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Healthcare-Related Determinants of Breast Cancer Prognosis in São Paulo, Brazil: A Population-Based Cohort

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Abstract

Purpose/Objective: To compare demographic characteristics, stage at diagnosis, treatment patterns, and survival outcomes of breast cancer patients treated in Brazil's public and private healthcare systems. **Materials and methods:** This retrospective cohort study analyzed data from the Fundação Oncocentro de São Paulo, including women diagnosed with invasive breast cancer between January 2000 and June 2020. Overall survival (OS) was estimated using Kaplan-Meier methods and log-rank tests. Prognostic factors were evaluated using Cox proportional hazards models. **Results:** A total of 65,543 patients were included. Age distribution was similar between the public and private sectors. However, early-stage diagnoses (stages I and II) were significantly more frequent in the private sector (77.8%), whereas the public system had a higher proportion of patients diagnosed at advanced stages (67.8% in stages II and III) and with metastatic disease (11.1% vs. 5.3%). The proportion of patients receiving surgery and at least 2 adjuvant therapies (trimodal therapy) was comparable between sectors (46.6% private vs. 46.2% public). Survival analysis demonstrated consistently higher 5- and 10-year OS across all stages in the private sector. Ten-year OS by stage was: I–81.6% (private) versus 77.5% (public), $P < .001$; II–74.0% vs. 63.3%, $P < .001$; III–55.6% versus 39.6%, $P < .001$; IV–7.6% versus 6.4%, $P = .306$. Multivariate analysis identified treatment in the private sector, younger age at diagnosis, higher education level, receipt of trimodal therapy, and earlier stage as independent predictors of improved OS. **Conclusion:** Breast cancer patients treated in the public healthcare system in Brazil more often present with advanced disease, which is associated with inferior survival outcomes.

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Introduction

Breast cancer remains the most commonly diagnosed malignancy among women globally, and a leading cause of cancer-related mortality, accounting for over 2.3 million new cases and 685,000 deaths annually worldwide.[1] Despite advances in screening, diagnosis, and treatment, substantial disparities persist in breast cancer outcomes across regions and within countries—especially in low- and middle-income countries (LMICs), where health system performance and socioeconomic factors strongly influence access and quality of care.[1-5]

Brazil represents a unique epidemiologic and policy landscape to examine such disparities. The country operates a dual healthcare system composed of a public sector—the Unified Health System (*Sistema Único de Saúde, SUS*)—which provides universal, state-funded care, and a heterogeneous private sector, accessed through employer-sponsored plans or out-of-pocket payments. Although the SUS has expanded access to cancer care over the past 2 decades,

critical concerns remain regarding timeliness, quality, and equity of oncologic services, particularly for screening, staging, and multimodal treatment of breast cancer.[6,7]

Prior research has suggested that patients treated within Brazil's private healthcare system benefit from earlier diagnoses, more comprehensive staging, and more guideline-concordant therapy compared to those in the public system.[8-10] However, few large-scale, population-based studies have rigorously quantified how differences in healthcare sector impact stage at diagnosis, treatment delivery, and long-term survival outcomes for breast cancer.[4]

The Fundação Oncocentro de São Paulo (FOSP) registry is particularly robust and representative compared to other state registries, owing to its long-standing history, wide population coverage, and standardized reporting practices. Using data from the FOSP, a robust population-based oncology registry, this study aimed to evaluate the influence of healthcare setting (public vs. private) on breast cancer presentation, treatment patterns, and 10-year overall survival (OS). We further investigated whether disparities persisted after adjusting for age, educational level, disease stage, and treatment modality. By elucidating the health system-related drivers of breast cancer outcomes in Brazil, our findings aim to inform policy interventions targeted at reducing inequities and improving oncologic care delivery in LMICs.

Patients and Methods

This retrospective cohort study analyzed female patients with invasive breast cancer using data from Fundação Oncocentro de São Paulo (FOSP), a state-level cancer registry that compiles standardized oncological data from public and private healthcare institutions across São Paulo, Brazil. The database includes clinical and sociodemographic variables such as age at diagnosis, educational level, health care system (public vs. private), tumor characteristics, and treatment modalities, including surgery, chemotherapy, radiotherapy, and endocrine therapy.

