BMC Public Health

RESEARCH

Open Access

Disparities in breast cancer screening, stage at diagnosis, and treatment in Brazil: a warning of the need to change public policies

Ruffo Freitas-Junior[1*], Aline Ferreira Bandeira de Melo Rocha[2], Leonardo Ribeiro Soares[1] and Glalber Luiz da Rocha Ferreira[3]

Abstract

Background Breast cancer (BC) is the most prevalent form of cancer in Brazilian women, contributing significantly to cancer-related mortality, particularly when diagnosed at advanced stages.

Methods This ecological, temporal series study evaluated breast cancer mammography screening rate, clinical staging, and the time from diagnosis to treatment initiation in women of 40–49, 50–69 and $\geq$ 70 years of age in Brazil, its geographical regions, and states between 2013 and 2022. The data were extracted from databases of the Unified Health System (DATASUS).

Results There was a decreasing trend in mammography screening rate for the 40-49-year age group between 2013 and 2020 (Annual Percentual Change- APC= -10.79; $p < 0.001$), and stability in 2020–2022. Rates for the 50-69-year group remained stable, while fell for women $\geq$ 70 years of age (APC= -6.27; $p < 0.001$) between 2013 and 2022. Cases of advanced stages at diagnosis tended to increase in all age groups: 40–49 (APC=1.71; $p < 0.001$), 50–69 (APC = 1.43; $p < 0.001$) and $\geq$ 70 years (APC = 1.82; $p = 0.001$). The mammography screening rate was low for all the age groups and all geographical regions, with lower rates found for the 40–49 and $\geq$ 70-year age groups. The poorest screening rates were seen in the regions North, Northeast and Midwest, revealing regional disparities. The proportion of cases diagnosed at advanced stages (III/IV) increased, particularly in 40–49 and $\geq$ 70-year age groups. Time from diagnosis to treatment initiation exceeded 60 days in >50% of cases in all age groups, with an increasing trend in women of 50–69 (APC = 1.27; $p < 0.001$) and $\geq$ 70 years of age (APC=1.83; $p < 0.001$).

Conclusions This study highlights the urgent need for public policies to increase BC mammography screening rate beyond the 50-69-year age group, and to guarantee equitable access to early diagnosis and timely treatment, particularly in less affluent areas. Dealing with these disparities is crucial to improving BC outcomes in Brazil, positively influencing clinical stage at diagnosis, treatment efficacy, and ultimately, survival and mortality.

*Correspondence:
Ruffo Freitas-Junior
ruffojr@terra.com.br

Full list of author information is available at the end of the article

Keywords Breast cancer, Breast cancer screening, Advanced clinical stage at diagnosis, Time from diagnosis for treatment initiation, Public health, Health disparities, Brazil, Mammography

Background

Breast cancer (BC) is a leading cause of female mortality worldwide, with GLOBOCAN 2022 estimates projecting a rising global burden through 2050 [1]. These trends mark profound disparities across continents, age groups, and socioeconomic levels [1]. While high-human development index (HDI) regions like North America demonstrate effective cancer management, Latin America and the Caribbean face substantial hurdles in equitable access and timely diagnosis, often exacerbated by geographical barriers and limited advanced care in some areas [1–3].

In Brazil, this regional pattern is evident: BC is the most frequent malignancy among women, accounting for 30.3% of new cases and serving as the primary cause of cancer-related deaths [4, 5]. Despite national efforts, high mortality rates persist due to late-stage diagnoses, 37.0% to 53.5% of cases, representing a crisis by deep regional and socioeconomic inequalities [6, 7]. Understanding Brazil's position within this global and regional framework is therefore essential for refining public health policies and identifying strategic areas for improvement, as its experiences may also inform strategies in other low- and middle-income countries (LMICs).

Unlike high-income countries, where the disease predominantly affects older populations, the mean age at diagnosis in the Brazil is 53.9 to 55.0 years, significantly lower than global averages. Approximately 23.9% to 33.1% of Brazilian women are diagnosed below the age of 50 [8, 9].

The Brazilian healthcare system is characterized by a dual-tier structure. The Unified Health System (SUS) provides universal, tax-funded, and comprehensive care free of charge at the point of service [10, 11]. Approximately 70% of the population relies exclusively on the SUS for all health needs [12], mostly low-income groups and smaller municipalities residents, where geographical inequalities are worsened [10]. In contrast, about 28.5% of the population, primarily higher-income, formally employed individuals in urban centers, possesses private health insurance (PHI), which grants access to a differentiated network of providers [13].

Regarding BC, Brazil currently employs an opportunistic screening model rather than an organized national program. This means screening depends on a woman's initiative to seek care or a physician's recommendation during a consultation, rather than a systematic, active invitation process.

Brazilian Ministry of Health recommends biennial mammograms for women aged 50–69 [14]. This strategy limits Brazilian National Health Service screening access for women outside this age group. Some Brazilian organizations advocate annual screening for women aged 40–74, extending to those ≥ 75 with > 7 years life expectancy [15].

The World Health Organization (WHO) recommends a mammography screening coverage rate of 70% for the target population of women aged 50 to 69 years [16]. However, in Brazil, BC screening rates remain below this recommended level [17, 18], which limits the overall effectiveness of the screening strategy. This deficit was significantly exacerbated by the disruptions to healthcare services during the COVID-19 pandemic, which led to a substantial decline in mammographic examinations and diagnostic procedures [18].

In this context, early detection is crucial for successful treatment [19]; mammography is a key tool to reducing breast cancer-related mortality [19, 20]. The time from signs and symptoms to treatment is a crucial indicator of early diagnosis and treatment [21]; long waiting periods negatively affect survival [22]. Despite no consensus on ideal care intervals, Brazilian legislation establishes treatment should begin within 60 days of confirmed malignancy diagnosis [23].

No Brazilian studies correlate BC screening, clinical stage, and time from diagnosis to treatment initiation. Identifying these factors is crucial for developing strategies for breast cancer prevention, control, and improvement of health outcomes.

This study assesses these variables for Brazil, its regions, and states. We hypothesize that low screening rates in women over 40 and treatment delays exceeding 60 days contribute to increased late-stage diagnoses (III/IV).

Methods

This ecological, temporal series study evaluated BC mammography screening rate, local advanced and advanced clinical stage (III/IV) at diagnosis, and treatment initiation delays (> 60 days) in the female population receiving care within the SUS.

This study encompassed Brazil, a nation of continental dimensions spanning approximately 8.5 million km2. The country is administratively divided into 26 states and the Federal District. For a comprehensive geographical analysis, the variables were evaluated at three distinct levels: the entire Brazilian territory, its five official geographical macro-regions, and each of its 27 federative units (states and Federal District) [24].

The macro-regions and their respective states are [24]:

- North: Acre (AC), Amapá (AP), Amazonas (AM), Pará (PA), Rondônia (RO), Roraima (RR) and Tocantins (TO).
- Northeast: Alagoas (AL), Bahia (BA), Ceará (CE), Maranhão (MA), Paraíba (PB), Pernambuco (PE), Piauí (PI), Rio Grande do Norte (RN) and Sergipe (SE).
- Southeast: Espírito Santo (ES), Minas Gerais (MG), Rio de Janeiro (RJ) and São Paulo (SP).
- South: Paraná (PR), Rio Grande do Sul (RS) and Santa Catarina (SC).
- Midwest: Distrito Federal (DF), Goiás (GO), Mato Grosso (MT) and Mato Grosso do Sul (MS).

The analysis covered the period from 2013 to 2022, allowing for a decade-long assessment of trends across these geographical divisions.

The population was divided into three age groups: 40–49, 50–69, and ≥ 70 years. The Ministry of Health recommends SUS screening only for the 50–69 age group. Statistical comparisons used these three age groups, with 50–69 years compared against 40–49 and ≥ 70 years (non-recommended groups), due to varying age stratification criteria in different database sources.

The rationale for including women aged 40–49 in this analysis is based on the unique epidemiological profile of breast cancer in Brazil. Given the high potential for more aggressive biological behaviour in younger patients, evaluating the care continuum for the 40–49 age group is essential to identify gaps in early detection and to support the expansion of screening recommendations.

Despite screening recommendations typically ceasing at 69 years, women aged ≥ 70 years were included due to the continued high incidence of breast cancer in this demographic. This cohort faces unique challenges, including potential age-related biases in healthcare access and increased vulnerability to systemic delays, which can lead to advanced diagnoses. Analysing this group is crucial for identifying specific disparities and informing tailored interventions beyond standard screening guidelines.

A secondary database was created using mammogram data from the SUS Outpatient Health Data System (SIA/DATASUS) [25], and clinical stage/treatment initiation time from the Oncology Panel [26]. Target population calculations used IBGE data [27], and supplementary healthcare coverage estimates used National Agency of Supplementary Health data [27]. As an ecological study, these aggregate-level data were integrated by geographical unit (Brazil, macro-regions, states), age group, and year. The age variable was consistently accessible and applied across all primary and supplementary data sources.

The internal review board of the Teaching Hospital, Federal University of Goiás approved the study protocol under reference CAAE 56747022.0.0000.5078. Informed consent was waived as open and unrestricted data were used.

Target population

Target population for 2013–2022 was calculated using population projections from IBGE's 2018 update [27], due to late 2022 census publication only on 28 June 2023. The percentage of women with private healthcare insurance was subtracted annually from projected sizes to estimate expected mammograms [28]. This percentage was stratified and varied annually by region, state, and age group to ensure precise estimation.

Mammography screening rate

Although the Ministry of Health does not recommend BC screening for women of 40–49 years of age or for those ≥ 70 years of age, for the purpose of comparing these groups with the 50-69-year group, it was decided to use the same method of calculating mammography screening rate for all groups. Annual mammogram counts (2013–2022) were sourced from SIA/DATASUS [25] (codes 02.04.03.018-8, 02.04.03.003-6).

