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Temporal trends of breast cancer mortality in Brazil between 1980 and 2023

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ABSTRACT

Introduction: Breast cancer (BC) is a neoplasm that represents one of the most prevalent and heterogeneous malignancies affecting individuals worldwide. Its epidemiological trends present important variations across periods and regions. Acquiring knowledge about BC is essential for promoting targeted interventions and effective public policies. The aim of this study was to evaluate the temporal trends and regional disparities of BC mortality in Brazil between 1980 and 2023. **Methods:** This ecological study analyzed temporal trends in BC mortality in Brazil using age-adjusted annual mortality rates from 1980 to 2023. Mortality data were obtained from the DATASUS. Data analysis included descriptive statistics using R 4.4.2®, with temporal trends assessed via annual percentage change (APC) calculated using Joinpoint 5.0®. APCs were adjusted for age and demographic variations, with statistical significance determined by 95% confidence intervals ($p<0.05$). **Results:** BC mortality in Brazil from 1980 to 2023 showed regional variations. While the Northeast and North experienced steady increases, the Southeast initially rose, declined, and then stabilized. The South followed a rise-decline-rise pattern, and the Midwest consistently increased. Nationally, mortality initially rose, briefly declined, and then increased moderately. **Conclusion:** This study highlights significant temporal trends in BC mortality across Brazil from 1980 to 2023, revealing notable regional disparities. These findings emphasize the critical need for equitable and region-specific public health strategies and targeted actions to improve BC outcomes and reduce mortality rates regionally and nationwide.

KEYWORDS: breast cancer; mortality; Brazil; epidemiology.

INTRODUCTION

Breast cancer (BC), a malignant neoplasm originating primarily from the epithelial lining of mammary ducts or lobules, represents one of the most prevalent and heterogeneous malignancies affecting individuals worldwide[1]. Influenced by genes, hormones, and environmental factors, BC presents a high histological diversity, with a wide spectrum of clinical features[1,2].

BC constitutes a profound public health concern, being the most commonly diagnosed cancer among women and a leading cause of cancer-related mortality worldwide[3,4]. Its incidence demonstrates geographic and demographic variability, influenced by factors such as age, socioeconomic status, and access to healthcare[2-4]. Notably, developed nations report higher detection rates due to advanced screening programs, while lower-resource settings face challenges in timely diagnosis and treatment[4].

The landscape of BC's mortality in Brazil reveals pronounced regional disparities[1-4]. For instance, the Southeast region accounted for 51.6% of Brazilian BC's deaths between 2005 and 2019, followed by the Northeast (20.9%), South (17.8%), Central-West (6.2%), and North (3.5%)[2-4]. Notably, the South and Southeast regions exhibited the highest average mortality rates, while the North reported the lowest[2-4]. Women residing in economically disadvantaged areas, as most of the North region, face a 17% higher risk of developing BC compared to women who live in wealthy locals[1,3,4]. Nonetheless, most cases cannot be monitored in their own regions due to the lack of specialized professionals and concrete resources, such as computed tomography scanners[3,4]. Subsequently, these women tend to migrate to developed centers that include metropolitan regions in the states and regional capitals, or even to other Brazilian states and regions[3,4].

Understanding how BC temporal trends evolved in recent years could be a hallmark in terms of public health, since it would be possible to identify growing and/or decreasing trends that may guide resource allocation and inform tailored interventions

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on the issue. Thereto, this study was developed with the aim of evaluating the temporal trends and regional disparities of BC mortality in Brazil between 1980 and 2023.

METHODS

Study design

This ecological study aimed to evaluate the temporal trends and regional disparities of BC mortality in Brazil between 1980 and 2023. Within this scope, an analysis was conducted on the annual age-adjusted mortality rates of BC per 100,000 individuals.