Eligible patients were patients diagnosed with invasive breast carcinoma—classified under ICD-10 code C50—between January 1, 2000, and June 30, 2020, with documented information regarding the type of healthcare coverage. Exclusion criteria were patients with in-situ carcinomas, sarcomas, phyllodes tumors, or those lacking key demographic or staging information. Missing data on noncritical variables were handled using complete case analysis, which is widely recommended in observational studies to minimize bias when the proportion of missingness is low and assumed to be random.

Patients were stratified by age group, educational level (low vs. medium/high), clinical stage at diagnosis (I to IV, based on the AJCC eighth edition of the TNM staging system), and healthcare coverage (public vs. private). Treatment variables included surgery, chemotherapy, radiotherapy, endocrine therapy, and combined modalities, with trimodal therapy defined as surgery plus at least 2 adjuvant treatment types.

The primary outcome was overall survival (OS), defined as the time from initial cancer diagnosis to death from any cause or last follow-up. Survival time was measured in years, and patients were censored at the last known follow-up if death had not occurred. This study adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines (https://www.equator-network.org/reporting-guidelines/strobe/).

Statistical Analyses

Descriptive statistics were used to summarize baseline characteristics. Categorical variables were expressed as frequencies and percentages, and comparisons between the public and private healthcare groups were performed using the Chi-square or Fisher's exact test, as appropriate. Survival estimates were generated using the Kaplan–Meier method and compared via log-rank test. Cox proportional hazards regression models were used to identify independent prognostic factors for OS, incorporating variables such as age, educational level, cancer stage, treatment modality, and healthcare system.

Both univariable and multivariable models were constructed to estimate hazard ratios (HRs) and 95% confidence intervals (CIs). A 2-sided P-value < .05 was considered statistically significant. All statistical analyses were conducted using SPSS version 23.0 (IBM Corp., Armonk, NY) and RStudio (https://rstudio.com/; R version 3.6.0, https://www.r-project.org/, packages "survival" version 3.2-7 and 'forest model' version 0.5.0).

Results

A total of 65,543 patients diagnosed with invasive breast cancer between January 2000 and June 2020 were included in this study. Among them, 16.4% were treated in the private healthcare system and 83.6% in the public system. The demographic distribution was comparable between the 2 groups in terms of gender and age. The majority of patients were female (99.2%), and the predominant age range was 51-70 years (47.6%). Histologically, invasive ductal carcinoma was the most frequent subtype (89.1%)—Table 1.

Disparities were observed in the distribution of clinical stage at diagnosis between the public and private healthcare systems. Patients treated in the private sector were more frequently diagnosed at earlier stages, with 41.44% presenting with stage I disease and 36.38% with stage II. Conversely, among those treated in the public system, a markedly higher proportion were diagnosed with advanced-stage disease: 29.47% at stage III and 11.06% at stage IV, compared to only 16.91% and 5.27%, respectively, in the private sector. This difference in stage distribution was statistically significant (P < .001) —Table 2.

Despite similar overall rates of trimodal therapy (surgery plus 2 adjuvant modalities) between groups (46.6% in private vs. 46.2% in public), differences in treatment impact were evident in survival analyses. Kaplan–Meier survival curves demonstrated significantly better OS for patients treated in the private system across all disease stages (Figure 1). Ten-year OS in stages I, II, III, and IV in the private and public systems were, respectively, 81.6% versus 77.5%, 74.0% versus 63.3%, 55.6% versus 39.6%, and 7.6% versus 6.4%. A stage-stratified comparative analysis confirmed that these differences were statistically significant for stages I, II, and III (all P < .001), indicating a consistent survival advantage in the private sector for early and locally advanced disease. However, no statistically significant difference was observed for stage IV patients (P = .306), suggesting similarly poor outcomes across both healthcare systems in the metastatic setting (Table 3).