Analysis was restricted to the period beginning in 2013, since the Oncology Panel data on clinical stage and on the time from diagnosis to treatment initiation are only available from that year onwards.

Under-notification is unlikely as registration is required for payment. Mammography screening rates accounted for private healthcare beneficiaries to avoid overestimation [28]. Assuming biennial screening for 100% of the target population, annual need covered half the female population [28]. Estimated percent coverage was the ratio of exams performed to expected exams for the target population [28].

Clinical staging

Clinical staging data, from 2013 onwards, was obtained from the Oncology Panel [26]. This refers to the final recorded clinical-histopathological stage at diagnosis. Only stages I, II, III, and IV were selected (excluding stage 0 that represents ductal carcinoma in situ, a precancerous lesion not considered breast cancer). Data was grouped into initial (stages I and II) and advanced (stages III and IV) stages of disease.

Time from diagnosis to treatment initiation

Time from diagnosis to treatment initiation was calculated in days from the diagnostic test date to the first treatment (surgery, chemotherapy, or radiotherapy). Data, available from 2013 [26], was categorized into ≤ 60 days and > 60 days. This calculation was performed for

all women with recorded data in the Oncology Panel, irrespective of their detection method or initial tumour stage. For surgical treatments, if diagnosis occurred post-surgery, procedures were counted within 0–30 days, provided negative time did not exceed 90 days [26].

Statistical analysis

Trends were analyzed using Annual Percent Change (APC) for Brazil, its macro-regions and states via Poisson regression model (JoinPoint Regression analysis [29]). Statistical significance was set at $p < 0.05$, with 95% confidence intervals (95%CI). Trends were classified as increasing (APC positive, CI lower limit > 0), decreasing (APC negative, CI upper limit < 0), or stable (CI includes zero).

Results

The study encompassed a substantial number of records from the Brazilian public health system (SUS) between 2013 and 2022. The data describe three variables across age groups: screening mammography, advanced staging, and treatment delay greater than 60 days. For screening mammography, there were 11,970,315 exams recorded for the 40–49 years group; 25,171,122 mammograms in the 50–69 years age group and 2,634,096 for the ≥ 70 years group, with a total of 39,775,533 exams. For local Stage III/IV, there are 38,677 cases in the 40–49 years group, 73,761 cases in the 50–69 years group, and 24,148 cases in the ≥ 70 years group, with a total of 136,586 cases recorded. For treatment delay greater than 60 days, there are 48,270 cases in the 40–49 years group, 112,440 cases in the 50–69 years group, and 38,023 cases in the ≥ 70 years group, totaling 198,733 cases.

Mammography screening rate

Over the period (2013–2022), average mammography screening rate was below the recommended levels for all age groups and in all geographical regions, often below 30% nationally, short of optimal levels (Table 1). Marked regional disparities were evident, with the North and Northeast exhibiting the lowest average rates. The Midwest also presented average rates below the national average, though typically higher than the North and Northeast. In contrast, the South and Southeast generally recorded higher, yet still suboptimal, rates for the same age cohorts. The mean mammography screening rate, according to each Brazilian state, can be seen in Fig. 1.

For the target age group of 50–69 years, mammography screening rates in some Northern states barely reached 10%. Similarly, women aged 40–49 and ≥ 70 years in the North and Northeast also experienced lower average screening rates compared to other macro-regions, highlighting a regional deficit irrespective of age group.

Analysis of Annual Percent Change (APC) revealed a concerning national decline in mammography screening rate (Table 2). In the 40–49 age group this decline

Table 1 Breast cancer mammographic screening rates, within Brazilian Public Healthcare System, by age group, for Brazil as a whole and by region, from 2013 to 2022

Breast cancer mammographic screening rates (%)											
Country/ Region	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**Mean**
40 to 49 years											
Brazil	31.33	28.66	26.06	24.32	21.85	20.79	19.69	11.93	16.31	19.11	22.00
North	12.77	14.42	12.41	9.40	9.81	9.03	8.66	6.48	7.64	9.40	10.00
Northeast	23.11	19.63	18.98	18.53	15.52	15.00	13.89	8.55	13.39	14.89	16.15
Southeast	41.42	40.07	35.53	32.02	28.71	27.58	25.84	15.60	20.58	24.70	29.20
South	40.14	33.16	31.74	30.67	29.29	27.70	26.46	15.83	20.20	23.30	27.85
Midwest	17.53	16.93	13.15	14.32	12.70	11.20	12.82	6.91	10.67	13.82	13.01
50 to 69 years											
Brazil	35.11	38.82	38.20	38.11	37.64	34.83	33.88	20.05	27.17	32.32	33.61
North	14.09	18.03	16.35	13.43	15.22	12.88	12.72	9.89	11.46	14.00	13.81
Northeast	26.50	29.10	30.44	32.04	32.40	26.36	25.63	14.07	22.29	23.95	26.28
Southeast	44.40	51.31	50.04	48.62	47.13	45.55	43.81	26.74	34.41	42.34	43.43
South	42.25	42.37	42.36	42.85	42.40	41.47	40.16	23.48	30.22	36.71	38.43
Midwest	19.57	20.41	15.55	17.10	15.96	15.39	18.03	9.64	15.59	20.29	16.75
≥ 70 years											
Brazil	13.37	12.92	12.41	12.02	11.35	11.06	10.77	6.31	8.01	10.33	10.85
North	4.82	5.60	5.22	4.30	4.83	3.93	3.85	2.78	2.96	3.92	4.22
Northeast	7.85	6.90	7.21	7.10	6.15	5.72	5.66	2.96	4.33	5.22	5.91
Southeast	18.90	19.25	18.19	17.37	16.41	16.39	15.87	9.74	12.11	16.01	16.02
South	15.83	14.38	14.36	14.34	14.39	14.12	13.76	7.92	9.76	12.47	13.13
Midwest	8.14	7.51	5.57	5.86	5.31	5.37	5.80	2.81	4.36	6.40	5.71

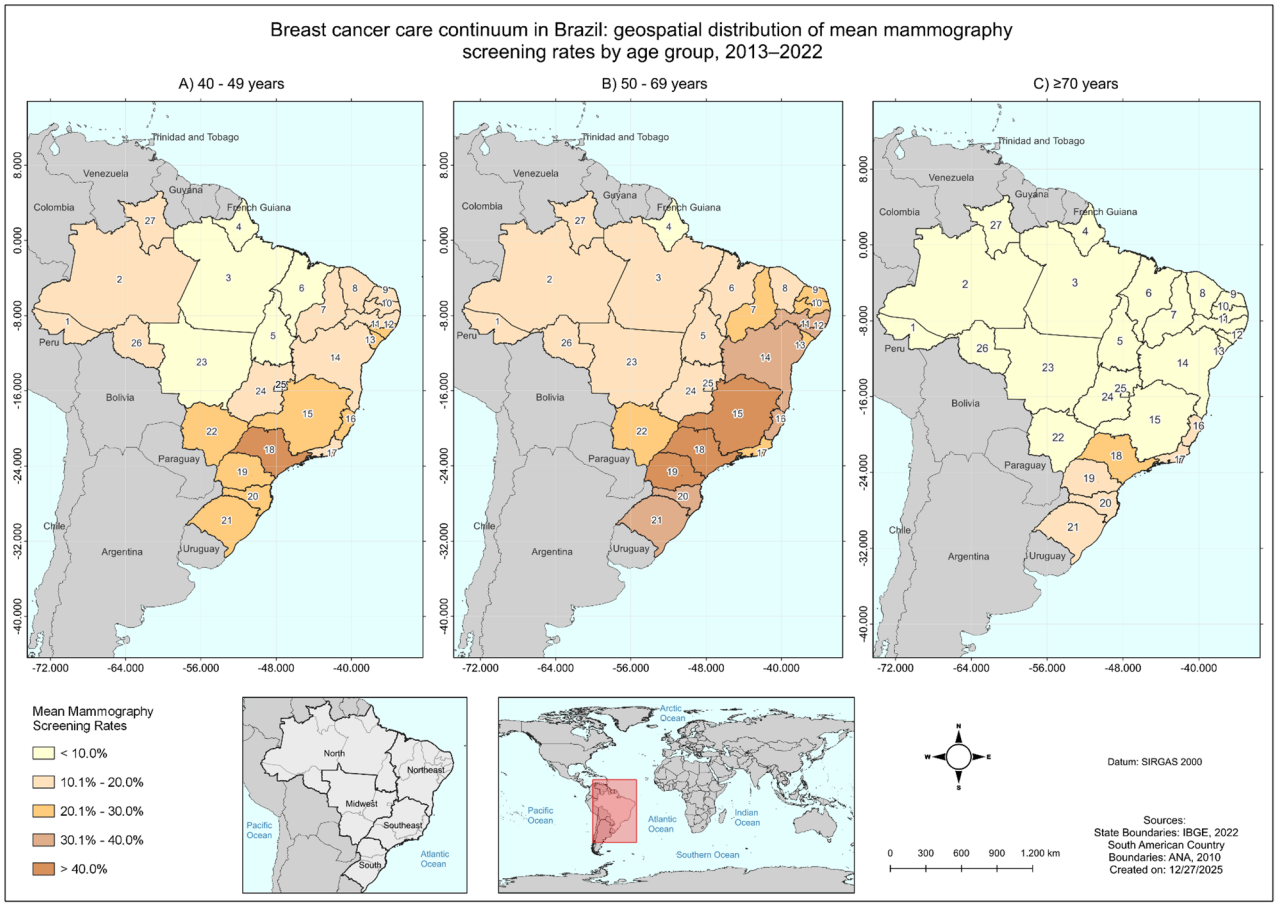

Fig. 1 The maps illustrate the mean mammography screening rates (%) across Brazilian states for three distinct age cohorts: **A** 40–49 years; **B** 50–69 years; and **C** ≥ 70 years. The colour gradient represents the average percentage of women who underwent screening within the public health system (SUS) during the study period. Data reflect the opportunistic screening model currently in place. Note: Brazilian Federative Units are numbered as follows: 1-AC; 2-AM; 3-PA; 4-AP; 5-TO; 6-MA; 7-PI; 8-CE; 9-RN; 10-PB; 11-PE; 12-AL; 13-SE; 14-BA; 15-MG; 16-ES; 17-RJ; 18-SP; 19-PR; 20-SC; 21-RS; 22-MS; 23-MT; 24-GO; 25-DF; 26-RO; 27-RR

was pronounced, between 2013 and 2020, with an APC of -10.79 (95%CI: -19.17 to -7.80 $p < 0.05$) and stabilized between 2020 and 2022, with an APC of 13.54 (95%CI: -7.76 to 29.78 $p < 0.05$), suggesting that the declining trend had been interrupted. In the ≥ 70 years age groups, there was a decreasing trend in breast cancer screening in Brazil over the study period, with an APC of -6.27 (95%CI: -10.13 to -2.69 $p < 0.05$).