Data location

Brazil is the largest country in South America. It can be understood by its five main regions: North, which houses the Amazon rainforest, being the largest region in terms of territorial extension, but one of the least economically developed; the Central-West, characterized by housing the Brazilian cerrado and Pantanal, an area of important agricultural expansion and focused urban densification; the Northeast, marked by regional subdivisions associated with diverse climatic and population patterns; the Southeast, classified as the most economically developed; the South, marked by a milder climate and important socio-economic development. Figure 1 brings a graphical representation of it.

Data source

All data used in this study were obtained from the DATASUS, available at the following link: https://datasus.saude.gov.br/. DATASUS is an online platform created and maintained by the Ministério da Saúde Brasileiro that provides health data in the country publicly, openly, and free of charge.

Information regarding the resident population in each year was obtained from censuses and demographic projections conducted by the Instituto Brasileiro de Geografia e Estatística.

Information regarding BC deaths was retrieved from the Brazilian Sistema de Informações de Mortalidade, an online platform that stores all mortality data in the country.

Data collection

Data were collected on all deaths and populations between 1980 and 2023, being stratified by individuals' age and Brazilian regions. The collection was carried out manually by the author of this research by transposing the data into Excel® spreadsheets using the Tabwin® source.

Softwares R 4.4.2 (R) and Joinpoint 5.0 (R) were employed in data analysis and figures construction. In this sense, the Annual Percentage Change (APC) will be calculated by arranging the data on a logarithmic scale, allowing the evaluation of its behavior in relation to the averages presented throughout the period. Thus, it is possible to identify behaviors of increasing trends (APC > 0 and statistically significant - p-value < 0.05), decreasing (APC

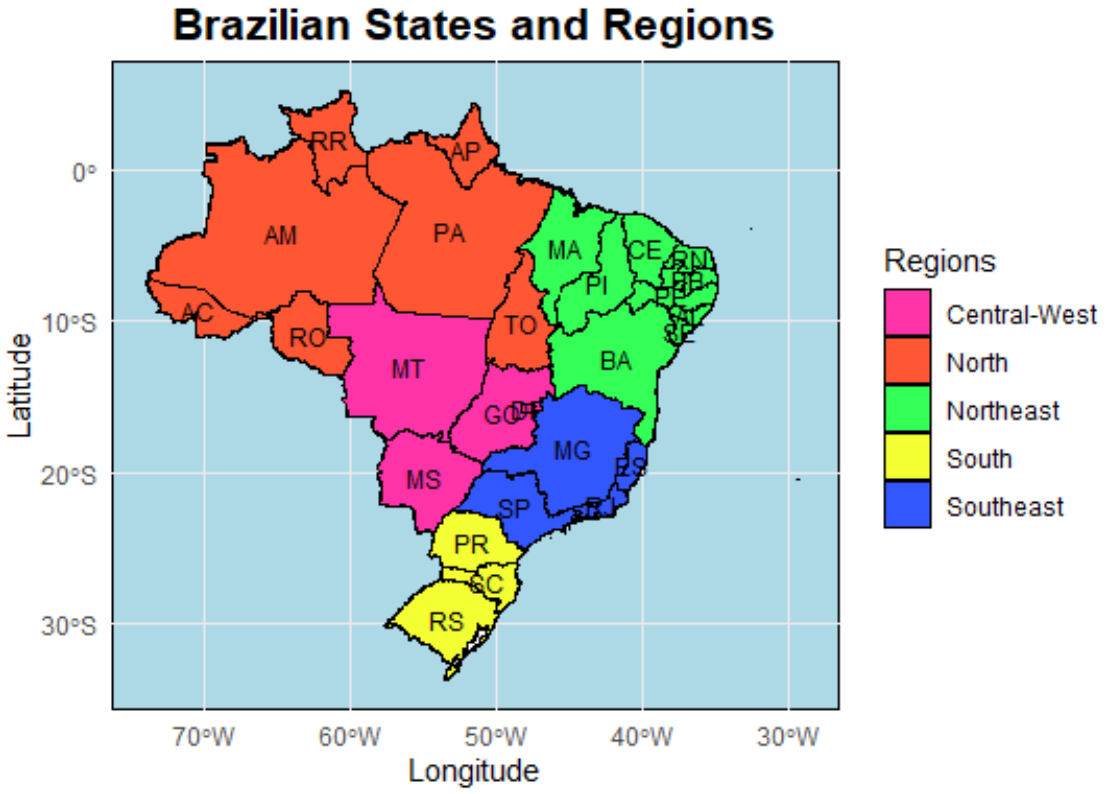


Figure 1. Brazil macroregions (own author produced).