Table 1	Characteristics of Breast Cancer Patients in Public and Private Care in São Paulo State Between 2000 and 2020				
Gender	Male	N	81	434	515
		%	0.7%	0.8%	0.8%
	Female	N	10,775	54253	65,028
		%	99.3%	99.2%	99.2%
Histology	Ductal invasive carcinoma	N	9072	49350	58,422
		%	83.6%	90.2%	89.1%
	Lobular invasive carcinoma	N	1163	2982	4145
		%	10.7%	5.5%	6.3%
	Special subtypes	N	621	2355	2976
		%	5.7%	4.3%	4.5%
		%	0.3%	1.0%	0.9%
Stage	I	N	4499	11588	16,087
		%	41.4%	21.2%	24.5%
	II	N	3949	20934	24,883
		%	36.4%	38.3%	38.0%
	III	N	1836	16115	17951
		%	16.9%	29.5%	27.4%
	IV	N	572	6050	6622
		%	5.3%	11.1%	10.1%
Age	< 35	N	716	2969	3685
		%	6.6%	5.4%	5.6%
	36-45	N	2050	9387	11,437
		%	18.9%	17.2%	17.4%
	46-50	N	1535	7327	8862
		%	14.1%	13.4%	13.5%
	51-70	N	4842	26333	31175
		%	44.6%	48.2%	47.6%
	> 70	N	1713	8671	10,384
		%	15.8%	15.9%	15.8%

Figure 1	Overall survival according to health system.
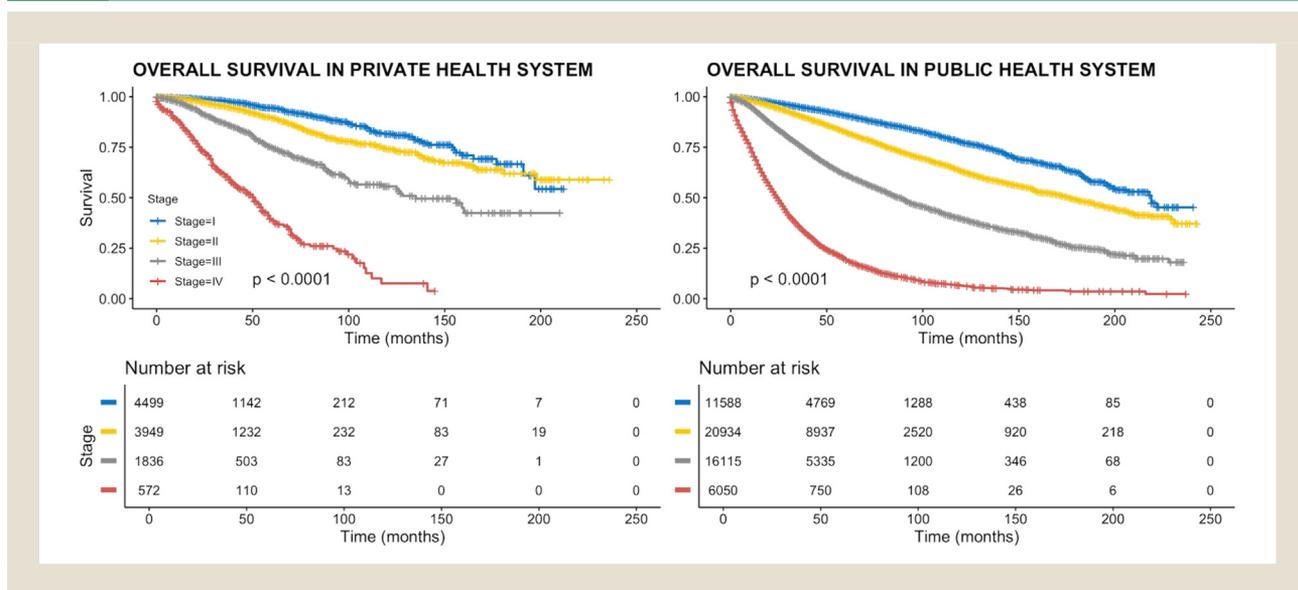
OVERALL SURVIVAL IN PRIVATE HEALTH SYSTEM

OVERALL SURVIVAL IN PUBLIC HEALTH SYSTEM

Table 2	Stage at Breast Cancer Diagnosis According to Health System		
Stage	**Private n (%)**	**Public n (%)**	**P-Value**
I	4499 (41.44%)	11,588 (21.19%)	< .001
II	3949 (36.38%)	20,934 (38.28%)	
III	1836 (16.91%)	16,115 (29.47%)	
IV	572 (5.27%)	6050 (11.06%)	