These results reflect their non-prioritised status in current SUS screening recommendations for BC. Comparing regional trends, the North and Northeast exhibited the steepest and most statistically significant declines in mammography screening rates across all three age groups. The Midwest region also showed significant negative APCs, contributing to the overall national decline. Conversely, the South and Southeast showed more stable or less pronounced declines in screening rates across all age groups.

Detailed state-level trends for mammography screening rate are provided in the Supplementary Material (Supplementary Tables S1-S3).

Local advanced and advanced-Stage cases at diagnosis

Consistent with the observed screening patterns, average rates of clinical stage (III/IV) BC cases at diagnosis were alarming in Brazil as a whole, indicating a substantial burden of late detection and a gap in early detection over time.

In the 40-49-year age group, 54.3% of women were diagnosed at an advanced stage, with this being the highest national mean percentage, followed by the 70-year age group (49.12%) and the 50-69-year age group (48.44%), as shown in Table 3. The Midwest had the highest mean percentages of advanced stage cases in all age groups, particularly in the 40-49-year age group (66.90%). Means were also high in the North and Northeast in all age cohorts.

Table 2 Trends in breast cancer mammographic screening rates within the Brazilian Public Healthcare System, for Brazil as a whole and for each region, in women of 40–49, 50–69 and ≥ 70 years of age from 2013 to 2022

Regions/States	Age	Period 1	APC	95%CI	Interpretation	Period 2	APC	95%CI	Interpretation
Brazil	40–49	2013–2020	-10.79 *	-19.17 to -7.80	Reduction	2020–2022	13.54	-7.76 to 29.78	Stability
	50–69	2013–2022	-4.61	-9.23 to 0.23	Stability	-	-	-	-
	≥ 70	2013–2022	-6.27 *	-10.13 to 2.69	Reduction	-	-	-	-
North	40–49	2013–2020	-9.56 *	-23.02 to -4.25	Reduction	2020–2022	13.82	-8.45 to 31.64	Stability
	50–69	2013–2020	-6.24	-22.96 to 16.11	Stability	2020–2022	10.22	-12.08 to 30.22	Stability
	≥ 70	2013–2022	-7.39 *	-10.90 to -4.19	Reduction	-	-	-	-
Northeast	40–49	2013–2020	-9.91 *	-17.20 to -7.34	Reduction	2020–2022	15.93	-4.73 to 31.32	Stability
	50–69	2013–2022	-3.96	-8.05 to 0.02	Stability	-	-	-	-
	≥ 70	2013–2022	-7.97 *	-12.11 to -4.21	Reduction	-	-	-	-
Southeast	40–49	2013–2020	-10.72 *	-18.49 to -6.82	Reduction	2020–2022	9.81	-8.56 to 23.93	Stability
	50–69	2013–2022	-3.63 *	-7.01 to -0.48	Reduction	-	-	-	-
	≥ 70	2013–2022	-4.73 *	-9.06 to -0.69	Reduction	-	-	-	-
South	40–49	2013–2022	-7.06 *	-10.00 to -4.65	Reduction	-	-	-	-
	50–69	2013–2022	-3.56 *	-7.01 to -0.25	Reduction	-	-	-	-
	≥ 70	2013–2022	-5.28 *	-9.80 to -0.97	Reduction	-	-	-	-
Midwest	40–49	2013–2020	-8.51 *	-16.84 to -5.45	Reduction	2020–2022	18.81	-1.86 to 37.63	Stability
	50–69	2013–2020	-6.08 *	-17.51 to -2.46	Reduction	2020–2022	22.34 *	0.87 to 43.90	Increase
	≥ 70	2013–2020	-9.21 *	-21.66 to -5.22	Reduction	2020–2022	23.58	-0.31 to 47.36	Stability

* Statistically significant: $p < 0.05$; *APC* Annual percent change, *95%CI* 95% confidence interval. '-' symbol where a trend analysis was not applicable

Table 3 Late-stage breast cancer diagnosis rates within the Brazilian Public Healthcare System, by age group, for Brazil as a whole and by region, from 2013 to 2022

Advanced Stage Cases (%)											
Country/ Region	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**Mean**
40 to 49 years											
Brazil	50.12	50.50	52.75	53.35	53.59	53.59	54.11	56.20	57.54	58.60	54.03
North	56.38	60.75	59.79	57.64	63.61	59.61	64.52	65.20	62.82	63.34	61.37
Northeast	50.53	51.11	51.67	56.04	54.52	53.79	52.90	57.00	57.15	57.43	54.21
Southeast	49.64	50.87	53.69	52.20	53.59	54.22	53.93	55.85	56.91	58.97	53.99
South	46.34	45.20	46.96	47.48	46.22	47.91	47.93	49.09	50.37	51.27	47.88
Midwest	60.25	55.44	65.10	65.26	65.41	62.18	69.17	70.70	78.61	76.85	66.90
50 to 69 years											
Brazil	45.32	46.26	47.41	47.37	46.87	48.19	47.64	51.75	52.07	51.49	48.44
North	52.53	51.57	62.71	54.60	56.73	54.64	56.06	63.32	61.87	62.24	57.62
Northeast	48.26	47.07	46.61	48.68	48.23	48.48	47.22	53.33	50.43	50.54	48.88
Southeast	44.08	45.47	47.79	47.31	47.22	47.98	47.61	50.89	51.90	50.74	48.10
South	42.49	44.95	43.86	42.57	40.64	44.82	44.28	45.25	45.89	45.51	44.03
Midwest	52.69	52.97	53.84	56.41	56.25	57.52	58.15	67.73	73.70	70.30	59.95
≥ 70 years											
Brazil	45.04	45.75	48.20	47.73	49.47	47.92	48.82	53.63	52.85	51.77	49.12
North	46.38	52.96	57.02	61.52	58.02	51.65	53.53	62.67	54.81	57.10	55.56
Northeast	47.15	46.11	48.95	49.16	47.92	46.72	47.26	54.13	51.02	51.13	48.95
Southeast	44.23	46.41	48.28	48.59	49.88	49.77	49.06	53.74	53.59	50.98	49.45
South	43.45	42.56	46.19	44.97	49.03	45.37	48.09	49.10	47.50	49.69	46.60
Midwest	50.60	51.52	49.66	49.69	48.64	47.42	53.20	68.89	79.33	64.39	56.33

The 40–49 years cohort presented a high proportion of late diagnoses, underscoring the aggressive nature of the disease in younger women and potential diagnostic delays exacerbated by regional access barriers. This stark inverse correlation between low screening and high advanced-stage diagnoses underscores a failure in early detection mechanisms. The mean rates of BC cases diagnosed at clinical stages III/IV, according to each Brazilian state, can be seen in Fig. 2.