< 0 and p-value < 0.05) or even stable (APC = 0 and/or p-value > 0.05). The calculation of 95% confidence intervals (95%CI) allows the determination of the significance of the results obtained.

Ethical considerations

This study utilized secondary data obtained from publicly available sources, which are freely accessible and de-identified. As the data do not involve direct patient interactions or personally identifiable information, ethical approval was not required. The analysis was conducted in accordance with established guidelines for the use of open-access epidemiological datasets, ensuring compliance with ethical and legal standards.

RESULTS

In the Northeast, mortality rates increased significantly during the first period (APC: 1.89; 95%CI: 1.57–2.24; p-value<0.01) and rose sharply from 2003 to 2006 (APC: 9.02; 95%CI: 4.59–10.37; p-value=0.02). A moderate increase was observed between 2006 and 2018 (APC: 2.41; 95%CI: 2.01–3.29; p-value<0.01), followed by a stabilization with no significant change from 2018 to 2023 (APC: 0.22; 95%CI: –1.78–1.37; p-value=0.73) (Table 1, Figures 2 and 3).

In the North, mortality exhibited a consistent and significant increase over the entire period from 1980 to 2023 (APC: 2.78; 95%CI: 2.56–3.13; p-value<0.01) (Table 1, Figures 2 and 3).

In the Southeast, initial increases in mortality were noted from 1980 to 1998 (APC: 1.38; 95%CI: 1.11–1.77; p-value<0.01), followed by a significant decline between 1998 and 2002 (APC: –3.55; 95%CI: –5.39–1.46; p-value<0.01). No significant trend was observed from 2002 to 2023 (APC: 0.12; 95%CI: –0.05–0.35; p-value=0.13) (Table 1, Figures 2 and 3).

In the South, mortality rates rose significantly from 1980 to 1994 (APC: 2.56; 95%CI: 1.99–3.34; p-value<0.01), experienced a modest decline from 1994 to 2006 (APC: –0.77; 95%CI: –3.34–0.18; p-value=0.01), and exhibited a small but significant increase from 2006 to 2023 (APC: 0.48; 95%CI: 0.20–1.13; p-value<0.01) (Table 1, Figures 2 and 3).

In the Midwest, a consistent and significant rise in mortality was observed throughout the period from 1980 to 2023 (APC: 1.51; 95%CI: 1.34–1.76; p-value<0.01).

At the national level, mortality rates increased significantly from 1980 to 1998 (APC: 1.67; 95%CI: 1.45–2.01; p-value<0.01), declined from 1998 to 2001 (APC: –2.77; 95%CI: –3.59–0.35; p-value=0.02), and rose modestly but significantly from 2001 to 2023 (APC: 0.84; 95%CI: 0.73–1.01; p-value<0.01) (Table 1, Figures 2 and 3).