Multivariable Cox regression analysis identified several independent predictors of improved OS (Figure 2). Treatment in the private system was associated with a significantly lower hazard of death (HR 0.59, 95% CI 0.54-0.63; $P < .001$). Additional favorable prognostic factors included higher educational level (HR 0.87, 95% CI 0.84-0.90; $P < .001$), younger age at diagnosis (particularly < 50 years), and receipt of multimodal therapy. Patients undergoing surgery combined with radiotherapy and endocrine therapy (HR 0.30, 95% CI 0.27-0.34; $P < .001$), or with all 3 modalities including chemotherapy (HR 0.28, 95% CI 0.25-0.30; $P < .001$),), had the lowest mortality risks. Older age (>70 years), advanced stage at diagnosis, and absence of treatment were significantly associated with worse survival outcomes.

Discussion

This large, population-based analysis demonstrates significant disparities in breast cancer diagnosis, treatment, and outcomes between patients treated in Brazil's public and private healthcare systems. Patients managed within the public sector presented more frequently with advanced-stage disease and had consistently inferior 10-year overall survival (OS), even after adjusting for age, education, clinical stage, and treatment modality. Rather than repeating descriptive data, these results are interpreted in the context of structural inequities, emphasizing the persistent impact of systemic barriers on oncologic outcomes, particularly in LMICs.[4,9]

A central finding of this study is the stark difference in stage at diagnosis between patients in the public and private healthcare systems While numerical details have been streamlined, the interpretation underscores how delayed access to screening, diagnostic imaging, and referral pathways contributes to advanced disease at presentation. These disparities mirror evidence from the AMAZONA III study, which demonstrated higher stage III presentation among patients in the public system, reinforcing systemic barriers within Brazil's Unified Health System (SUS). By situating

these results within global LMIC data, the discussion highlights that inequities in timely diagnosis and stage distribution are consistent challenges across resource-limited settings.[10]

It is also important to acknowledge that outcomes in the private sector may represent a smaller, more advantaged subset of patients, with greater access to education, health literacy, and navigation resources. This uneven distribution must be considered when interpreting survival differences, as the private cohort may not reflect the broader population. Framing results in this way clarifies implications for health equity and emphasizes the need for system-level interventions.[11,12]

Our findings align closely with data reported for other malignancies in Brazil, reinforcing the broad implications of healthcare setting disparities. For instance, Marta et al. demonstrated similar patterns in glioblastoma patients, showing significantly reduced median OS for publicly insured patients compared to privately insured counterparts (8 vs. 17 months, $P < .001$).[8] These congruent outcomes across cancer types emphasize systemic shortcomings within the SUS infrastructure, and can affect diverse oncological outcomes uniformly.

Educational attainment emerged as a significant independent predictor of survival, mirroring the results reported by Rosa et al.[10] and further supported by Barrios,[13] who noted global inequities particularly prominent in LMICs. Higher education likely serves as a surrogate for multiple interrelated determinants, including health literacy, socioeconomic status, proactive care-seeking behaviors, and system navigation proficiency. Therefore, comprehensive cancer care strategies must extend beyond healthcare provision alone, integrating broader societal investments in education, awareness, and patient navigation programs.[11,12,14-17]