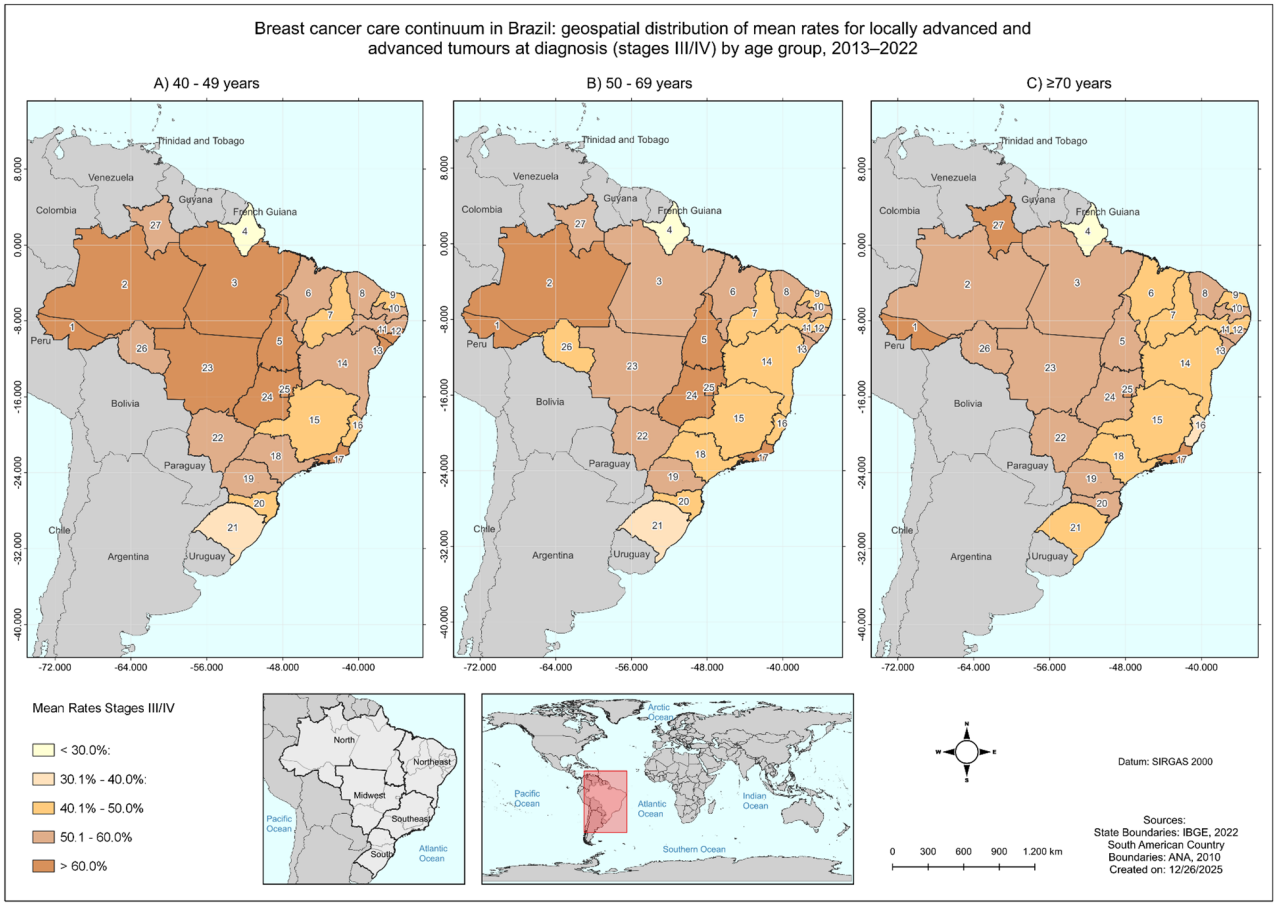

Fig. 2 The maps illustrate the mean rates for locally advanced and advanced tumours (%) at diagnosis (stages III/IV) across Brazilian states, segmented by age group: **A** 40–49 years; **B** 50–69 years; and **C** ≥ 70 years. Higher percentages indicate a greater burden of advanced-stage detection within each specific age group. Note: Brazilian Federative Units are numbered as follows: 1-AC; 2-AM; 3-PA; 4-AP; 5-TO; 6-MA; 7-PI; 8-CE; 9-RN; 10-PB; 11-PE; 12-AL; 13-SE; 14-BA; 15-MG; 16-ES; 17-RJ; 18-SP; 19-PR; 20-SC; 21-RS; 22-MS; 23-MT; 24-GO; 25-DF; 26-RO; 27-RR

As demonstrated in Table 4, in Brazil, the proportion of cases of BC diagnosed at advanced stages (III/IV) increased significantly between 2013 and 2022, in all age groups. 40–49 years of age APC of 1.71 (95%CI: 1.31 to -2.10 $p < 0.05$), 50–69 years of age APC 1.43 (95%CI: 0.95 to 1.95 $p < 0.05$), ≥70 years of age APC 1.82 (95%CI: 0.79 to 3.06 $p < 0.05$).

Regionally, the Midwest had higher average rates in advanced-stage diagnoses over time, in all age groups. The North and Northeast had higher average rates too.

Detailed state-level trends for advanced-stage diagnosis are provided in the Supplementary Material (Supplementary Tables S4-S6).

Time from diagnosis to treatment initiation > 60 days

As shown in Table 5, a substantial proportion of women in the SUS experienced delays in treatment initiation exceeding the legally mandated 60-day over the study period. This pervasive issue was evident across all age groups and regions, indicating systemic challenges in the patient journey that directly contravene national legislation.

The mean for Brazil was 53.29% for the 40-49-year age group, 56.56% for the 50-69-year age group and 57.56% for those 70 years of age. The highest mean percentages of these cases were in the North and Southeast of the country for all the age groups but particularly for the 70-year (61.01%) and 50-69-year age groups (59.89%). Although means were lower in the south of the country, there was an increasing trend, particularly after 2019. The mean rates of cases with a time > 60 days from breast cancer diagnosis to the initiation of treatment, according to each Brazilian state, can be seen in Fig. 3.

Furthermore, APC analysis revealed a worsening trend in treatment delays across various regions and age groups (Table 6). To the ≥70 years age group, showing an APC of 1.3 (95%CI: 1.51 to 2.36 $p < 0.05$), pointing to potential age-related biases or increased logistical complexities in their care. The 50–69 years age group also experienced significant increases in treatment delays, showing an APC of 1.27 (95%CI: 0.33 to 2.01 $p < 0.05$), underscoring

Table 4 Trends in late stage breast cancer diagnosis within the Brazilian Public Healthcare System, for Brazil as a whole and for each region, in women of 40–49, 50–69 and ≥ 70 years of age from 2013 to 2022

Regions/States	Age	Period 1	APC	95%CI	Interpretation	Period 2	APC	95%CI	Interpretation
Brazil	40–49	2013–2022	1.71 *	1.31 to 2.10	Increase	-	-	-	-
	50–69	2013–2022	1.43 *	0.95 to 1.95	Increase	-	-	-	-
	≥ 70	2013–2022	1.82 *	0.79 to 3.06	Increase	-	-	-	-
North	40–49	2013–2022	1.27 *	0.05 to 2.88	Increase	-	-	-	-
	50–69	2013–2022	1.44	-0.19 to 3.37	Stability	-	-	-	-
	≥ 70	2013–2022	1.04	-2.30 to 5.21	Stability	-	-	-	-
Northeast	40–49	2013–2022	1.42 *	0.83 to 2.06	Increase	-	-	-	-
	50–69	2013–2022	0.90 *	0.12 to 1.69	Increase	-	-	-	-
	≥ 70	2013–2022	1.17 *	0.29 to 2.24	Increase	-	-	-	-
Southeast	40–49	2013–2022	1.72 *	1.41 to 2.05	Increase	-	-	-	-
	50–69	2013–2022	1.54 *	0.90 to 2.18	Increase	-	-	-	-
	≥ 70	2013–2022	1.96 *	1.04 to 2.97	Increase	-	-	-	-
South	40–49	2013–2022	1.25 *	0.84 to 1.73	Increase	-	-	-	-
	50–69	2013–2017	1.10	-4.40 to 1.00	Stability	2017–2022	1.82 *	0.80 to 5.41	Increase
	≥ 70	2013–2022	1.21 *	0.14 to 2.34	Increase	-	-	-	-
Midwest	40–49	2013–2022	2.99 *	1.89 to 4.48	Increase	-	-	-	-
	50–69	2013–2022	1.54 *	0.90 to 2.18	Increase	-	-	-	-
	≥ 70	2013–2022	5.25 *	1.26 to 11.67	Increase	-	-	-	-

* Statistically significant: $p < 0.05$; *APC* Annual percent change, *95%CI* 95% confidence interval. '-' symbol where a trend analysis was not applicable

Table 5 Time from diagnosis to treatment initiation exceeding 60 days rates within the Brazilian Public Healthcare System by age group, for Brazil as a whole and by region, from 2013 to 2022

Time until treatment > 60 days (%)											
Country/ Region	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Mean
40 to 49 years											
Brazil	50.26	54.56	53.37	53.13	53.89	52.48	52.92	50.87	53.72	57.75	53.29
North	53.93	64.71	59.77	61.26	55.55	55.66	52.18	56.47	63.15	66.12	58.88
Northeast	46.06	49.63	48.91	50.21	52.55	50.93	49.70	51.17	51.30	58.86	50.93
Southeast	56.91	59.44	57.49	57.87	57.91	56.87	57.64	51.86	55.71	59.55	57.13
South	41.45	48.07	48.43	46.01	47.89	46.42	47.25	43.73	48.07	49.08	46.64
Midwest	44.26	53.51	51.14	48.81	51.21	47.72	51.69	58.84	59.66	61.62	52.85
50 to 69 years											
Brazil	52.02	55.68	55.78	55.83	57.20	56.89	57.89	53.75	58.28	62.28	56.56
North	58.60	63.94	59.49	61.11	59.42	59.19	57.33	60.90	65.66	64.49	61.01
Northeast	47.14	51.23	52.46	52.54	55.51	55.85	55.97	52.82	58.73	63.24	54.55
Southeast	57.43	60.40	60.16	60.39	60.64	60.98	60.27	55.14	59.25	64.24	59.89
South	43.91	48.22	49.21	49.46	51.35	49.30	53.95	48.40	52.92	55.31	50.20
Midwest	49.96	53.82	22.67	51.46	55.41	53.11	59.02	58.51	60.29	65.65	52.99
≥ 70 years											
Brazil	53.25	55.00	55.79	56.98	58.17	58.58	59.10	55.29	59.85	63.56	57.56
North	58.82	70.08	66.24	60.38	61.91	57.95	57.47	60.54	68.59	62.58	62.46
Northeast	51.18	55.69	53.33	56.08	60.59	61.14	60.16	55.79	61.13	65.67	58.07
Southeast	57.03	59.56	58.93	61.37	60.59	60.13	61.31	56.13	60.37	65.03	60.04
South	46.28	43.73	49.55	48.39	49.90	51.99	53.33	50.28	55.16	57.75	50.64
Midwest	51.91	48.68	56.12	53.14	60.62	59.30	58.58	61.41	61.64	67.90	57.93

that systemic inefficiencies impact even the priority population.

Detailed state-level trends for time from diagnosis to treatment initiation are provided in the Supplementary Material (Supplementary Tables S7-S9).

Discussion

Although oncological care has improved in Brazil, our findings highlights persistent disparities in BC screening, diagnosis, and treatment delays, regardless of age or region, align with broader global and regional contexts.

