. The 52 associated in-hospital deaths (1.216%) are reported descriptively in Supplementary Table S1 and should not be interpreted as a breast surgical outcome; a substantial, unknown proportion of these admissions and deaths may correspond to non-breast indications.

No in-hospital deaths were recorded among admissions for reconstructive procedures or gender-affirming bilateral simple mastectomies in the primary analysis (Table 2). These procedures represent distinct clinical indications and patient populations and were therefore analyzed separately. The absence of recorded deaths should not be interpreted as proof of the absence of surgical risk, because SIH/SUS captures only deaths occurring during the corresponding hospitalization and does not provide information on deaths after discharge, readmissions, delayed complications, or long-term outcomes.

The marked reduction in hospital admissions observed in 2020 is consistent with the widespread disruption of cancer care during the COVID-19 pandemic (Figure 1B). International studies reported postponement of elective procedures, interruption of diagnostic pathways, reallocation of hospital resources, and delays in cancer referral and treatment during this period[9,10]. In the present study, surgical activity increased significantly from the pandemic nadir through 2025 (APC=+8.10%; 95%CI 2.36 to 14.16; p=0.017) and exceeded pre-pandemic annual volumes in 2024, although the increase was no longer statistically significant when the post-pandemic period (2021–2025) was evaluated alone (APC=+7.35%; 95%CI –2.23 to 17.88; p=0.095). Consistent with this pattern, log-linear regression across the complete 2015–2025 period showed no statistically significant overall trend. Together, these findings indicate a stable pre-pandemic baseline, a temporary but substantial pandemic-related disruption, and a significant increase from the 2020 nadir through 2025, driven largely by the rebound from the pandemic-related decline, rather than a sustained linear increase or decrease across the entire study period.

For the complete screened cohort, the mean length of hospital stay was 1.5 days, while total approved hospitalization reimbursement value exceeded R$ 574 million. These findings demonstrate the substantial volume of hospital resources associated with breast-related surgical care within the SUS. These values represent amounts approved for reimbursement rather than the real economic cost incurred by hospitals, were not adjusted for inflation, and were not disaggregated by procedure category; therefore, they should not be interpreted as measures of real temporal changes in healthcare expenditure, procedural efficiency, or resource intensity.

The largest absolute numbers of hospital admissions, considering the complete screened cohort, were recorded in São Paulo, Minas Gerais, Rio de Janeiro, Bahia, and Rio Grande do Sul. These results should be interpreted exclusively as descriptive counts because the analysis did not incorporate state population size, age structure, breast cancer incidence, referral flows, number of available hospitals, or regional healthcare capacity. Consequently, the geographic distribution observed in this study does not support conclusions regarding differences in access, availability of specialized services, or regional inequalities in breast surgical care.

This study has several limitations. First, SIH/SUS is an administrative database designed primarily for hospital reimbursement and may be affected by coding errors, incomplete registration, and changes in coding practices. Because data extraction occurred on April 25, 2026, records from late 2025 may be subject to further

processing updates (Methods). Second, the unit of analysis was the hospital admission rather than the individual patient, allowing the same patient to contribute more than one record. Third, procedure-based case identification in SIH/SUS does not allow linkage to the principal diagnosis; although isolated axillary lymphadenectomy codes were excluded from the primary analysis for this reason, sector resection/quadrantectomy—the largest contributor to the breast-conserving category—remains compatible with benign breast diagnoses, so the primary analysis should still not be interpreted as exclusively comprising malignant breast disease. Fourth, the absence of individual clinical information prevented risk-adjusted analyses and limited the interpretation of the mastectomy-*versus*-breast-conserving mortality comparison, which is reported as a secondary, descriptive finding for this reason. Fifth, in-hospital mortality does not capture deaths occurring after discharge, and SIH/SUS does not provide longitudinal follow-up. Sixth, length of stay and hospitalization reimbursement values could not be disaggregated to exclude the admissions screened out of the primary analysis and are therefore reported for the complete screened cohort; these values represent approved reimbursement rather than real economic cost and were not adjusted for inflation. Finally, geographic results were based on absolute numbers without population denominators.

Despite these limitations, this study provides a nationwide assessment of breast-related surgical hospital activity over an 11-year period using a large public healthcare database. The explicit presentation of the screened SIGTAP codes and their diagnostic compatibility, the exclusion of procedures with limited specificity for breast disease from the primary analysis, the separation of clinically distinct procedure categories, and the use of statistical analyses to assess temporal trends and mortality differences improve the transparency and reproducibility of the findings.

Future studies should integrate SIH/SUS data with population-based cancer registries, clinical databases, mortality information systems, and population denominators. Such integration may allow analyses stratified by age, tumor stage, histological subtype, comorbidity burden, and geographic region. Risk-adjusted and longitudinal studies, ideally using diagnosis-linked procedure records, would provide a more accurate assessment of the determinants of mortality, postoperative outcomes, healthcare expenditure, and patterns of breast surgical treatment within the SUS.

CONCLUSION

Breast-conserving procedures accounted for most breast-related surgical hospital admissions recorded in the SUS between 2015 and 2025. Crude in-hospital mortality was higher for mastectomy than for breast-conserving admissions; because sector resection/quadrantectomy is not exclusive to malignant disease and the SIH/SUS dataset used for this analysis does not provide clinical indication, tumor stage, comorbidities, disease severity, or other potential confounding factors, this difference should be interpreted descriptively rather than causally, and the associated RR should not be treated as a robust effect estimate.

Breast-related surgical activity was stable before the COVID-19 pandemic, decreased markedly in 2020, and increased significantly from the pandemic nadir through 2025, although no significant linear trend was identified when the full 11-year period was analyzed as a single segment. The findings provide a nationwide description of surgical hospital activity within the SUS but should not be interpreted as evidence of treatment effectiveness, procedural safety, or regional access. Future studies integrating administrative, clinical, oncologic, and population-based data—including diagnosis-linked procedure records—are needed to clarify the determinants of surgical patterns and in-hospital outcomes in Brazil.

AUTHORS' CONTRIBUTIONS

PCC: Conceptualization, Formal analysis, Methodology, Project administration, Supervision, Validation, Visualization. BLBC: Data curation, Investigation, Writing – review & editing. GM: Data curation, Investigation, Writing – review & editing. CHH: Data curation, Investigation, Writing – review & editing. VGF: Validation, Visualization. MWS: Writing – review & editing. MVZ: Writing – original draft, Writing – review & editing.

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Conflict of interest: nothing to declare.
Artificial intelligence usage: Generative artificial intelligence was not used in the conception, data analysis, or writing of this study. At the proof stage, Claude (Anthropic) was used to support the review of the copyedited text and the drafting of the data availability statement. All changes were reviewed and approved by the authors, who take full responsibility for the content of the article.
Data availability statement: The data analyzed in this study are publicly available from the Hospital Information System of the Brazilian Unified Health System (SIH/SUS) through DATASUS/TabNet (https://datasus.saude.gov.br/acesso-a-informacao/producao-hospitalar-sih-sus/), using the query parameters and SIGTAP codes described in the Methods and Supplementary Table S1. The aggregated datasets extracted for this analysis are available from the corresponding author upon reasonable request.
Supplementary material: https://drive.google.com/file/d/1WvlDrDYiCM9cDyuvXD2LT9cUyxBbT7h4/view?usp=sharing
Study registration: Not applicable. This study is an observational analysis based on secondary, publicly available, and anonymized data.

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