Policy-oriented recommendations are critical. Structural reforms should prioritize strengthening referral pathways, expanding organized mammography screening, and ensuring equitable distribution of radiotherapy infrastructure across regions. Additionally, policies promoting patient navigation, financial protection, and integration of palliative care could mitigate observed disparities.
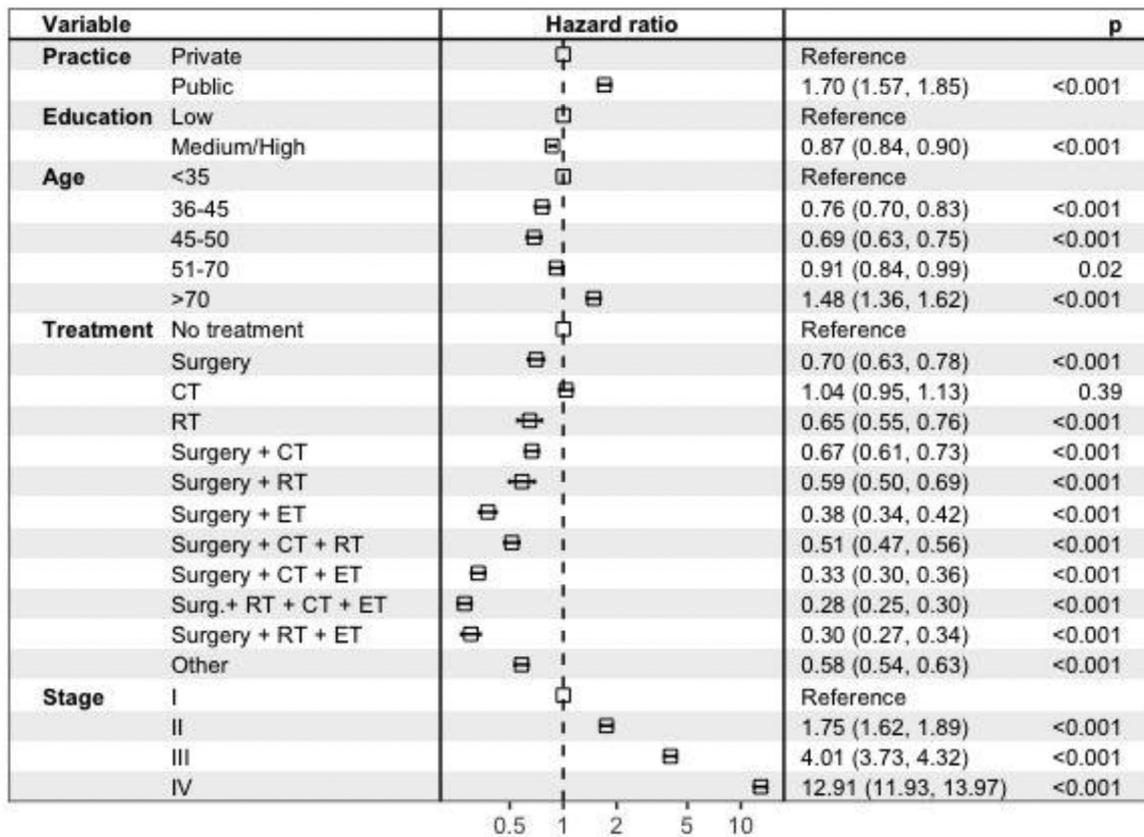
Although overall rates of multimodal therapy appeared comparable between healthcare systems, this equivalence may obscure critical differences in treatment quality, sequencing, adherence, and access to advanced therapeutic modalities. Treatment modalities involving surgery combined with radiotherapy and endocrine therapy, or all 3, showed clear survival benefits. However, public sector patients frequently face limitations regarding contemporary radiotherapy techniques and systemic therapy options, potentially contributing to observed disparities.[2,13]

Table 3	Impact of Healthcare Sector on 10-Year Overall Survival Across Breast Cancer Stages				
Stage	**Private (n)**	**Public (n)**	**10-Year OS Private (%)**	**10-Year OS Public (%)**	**P-Value**
I	4499	11,588	81.6	77.5	< .001
II	3949	20,934	74.0	63.3	< .001
III	1836	16,115	55.6	39.6	< .001
IV	572	6050	7.6	6.4	.306

Abbreviations: OS = Overall Survival.

Figure 2 Multivariable cox regression analysis for overall survival.