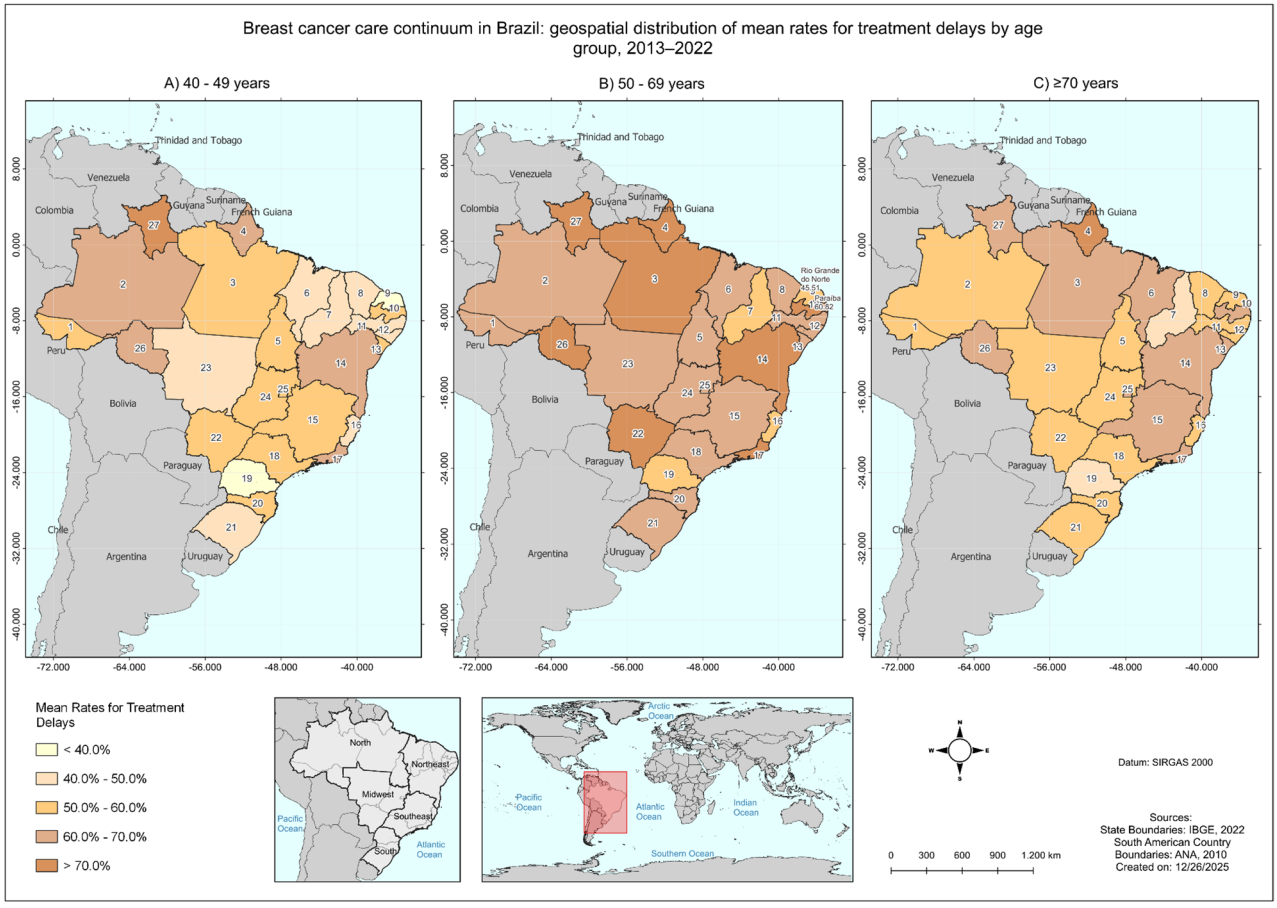

Fig. 3 The maps illustrate the mean rates (%) for treatment delay, defined as an interval ≥ 60 days between diagnosis and the initiation of treatment, across Brazilian states. The distribution is shown for: **A** 40–49 years; **B** 50–69 years; and **C** ≥ 70 years. The data highlight regional disparities in healthcare system responsiveness and patient navigation. Note: Brazilian Federative Units are numbered as follows: 1-AC; 2-AM; 3-PA; 4-AP; 5-TO; 6-MA; 7-PI; 8-CE; 9-RN; 10-PB; 11-PE; 12-AL; 13-SE; 14-BA; 15-MG; 16-ES; 17-RJ; 18-SP; 19-PR; 20-SC; 21-RS; 22-MS; 23-MT; 24-GO; 25-DF; 26-RO; 27-RR

The high mortality-to-incidence ratios in low- and middle-HDI regions, including Latin America, reflecting systemic failures into improved survival [1]. This positions Brazil alongside other nations in the intermediate HDI spectrum, where equitable access and quality of care remain challenging.

The continuous decline in BC screening rates, especially in the North and Midwest, may directly correlate with increased late-stage diagnoses. Regional disparities in diagnosis-to-treatment time also pose a critical challenge, notably in the North and Southeast.

Breast cancer screening and local advanced/advanced stage at diagnosis

From 2013 to 2022, BC screening rates for the 50–69 age group remained stable, albeit persistently below Ministry of Health recommendations [28], while declining for the 40–49 and ≥ 70 age groups. These age-stratified findings are consistent with broader global analyses, such as those by GLOBOCAN [1], which often highlight disproportionate screening gaps and subsequent treatment delays, particularly affecting women aged 40–49 and ≥ 70 years.

The observed decline in mammography screening practices reflects a consequence of inconsistent and inadequate public health strategies, especially in public health-dependent regions and evidence-based policy implementation [30].

This variation likely stems from non-uniform screening guidelines for younger and older women [14, 15]. Reduced mammography screening rates in these groups aligns with previous findings showing persistent challenges in early detection [17, 18, 31, 32]. Contributing factors include economic constraints, decreased prioritization of preventive services [33], COVID-19 impact [18, 32], limited healthcare access [33], and reduced focus on older women's screening [17].

The COVID-19 pandemic exacerbated breast cancer care challenges, evidenced by a more pronounced decline in screening and an increase in advanced-stage diagnoses [18, 32]. While interventions led to some regional

Table 6 Trends in time from diagnosis to treatment initiation within the Brazilian Public Healthcare System, for Brazil as a whole and for each region, in women of 40–49, 50–69 and 70 + years of age from 2013 to 2022

Regions/States	Age	Period 1	APC	95%CI	Interpretation	Period 2	APC	95%CI	Interpretation
Brazil	40–49	2013–2022	0.69	-0.49 to1.80	Stability	-	-	-	-
	50–69	2013–2022	1.27 *	0.33 to 2.01	Increase	-	-	-	-
	≥ 70	2013–2022	1.83 *	1.51 to2.36	Increase	-	-	-	-
North	40–49	2013–2019	-1.97	-8.54 to 0.42	Stability	2019–2022	6.59 *	1.21 to 17.68	Increase
	50–69	2013–2019	-0.48	-5.12 to 5.10	Stability	2019–2022	37.337	-1.00 to 9.19	Stability
	≥ 70	2013–2019	-2.33	-12.40 to 6.44	Stability	2019–2022	4.95	-2.04 to 13.9	Stability
Northeast	40–49	2013–2022	1.74 *	0.25 to 3.23	Increase	-	-	-	-
	50–69	2013–2022	2.59 *	1.46 to 3.64	Increase	-	-	-	-
	≥ 70	2013–2022	2.18 *	0.68 to 3.72	Increase	-	-	-	-
Southeast	40–49	2013–2022	-0.17	-0.82 to 0.51	Stability	-	-	-	-
	50–69	2013–2022	0.44	-0.23 to 1.03	Stability	-	-	-	-
	≥ 70	2013–2022	0.85	-0.02 to 1.65	Stability	-	-	-	-
South	40–49	2013–2022	0.52	-0.71 to 1.80	Stability	-	-	-	-
	50–69	2013–2022	1.84 *	0.71 to 2.88	Increase	-	-	-	-
	≥ 70	2013–2022	2.57 *	1.83 to 3.36	Increase	-	-	-	-
Midwest	40–49	2013–2018	0.17	-9.88 to 7.45	Stability	2018–2022	6.32 *	1.13 to 16.00	Increase
	50–69	2013–2022	2.98 *	1.69 to 4.60	Increase	-	-	-	-
	≥ 70	2013–2022	2.99 *	1.32 to 5.01	Increase	-	-	-	-

* Statistically significant: $p < 0.05$; *APC* Annual percent change, *95%CI* 95% confidence interval. '-' symbol where a trend analysis was not applicable

screening stabilization from 2020 [32], this was not uniform, with the ≥70 age group receiving less attention, raising concerns regarding the vulnerability of this group.

The high incidence of stage III/IV BC cases [6, 7, 33] is alarming, emphasizing an urgent need for improved early detection across all age groups [17, 18, 33, 34]. Internationally, local advanced and advanced stages correlate with greater aggressiveness, less effective treatment, and poorer prognosis [22]. However, inadequate screening access, diagnostic delays, and limited treatment resources can also contribute to this trend [31, 33].

Decreased screening mammography rates alongside increased late-stage diagnoses suggests public health policies and awareness campaigns are ineffective [35, 36]. Poor screening compliance inevitably leads to more advanced diagnoses [6, 37, 38]. This underscores the need for better early detection, diagnosis, and treatment access. Delayed diagnosis is also influenced by lack of information [39], low education [33], lower socioeconomic status [33], and limited healthcare access [31, 33].

A comparison of the two healthcare systems in Brazil, public (SUS) and private, showed that in the former there is a greater tendency for patients to present a worse prognosis, not due to the characteristics of the tumors, but due to the difficulties faced by the patient in screening, diagnosis and treatment [8, 9, 40]. The present study emphasizes the difficulties faced by BC patients treated by the Brazilian Unified Health System (SUS), showing, over a decade, the difficulties observed in 3 different points of the patient's journey, as well as the lack of improvement in the 3 dimensions, even for patients who are considered of the priority group for the Ministry of Health (50 to 69 years old).

Regarding the elderly population (≥70 years), the data reveal a concerning trend towards late-stage diagnosis similar other studies that demonstrate stage IV reaching 20.4% within this age group [9]. This suggests that the cessation of routine screening after the age of 69, combined with potential diagnostic overshadowing by age-related comorbidities, significantly compromises early detection and adversely impacts overall survival [17].

Regional differences and socioeconomic factors

Our study highlights regional disparities, with outcomes poorer in Brazil's less developed regions, particularly the North, Northeast and Midwest. Geographical barriers and prevailing socioeconomic factors, especially in rural areas, significantly impede access to care, reflecting broader challenges observed across Latin America [3].