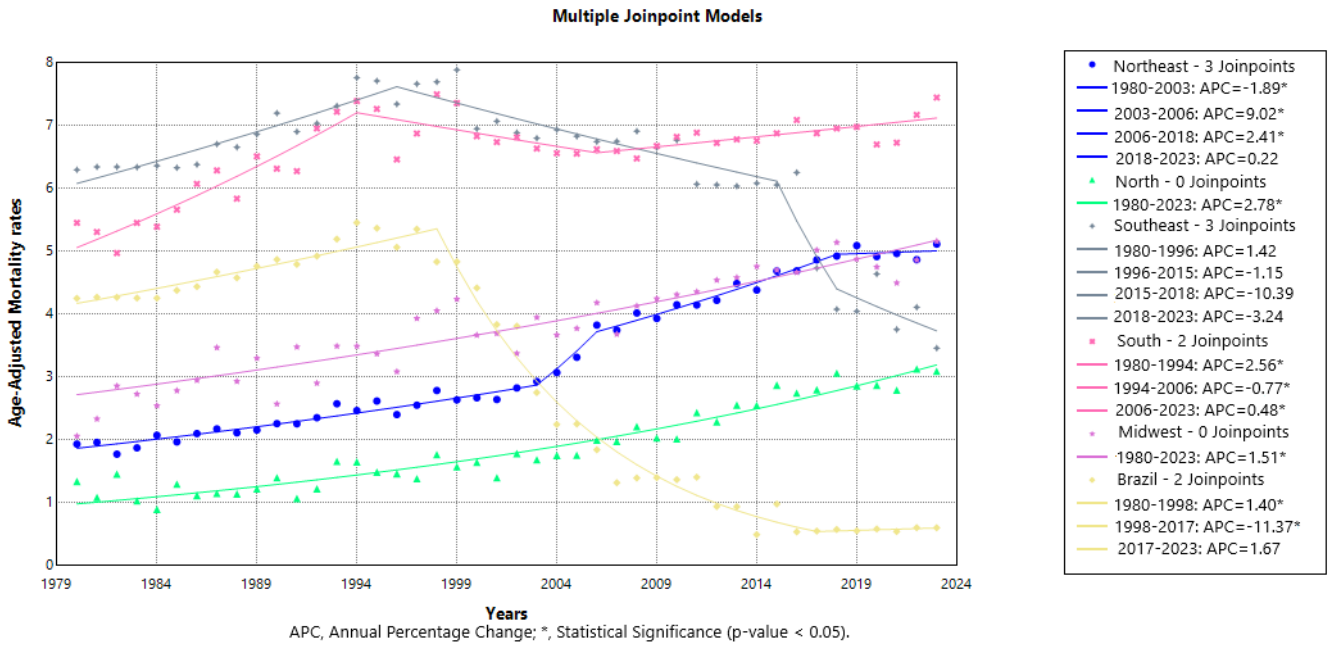
DISCUSSION

BC mortality trends in Brazil between 1980 and 2023 varied significantly across regions, reflecting the interplay of biological, socioeconomic, and healthcare-related factors. Regional disparities highlight the impact of healthcare accessibility, public health initiatives, and economic conditions. While high-income regions have seen mortality declines due to advancements in screening and treatment, economically vulnerable areas continue to experience rising rates.

Globally, declining BC mortality in high-income countries is largely attributable to widespread screening programs, early

Table 1. Temporal trends in Brazil and its macroregions across the evaluated period regarding BC mortality.

Cohort	Segment	Lower endpoint	Upper endpoint	APC	Lower CI	Upper CI	P-value
Northeast	1	1.980	2.003	1.89	1.57	2.24	<0.01
Northeast	2	2.003	2.006	09.02	4.59	10.37	0.02
Northeast	3	2.006	2.018	2.41	02.01	3.29	<0.01
Northeast	4	2.018	2.023	0.22	–1.78	1.37	0.73
North	1	1.980	2.023	2.78	2.56	3.13	<0.01
Southeast	1	1.980	1.998	1.38	1.11	1.77	<0.01
Southeast	2	1.998	2.002	–3.55	–5.39	–1.46	<0.01
Southeast	3	2.002	2.023	0.12	–0.05	0.35	0.13
South	1	1.980	1.994	2.56	1.99	3.34	<0.01
South	2	1.994	2.006	–0.77	–3.34	–0.18	0.01
South	3	2.006	2.023	0.48	0.20	1.13	<0.01
Midwest	1	1.980	2.023	1.51	1.34	1.76	<0.01
Brazil	1	1.980	1.998	1.67	1.45	02.01	<0.01
Brazil	2	1.998	2.001	–2.77	–3.59	–0.35	0.02
Brazil	3	2.001	2.023	0.84	0.73	01.01	<0.01



APC: Annual Percentage Change; *Statistical Significance (p<0.05).