Variable		Hazard ratio		p
Practice	Private		Reference	
	Public		1.70 (1.57, 1.85)	<0.001
Education	Low		Reference	
	Medium/High		0.87 (0.84, 0.90)	<0.001
Age	<35		Reference	
	36-45		0.76 (0.70, 0.83)	<0.001
	45-50		0.69 (0.63, 0.75)	<0.001
	51-70		0.91 (0.84, 0.99)	0.02
	>70		1.48 (1.36, 1.62)	<0.001
Treatment	No treatment		Reference	
	Surgery		0.70 (0.63, 0.78)	<0.001
	CT		1.04 (0.95, 1.13)	0.39
	RT		0.65 (0.55, 0.76)	<0.001
	Surgery + CT		0.67 (0.61, 0.73)	<0.001
	Surgery + RT		0.59 (0.50, 0.69)	<0.001
	Surgery + ET		0.38 (0.34, 0.42)	<0.001
	Surgery + CT + RT		0.51 (0.47, 0.56)	<0.001
	Surgery + CT + ET		0.33 (0.30, 0.36)	<0.001
	Surg.+ RT + CT + ET		0.28 (0.25, 0.30)	<0.001
	Surgery + RT + ET		0.30 (0.27, 0.34)	<0.001
	Other		0.58 (0.54, 0.63)	<0.001
Stage	I		Reference	
	II		1.75 (1.62, 1.89)	<0.001
	III		4.01 (3.73, 4.32)	<0.001
	IV		12.91 (11.93, 13.97)	<0.001

0.5 1 2 5 10

Note: CT = chemotherapy; RT = Radiotherapy; ET = Endocrine Therapy

Despite challenges, progress has been observed within the SUS. Evidence from FOSP demonstrates gradual improvements in survival over the past 2 decades, suggesting that incremental policy changes, increased awareness, and capacity building can yield measurable benefits even in resource-constrained environments. These findings mirror broader LMIC experiences, where health system strengthening has led to improved cancer outcomes.[5,18]

Our study's strengths include its large, representative sample and rigorous statistical approach, yet certain limitations must be acknowledged. Biological markers such as receptor status and genomic risk scores were unavailable, and treatment adherence and toxicity data were not captured. Potential lead-time bias should also be considered, as earlier diagnosis in the private sector may partly account for differences in survival outcomes, even after stage adjustment. In addition, while São Paulo provides a robust and resource-rich healthcare context compared to other Brazilian regions, caution is required when extrapolating our findings to the entire country. Regional heterogeneity within Brazil is considerable, and disparities in less resourced states are likely to be even greater than those observed in São Paulo.[10] Finally, potential misclassification bias exists given possible transitions between healthcare sectors.

Conclusion

This study provides compelling evidence of systemic inequities in breast cancer diagnosis and outcomes in Brazil. Patients treated in the public sector were more likely to present with advanced disease and had consistently worse survival despite similar access to multimodal therapy. Structural healthcare reforms focused on early detection, equitable treatment access, and social determinants of health—including education—are critical to improving outcomes and achieving meaningful equity in breast cancer care.

Clinical Practice Points

- Disparities in breast cancer outcomes between public and private systems in Brazil remain poorly quantified.
- This large population-based cohort study compared 65,543 patients by healthcare setting.
- Patients in the public system were more likely to present with advanced-stage disease.
- Overall survival was significantly lower in the public system across stages I to III.

- These results highlight the need for health system reforms to ensure equitable breast cancer care.

Data Availability Statement

Data generated or analyzed during the current study are available from the corresponding author upon justified request.

Ethics Approval

The research adhered to the ethical guidelines set forth in the Declaration of Helsinki. Approval was obtained from the Ethics Committee of Hospital Sírio-Libanês, Brazil (CAAE 45978821.5.0000.5461).

Disclosure

The authors report no relevant financial or nonfinancial interests that could have influenced the conduct or outcomes of this research.

CRediT authorship contribution statement

Gustavo Nader Marta: Writing – review & editing, Writing – original draft, Visualization, Validation, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Allan Andresson Lima Pereira:** Writing – review & editing, Methodology, Formal analysis. **Carlos Henrique Dos Anjos:** Writing – review & editing, Data curation, Conceptualization. **Rudinei Diogo Marques Linck:** Writing – review & editing, Conceptualization. **Daniel de Araujo Brito Buttros:** Writing – review & editing, Conceptualization. **Lincon Jo Mori:** Writing – review & editing, Conceptualization. **Samir Abdallah Hanna:** Writing – review & editing, Conceptualization. **André Guimarães Gouveia:** Writing – review & editing, Conceptualization. **Fabio Ynoe de Moraes:** Writing – review & editing, Supervision, Data curation, Conceptualization.

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