These disparities are deeply rooted in Brazil's continental geography and socioeconomic landscape. The territory is fundamentally characterised by a stark distinction between state capitals (primary urban and technological hubs where specialised oncology services and infrastructure are concentrated) and the 'interiors', vast regions comprising smaller municipalities and rural areas [41]. In these interiors, particularly across the North, Northeast, and Midwest, patients face significant logistical challenges, including extensive travel distances to reach urban centres for screening, diagnosis and treatment. This geographical impediment, compounded by high poverty levels, directly contributes to the higher rates

of advanced-stage diagnoses and prolonged treatment delays observed in the present study.

Our findings align with previous reports demonstrating significant variations in BC screening and treatment outcomes, consistently poorer in less developed states [6, 31, 32]. These disparities are attributable to variations in health infrastructure [42], resource allocation [31, 43], and socioeconomic conditions, including education and income levels [33], which collectively determine healthcare access [6, 7, 38]. Consequently, vulnerable populations disproportionately face challenges in accessing screening and early treatment, leading to higher rates of late-stage diagnosis [33, 38, 39, 42].

The presents data confirm that access issues within the SUS are not primarily due to a scarcity of mammography devices, but rather their unequal geographic distribution and insufficient utilisation [7, 31, 44]. Despite the SUS's expanded reach, significant access variations persist, particularly in smaller or poorer municipalities [10]. The underutilisation of existing equipment stems from a shortage of qualified personnel and bottlenecks in specialised care, directly contributing to prolonged waiting times for diagnosis and treatment initiation [10].

This systemic inefficiency within the public sector contrasts with the private sector, where women with PHI exhibit higher screening rates and earlier diagnoses [34, 45]. This divergence is exacerbated by the SUS's fragmented diagnostic and treatment pathways, forcing patients into an uncoordinated journey. Consequently, socioeconomic status and insurance type remain primary determinants of breast cancer outcomes in Brazil [11].

The diagnostic journey within the SUS is frequently hindered by structural fragmentation and a critical lack of digital integration. Many public referral centres lack on-site specialised diagnostic services (e.g., histopathology, immunohistochemistry), compelling patients to navigate a complex, Fragmented network of external laboratories [46]. This fragmentation often necessitates patients physically retrieving and transporting paper-based diagnostic results, a burden amplified by vast travel distances in many Brazilian regions. Such logistical bottlenecks contribute to treatment delays. Conversely, integrated diagnostic services and Non-Governmental Organisation-supported patient navigation have proven effective in substantially reducing time from consultation to treatment initiation, underscoring the urgent need for a cohesive 'one-stop-shop' approach in the public sector [46].

Ultimately, developed regions like the Southeast achieve greater early diagnosis [32], while less developed regions (North, Northeast and Midwest) struggle with late-stage diagnoses and treatment delays [31, 42]. These disparities reflect unequal resource distribution and ineffective public policies [31].

The increase in late-stage breast cancer diagnoses and extended diagnosis-to-treatment times (> 60 days) underscores the need to improve both screening and healthcare system efficiency in timely treatment initiation [42]. Geographical, economic, and social barriers necessitate targeted public policies [32, 42]. Prolonged time interval from diagnosis to treatment initiation and barriers to the healthcare system.

Prolonged time interval from diagnosis to treatment initiation and barriers to the healthcare system

A prolonged diagnosis-to-treatment interval is a major concern. Our findings, consistent with other studies [9, 31, 42, 43, 47], reveal significant treatment initiation delays (exceeding 60 days) for a substantial proportion of women, with over 50% affected irrespective of age group. Brazil's median treatment intervals are significantly longer than the sub-one-month standard in high-income nations [48]. Such delays, especially in advanced-stage patients, directly worsen survival and require more complicated treatment regimens [22, 49, 50].

The interval between diagnosis and the initiation of treatment has seen a marked and detrimental increase over the last two decades. The median time to treatment more than doubled from 32 days in the 2000–2004 period to 76 days in 2015–2019 [9]. This systemic delay is particularly pronounced for patients diagnosed outside the treating institution, suggesting that fragmented care pathways and bureaucratic hurdles in the referral system are primary drivers of treatment postponement and undermines clinical outcomes [9].

The efficacy of breast cancer management in Brazil is different between SUS and PHI. Patients within the public system face significantly longer wait times for both diagnostic confirmation and treatment initiation compared to those in the PHI [9]. Healthcare system complexity and lack of service integration contribute to these outcomes [30, 51], highlighting the need for more effective referral and simplified treatment pathways [42, 43]. Private facilities offer quicker access due to simplified processes, emphasizing public/private healthcare inequalities and the need for SUS improvements [42].

Implications for future public policies

Given that around 70% of Brazilians population depends on the SUS [12] and screening mammography is low, comprehensive strategies are needed to address early detection and treatment gaps. To mitigate the economic burden of BC and improve survival rates, Brazil must urgently transition from an opportunistic to an organized national screening program. Such a shift requires multifaceted strategies beyond mere equipment provision, including structured referral guidelines for suspicious cases, continuous training for healthcare professionals,

and the implementation of patient navigation systems [52].

Tailored interventions and improving primary healthcare are essential to overcome documented barriers and ensure equitable access across diverse populations [3], guaranteeing timely specialist referrals.

In India a study showed that clinical breast examination (CBE) may reduce mortality by almost 30% and late-stage diagnosis in women > 50 years of age [53]. In Brazil, the only ongoing multicenter, phase III, randomized, prospective clinical trial has trained female community health workers to perform a physical breast examination on women of 40 years of age or more within the SUS. That study aims to evaluate the effectiveness of this structured screening in reducing the rates clinical stages (III and IV) at diagnosis and of breast cancer-related mortality [54].

Training community health workers for CBE is a viable and scalable SUS strategy, especially for women who do not have regular access to mammography. This realistically expands screening and provides a practical path to reduce late diagnoses and mortality within the financial and structural limitations of the SUS. Furthermore, increasing mammography services (especially in underserved areas) and promoting awareness campaigns are crucial. Simplifying referral processes by reducing bureaucracy will accelerate treatment initiation and improve outcomes. Finally, developing targeted interventions addressing regional needs is essential to reduce socioeconomic disparities and ensure equitable healthcare access.

This study's limitations stem primarily from its reliance on publicly available, aggregate secondary data from the DATASUS platform (SIA/DATASUS, Oncology Panel), IBGE, and ANS. While this approach ensures a large, representative sample, it restricts our ability to incorporate granular individual-level demographic data. Consequently, despite effectively highlighting regional and age-group disparities in BC screening, diagnosis, and treatment delays, our analysis cannot fully explore their underlying social determinants.

Furthermore, the state-level data may mask more severe intra-state disparities, particularly between capital cities and rural areas, where healthcare access is more constrained. Future research should address this intra-state granularity.

Potential limitations also include inherent delays in data updates and the possibility of underreporting for cancer cases in DATASUS. However, the mandatory registration of all tumor diagnoses, regardless of aggressiveness, and the payment-linked recording of mammograms minimize the likelihood of significant under-notification, particularly for screening data.

Conclusion

Despite advances in certain areas about breast cancer, Brazil continues to confront significant challenges in BC control, particularly regarding equitable access to screening, diagnosis and treatment. The regional and age-related disparities identified in this study underscore an urgent need for targeted public policy interventions. These findings are critical for public health managers seeking to reform BC screening, diagnosis, and treatment strategies for women aged ≥ 40 years in Brazil.

We strongly recommend the extension of BC screening guidelines to include women aged 40–49 and those ≥ 70 years, integrated within Ministry of Health protocols. Such an expansion is essential to ensure that all women, irrespective of their geographical location or age group, receive timely diagnosis and appropriate treatment. Addressing these systemic disparities is paramount not only for reducing the substantial human and economic costs associated with BC but also for advancing Brazil towards more equitable health outcomes, potentially serving as a transferable model for other LMICs confronting similar public health challenges.

Abbreviations

APC	Annual Percent Change
CAAE	Certificate of Presentation for Ethical Appreciation
CBE	Clinical Breast Examination
CI	Confidence Interval
DATASUS	Brazilian Public Health System Department
HDI	Human Development Index
IBGE	Brazilian Institute of Geography and Statistics
INCA	Brazilian National Cancer Institute
LMICs	Low- and middle-income countries
PHI	Private Insurance Health
SUS	Unified Health System
SIA/DATASUS	SUS Outpatient Health Data System
WHO	World Health Organization

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12889-026-26805-7.

Supplementary Material 1.

Acknowledgements

Not applicable.

Authors' contributions

RFJ was responsible for the conception and study design. AFBMR was responsible for the collection and assembly of data. All author were resposible for data analysis, interpretation and manuscript writing. All authors read and approved the final manuscript.

Funding

No funding.

Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study was conducted ethically and in accordance with the Declaration of Helsinki. The internal review board of the Teaching Hospital, Federal University of Goiás approved the study protocol under reference CAAE 56747022.0.0000.5078. Since the study was conducted using freely available, unrestricted secondary data, the requirement for signed informed consent was waived by the aforementioned ethics committee.

Consent for publication

Not Applicable.

Competing interests

The authors declare no competing interests.

Author details

[1]Advanced Center for Breast Diagnosis (CORA), Mastology Program, Teaching Hospital Federal University of Goiás, 1ª Avenida, s/n, Setor Universitário, Goiânia, Goiás, GO 74605-050, Brazil
[2]Postgraduate Program in Health Sciences, School of Medicine, Federal University of Goiás, 1ª Avenida, s/n, Setor Universitário, Goiânia 74605-050, GO, Brazil
[3]Goiás State Department of Education, 5ª Avenida, 212, Setor Leste Vila Nova, Goiânia 74643-030, GO, Brazil

Received: 1 October 2025 / Accepted: 20 February 2026
Published online: 10 March 2026

References

1. Liao L. Inequality in breast cancer: Global statistics from 2022 to 2050. Breast. 2025;79:103851. https://doi.org/10.1016/j.breast.2024.103851. Epub 2024 Nov 22. PMID: 39580931; PMCID: PMC11625356.
2. Alvarado-Cabrero I, Doimi F, Ortega V, de Oliveira Lima JT, Torres R, Torregrosa L. Recommendations for streamlining precision medicine in breast cancer care in Latin America. Cancer Rep (Hoboken). 2021;4(6):e1400. https://doi.org/10.1002/cnr2.1400. Epub 2021 May 3. PMID: 33939336; PMCID: PMC8714537.
3. Guerron-Gomez G, Rojas-Fierro M, Parra-Medina R, Mosquera A, Suarez MG. A reflective analysis on the inequities in cancer diagnosis and treatment in Latin America: a call to action for public health. Int J Equity Health. 2025;24(1):113. https://doi.org/10.1186/s12939-025-02457-8. PMID: 40296041; PMCID: PMC12038987.
4. IARC, The Global Cancer O. 2021, Brazil. Globocan incidence, mortality and prevalence by cancer site. Available from: https://gco.iarc.fr/today/data/factsheets/populations/76-brazil-fact-sheets.pdf. Acessed 4 Jul 2022.
5. INCA. Estimativa 2023: incidência de câncer no Brasil. [2023 Estimate: cancer incidence in Brazil.] Rio de Janeiro: Instituto Nacional de Câncer José Alencar Gomes da Silva; 2019. https://www.inca.gov.br/publicacoes/livros/estimativa-2023-incidencia-de-cancer-no-brasil. Acessed 23 Apr 2023.
6. Abrahão KS, Bergmann A, Aguiar SS, Thuler LC. Determinants of advanced stage presentation of breast cancer in 87,969 Brazilian women. Maturitas. 2015;82:365–70. https://doi.org/10.1016/j.maturitas.2015.07.021. Acessed 10 May 2022.
7. Oliveira NPD, de Camargo Cancela M, Martins LFL, de Souza DLB. A multilevel assessment of the social determinants associated with the late-stage diagnosis of breast cancer. Sci Rep. 2021;11:2712. Acessed 2023 Fev 1. https://www.nature.com/articles/s41598-021-82047-0.
8. Rosa DD, Bines J, Werutsky G, Barrios CH, Cronemberger E, Queiroz GS, de Lima VCC, Freitas-Júnior R, Couto JD, Emerenciano K, Resende H, Crocamo S, Reinert T, Van Eyil B, Nerón Y, Dybal V, Lazaretti N, de Cassia Costamilan R, de Andrade DAP, Mathias C, Vacaro GZ, Borges G, Morelle A, Caleffi M, Filho CS, Mano MS, Zaffaroni F, de Jesus RG, Simon SD. The impact of sociodemographic factors and health insurance coverage in the diagnosis and clinicopathological characteristics of breast cancer in Brazil: AMAZONA III study (GBECAM 0115). Breast Cancer Res Treat. 2020;183(3):749–57. https://doi.org/10.1007/s10549-020-05831-y. Epub 2020 Jul 29. PMID: 32728860.
9. Verduzco-Aguirre H, Favorito FM, Ynoe de Moraes F, Marta G, Tagle C, Henrique Dos Anjos C, Mattar A, Wilson BE. Twenty years of breast cancer epidemiology and treatment patterns in São Paulo, Brazil-observed versus expected treatment utilization in a retrospective cohort. Lancet Reg Health Am. 2025;47:101115. https://doi.org/10.1016/j.lana.2025.101115. PMID: 40476049; PMCID: PMC12135424.
10. Castro MC, Massuda A, Almeida G, et al. Brazil's unified health system: the first 30 years and prospects for the future. Lancet. 2019;394(10195):345–56.
11. Coube M, Nikoloski Z, Mrejen M, et al. Persistent inequalities in health care services utilisation in Brazil (1998–2019). Int J Equity Health. 2023;22:25.
12. IBGE. Instituto Brasileiro de Geografia e Estatística. 2020. Pesquisa Nacional de Saúde 2019: percepção do estado de saúde, estilos de vida, doenças crônicas e saúde bucal: Brasil e grandes regiões. IBGE, Coordenação de Trabalho e Rendimento. [2019 National Health Survey: perception of health status, lifestyles, chronic diseases and oral health: Brazil and major regions. IBGE, Coordination of Work and Income]. Available from: https://www.pns.icict.fiocruz.br/wpcontent/uploads/2021/02/liv101764.pdf. Acessed 10 May 2022.
13. IBGE. Pesquisa nacional de saúde, 2019: Informações sobre domicílio, acesso e utilização de serviços de saúde. Rio de Janeiro: IBGE; 2020.
14. Migowski A, Silva GAE, Dias MBK, Diz MDPE, Sant'Ana DR, Nadanovsky P. Guidelines for early detection of breast cancer in Brazil. II – New national recommendations, main evidence, and controversies. Cad Saude Publica. 2018;34:e00074817. https://www.scielo.br/j/csp/a/8gGyb5s9Nt3nSsw5GFnnPQb/?lang=en. Acessed 12 Jun 2023.
15. Urban LABD, Chala LF, de Paula IB, Bauab SDP, Schaefer MB, Oliveira ALK et al. Recommendations for breast cancer screening in Brazil, from the Brazilian College of Radiology and Diagnostic Imaging, the Brazilian Society of Mastology, and the Brazilian Federation of Gynecology and Obstetrics Associations. Radiol Bras. 2023;56:207–14. https://www.scielo.br/j/rb/a/GsFsxzqvS8YqVPqb43vtW4h/?lang=en Acessed 14 Jan 2024.
16. World Health Organization. WHO Position Paper on Mammography Screening. Geneva: World Health Organization. 2014. Available from: https://www.ncbi.nlm.nih.gov/books/NBK269545/
17. Rocha AFBM, Freitas-Junior R, Soares LR, Ferreira GLR. Breast cancer screening and diagnosis in older adult women in Brazil: why it is time to reconsider the recommendations. Front Public Health. 2023;11:1232668. https://doi.org/10.3389/fpubh.2023.1232668/full. Acessed 2024 Mar 25. https://www.frontiersin.org/journals/public-health/articles/.
18. Rocha AFBM, Freitas-Junior R, Ferreira GLR, Rodrigues DCN, Rahal RMS. COVID-19 and breast cancer in Brazil. Int J Public Health. 2023;68:1605485. https://doi.org/10.3389/ijph.2023.1605485/full. Acessed 2024 Mar 12. https://www.ssph-journal.org/journals/international-journal-of-public-health/articles/.
19. WHO, Cancer. 2022. Available from: https://www.who.int/news-room/fact-sheets/detail/cancer. Acessed 6 Jul 2022.
20. Canelo-Aybar C, Ferreira DS, Ballesteros M, Posso M, Montero N, Solà I, et al. Benefits and harms of breast cancer mammography screening for women at average risk of breast cancer: A systematic review for the European Commission Initiative on Breast Cancer. J Med Screen. 2021;28:389–404. https://doi.org/10.1177/0969141321993866.
21. Petrova D, Garrido D, Špacírová Z, Fernández-Martínez NF, Ivanova G, Rodríguez-Barranco M, et al. Duration of the patient interval in breast cancer and factors associated with longer delays in low-and middle-income countries: A systematic review with meta-analysis. Psychooncology. 2023;32:13–24. https://doi.org/10.1002/pon.6064. Acessed 2024 Mar 4.
22. Bleicher RJ. Timing and delays in breast cancer evaluation and treatment. Ann Surg Oncol. 2018;25:2829–38. https://doi.org/10.1245/s10434-018-6615-2. Acessed 2022 Jul 4. https://link.springer.com/article/.
23. Legislaçãoda Presidência da República. Lei no 12.732 de 22 de novembro de 2012. [Legislation of the Brazilian Presidency of the Republic. Law No. 12,732 of November 22, 2012]. https://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/l12732.htm. Acessed 8 Jul 2024.
24. Brazilian Institute of Geography and Statistics (IBGE). Brazilian Territorial Division. Rio de Janeiro: IBGE. 2024. Available from: https://www.ibge.gov.br/geociencias/organizacao-do-territorio/divisao-regional/23701-divisao-territorial-brasileira.html. Accessed 30 Apr 2025.
25. DATASUS. Departamento de Informática do SUS-DATASUS. 2016. Sistema de Informações Ambulatoriais do SUS-SIASUS. [SUS-DATASUS Information Technology Department, 2016. SUS-SIASUS Outpatient Information System.] Available from: http://tabnet.datasus.gov.br/cgi/deftohtm.exe?sia/cnv/qbuf.def. Acessed 2 Apr 2022.
26. DATASUS. Painel de Monitoramento do Tratamento Oncológico: Painel-Oncologia. 2022. [Oncology Treatment Monitoring Panel: Oncology Panel, 2022]. Available from: http://tabnet.datasus.gov.br/cgi/dhdat.exe?PAINEL_ONCO/PAINEL_ONCOLOGIABR.def. Acessed 17 Apr 2022.
27. IBGE. Instituto Brasileiro de Geografia e Estatística. 2018. Projeções da população do Brasil e unidades da federação por sexo e idade: 2010–2060. [Brazilian

Institute of Geography and Statistics, 2018. Projections of the population of Brazil and its states by sex and age: 2010–2060]. Acessed 19 Mar 2022.
28. INCA. Parâmetros técnicos para rastreamento do câncer de mama. [Technical parameters for breast cancer screening.] Rio de Janeiro: Instituto Nacional de Câncer José Alencar Gomes da Silva. 2021. Available from: https://controlecancer.bvs.br/. Acessed 4 Jul 2022.
29. National Cancer Institute. Statistical Methodology and Applications Branch, Surveillance Research Program, 2023. Joinpoint Regression Program. Available from: https://surveillance.cancer.gov/joinpoint/. Acessed 12 Feb 2024.
30. Freitas-Junior R, et al. Mammography Coverage in Brazil and the Presidential Elections: Is There Anything to Celebrate? JCO Glob Oncol. 2023;9:e2200358. https://doi.org/10.1200/GO.22.00358.
31. Peroni DMA, Lindelow F, Oliveira de Souza M, Sjoblom D. Realizing the right to health in Brazil's Unified Health System through the lens of breast and cervical cancer. Int J Equity Health. 2019;18:39. https://doi.org/10.1186/s12939-019-0938-x. Acessed 2022 May 16. https://equityhealthj.biomedcentral.com/articles/.
32. Ferreira HNC, Capistrano GN, Morais TNB, Costa KT, Quirino ALS, Costa RLP, et al. Screening and hospitalization of breast and cervical cancer in Brazil from 2010 to 2022: A time-series study. PLoS ONE. 2023;18:e0278011. Acessed 2024 Jul 11. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0278011.
33. Campos AAL, Guerra MR, Fayer VA, Ervilha RR, Cintra JRD, Medeiros IR et al. Time to diagnosis and treatment for breast cancer in public and private health services. Rev Gaucha Enferm. 2022;43:e20210103. https://www.scielo.br/j/rgenf/a/w44Z5w37Y8j9fgR4B7zRFft/?lang=en. Acessed 4 Feb 2023.
34. Freitas-Junior R, Rocha AFBM, Couto HL, Bessa JF, Urban LABD. COVID-19 and breast cancer diagnosis in Brazil: An analogy to the sinking of the Titanic. JCO Glob Oncol. 2023;9:e2300108. https://doi.org/10.1200/GO.23.00108. Acessed 15 Jan 2024.
35. Sá MFS. Pink October and breast cancer in Brazil. Rev Bras Ginecol Obstet. 2021;43:725–7. https://journalrbgo.org/article/pink-october-and-breast-cancer-in-brazil/.
36. Antonini M, Pinheiro DJP, Salerno GRF, Matos ABT, Ferraro O, Mattar A, et al. Does Pink October really impact breast cancer screening? Public Health Pract. 2022;4:100316. Acessed 2024 Jan 25. https://www.sciencedirect.com/science/article/pii/S2666535222000921?via%3Dihub.
37. Franzoi MA, Rosa DD, Zaffaroni F, Werutsky G, Simon S, Bines J, et al. Advanced stage at diagnosis and worse clinicopathologic features in young women with breast cancer in Brazil: A subanalysis of the AMAZONA III Study (GBECAM 0115). J Glob Oncol. 2019;5:1–10. https://doi.org/10.1200/JGO.19.00263. Acessed 2024 Feb 10.
38. Lee BL, Liedke PE, Barrios CH, Simon SD, Finkelstein DM, Goss PE. Breast cancer in Brazil: present status and future goals. Lancet Oncol. 2012;13:e95–e102. https://doi.org/10.1016/S1470-2045(11)70323-0. Acessed 10 May 2022.
39. de Almeida RJ, de Moraes Luizaga CT, Eluf-Neto J, de Carvalho Nunes HR, Pessoa EC, Murta-Nascimento C. Impact of educational level and travel burden on breast cancer stage at diagnosis in the state of Sao Paulo, Brazil. Sci Rep. 2022;12:8357. https://www.nature.com/articles/s41598-022-12487-9. Acessed 2023 Mar 18.
40. Barroso-Sousa R, Laperche-Santos D, Resende H, Moura FC, Sousa Oliveira SC, Shimada AK, Arakelian R, Galvão ALZ, de Souza BSW, Custodio AGC, de Andrade MCFM, Bittencourt YCRB, Figueroa Magalhães MC, de Pádua Souza C, Paiva CE, Signorini PA, Pereira DJ, Nogueira-Rodrigues A, Rosa DD, Bychkovsky B, Assad-Suzuki D. Cancer: Impact of Public Versus Private Health Care on Diagnosis-to-Treatment Interval in Brazil. JCO Glob Oncol. 2025;11:e2500012. https://doi.org/10.1200/GO-25-00012. Epub 2025 Oct 8. PMID: 41061177. Cancer Health Disparities Among Patients With Early-Stage Estrogen Receptor-Positive Breast.
41. Gonzaga CM, Freitas-Junior R, Souza MR, Curado MP, Freitas NM. Disparities in female breast cancer mortality rates between urban centers and rural areas of Brazil: ecological time-series study. Breast. 2014;23(2):180–7. https://doi.org/10.1016/j.breast.2014.01.006. Epub 2014 Feb 4. PMID: 24503143.
42. Alves Soares Ferreira N, Melo Figueiredo de Carvalho S, Engrácia Valenti V, Pinheiro Bezerra IM, Melo Teixeira Batista H, de Abreu LC, et al. Treatment delays among women with breast cancer in a low socio-economic status region in Brazil. BMC Womens Health. 2017;17:13. https://doi.org/10.1186/s12905-016-0359-6. Acessed 2023 Oct 18. https://bmcwomenshealth.biomedcentral.com/.
43. Medeiros GC, Teodózio CGC, Fabro EAN, Aguiar SS, Lopes AHM, Conte BC, et al. Factors associated with delay between diagnosis and initiation of breast cancer treatment: a cohort study with 204,130 cases in Brazil. Revista Brasileira de Cancerologia. 2020;66:e–09979. Acessed 2024 Jun 10. https://rbc.inca.gov.br/index.php/revista/article/view/979/777.
44. Rodrigues DCN, Freitas-Junior R, Rahal RMS, Corrêa RS, Peixoto JE, Ribeiro NV, et al. Difficult access and poor productivity: mammography screening in Brazil. Asian Pac J Cancer Prev. 2019;20:1857–64. https://journal.waocp.org/?sid=Entrez:PubMed&id=pmid:31244310&key=2019.20.6.1857.
45. Vieira RAC, Formenton A, Bertolini SR. Breast cancer screening in Brazil. Barriers related to the health system. Rev Assoc Med Bras. 2017;63:466–74. Acessed 2023 Nov. 10. https://www.scielo.br/j/ramb/a/hCsgBd8kPG7YmNtLDc9csFg/?lang=en.
46. Dos Santos Andrade LS, De Melo Santos TT, Case de Oliveira ME, Lima Gomes KA, Araújo Pereira Soares AR, Almeida de Oliveira T, Weller M. Shorter delay to treatment by integrated diagnostic services and NGO-provided support among breast cancer patients in two Brazilian referral centres. J Public Health Res. 2021;10(3):1880. https://doi.org/10.4081/jphr.2021.1880. PMID: 33709643; PMCID: PMC8314677.
47. Nogueira MC, Atty ATM, Tomazelli J, Jardim BC, Bustamante-Teixeira MT, Silva GAE. Frequency and factors associated with delay in breast cancer treatment in Brazil, according to data from the Oncology Panel, 2019–2020. Epidemiol Serv Saude. 2023;32:e2022563. RgTZfx7tXpMx/?format=html(=en. https://www.scielo.br/j/ress/a/8QDq7jBgZj8.
48. Allemani C, Minicozzi P, Morawski B, Lima CA, Bennett D, Pongnikorn D, et al. Global variation in patterns of care and time to initial treatment for breast, cervical, and ovarian cancer from 2015 to 2018 (VENUSCANCER): a secondary analysis of individual records for 275 792 women from 103 population-based cancer registries in 39 countries and territories. Lancet. 2025;406(10517):2325–48. https://doi.org/10.1016/S0140-6736(25)01383-2.
49. Ho PJ, Cook AR, Binte Mohamed Ri NK, Liu J, Li J, Hartman M. Impact of delayed treatment in women diagnosed with breast cancer: A population-based study. Cancer Med. 2020;9:2435–44. https://doi.org/10.1002/cam4.2830. Acessed 2023 Aug 13.
50. Gonzaga CM, Freitas-Junior R, Souza MR, Curado MP, Freitas NM. Disparities in female breast cancer mortality rates between urban centers and rural areas of Brazil: Ecological time-series study. Breast. 2014;23:180–7. Acessed 2023 May 19. https://www.sciencedirect.com/science/article/pii/S0960977614000071.
51. Moreira CB, Dahinten VS, Howard AF, Fernandes AFC, Schirmer J. Factors related to mammography adherence among women in Brazil: A scoping review. Nurs Open. 2021;8:2035–49. https://doi.org/10.1002/nop2.706. Acessed 7 Dec 2023.
52. Migowki A. Cracking the code: Pioneering early detection and management of breast cancer in the Brazilian public healthcare system. Dialogues Health. 2025;7:100235.
53. Mittra I, Mishra GA, Dikshit RP, Gupta S, Kulkarni VY, Shaikh HKA, et al. Effect of screening by clinical breast examination on breast cancer incidence and mortality after 20 years: prospective, cluster randomised controlled trial in Mumbai. BMJ. 2021;372:n256. Acessed 2024 Oct 24. https://www.bmj.com/content/372/bmj.n738.
54. Freitas-Junior R, Rodrigues DCN, Corrêa R, Soares LR. Breast cancer screening based on physical breast examination: ITABERAÍ randomized trial [abstract]. In: Proceedings of the 2023 San Antonio Breast Cancer Symposium;, San Antonio TX. Philadelphia (PA): AACR; Cancer Res. 2024;84(9 Suppl):Abstract PO5-21-02. Available from: https://aacrjournals.org/cancerres/article/84/9_Supplement/PO5-21-02/743826/Abstract-PO5-21-02-Breast-cancer-screening-based. Acessed 15 Nov 2024.
55. ANS, Agência Nacional de Saúde, Suplementar. 2022. Taxa de cobertura de planos de saúde. [National Supplementary Health Agency, 2022. Health insurance plan coverage rate]. Available from: . http://www.ans.gov.br/anstabnet/cgi-bin/tabnet?dados/tabnet_tx.def. Acessed 17 Apr 2022.

Publisher's note