Figure 2. Graphical illustration of the temporal trends in Brazil and its macroregions across the evaluated period regarding BC mortality.

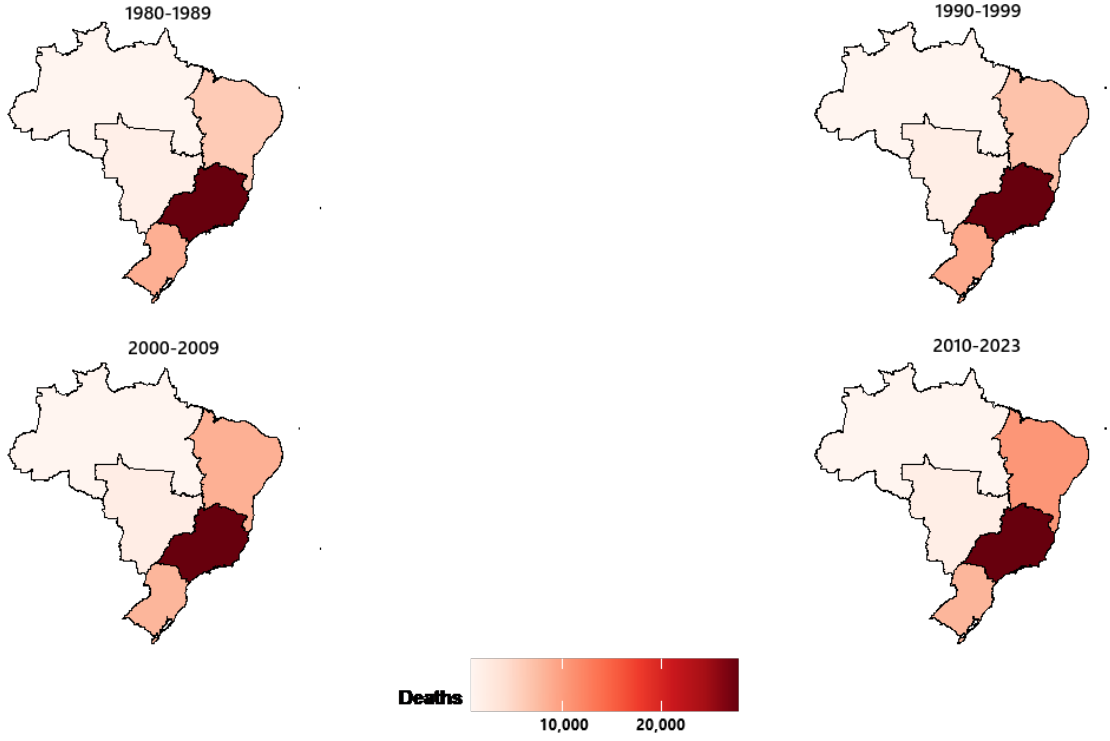


Figure 3. Heatmap of BC deaths by Brazilian macroregions across the evaluated period.

detection, and improved treatment access[5]. In contrast, many low- and middle-income countries (LMICs) face increasing mortality rates due to limited healthcare infrastructure and delayed diagnoses[6]. Brazil exemplifies these disparities, as wealthier regions benefit from earlier detection and better treatment, while lower-income areas struggle with late-stage diagnoses and inadequate medical resources[5,6].

Socioeconomic inequalities are key determinants of BC outcomes. In regions with lower Human Development Index (HDI) scores, the mortality-to-incidence ratio (MIR) remains high,

indicating poorer survival rates[7,8]. Limited access to mammography, shortages of specialized oncology services, and financial barriers to treatment delay diagnosis and increase mortality[7]. In Brazil, disparities in healthcare coverage and geographic accessibility further exacerbate these challenges, with rural and economically disadvantaged populations disproportionately affected[7]. Addressing these inequities requires investment in healthcare infrastructure, targeted public health campaigns, and expanded screening programs, particularly in underserved regions[8].

Beyond healthcare accessibility, sociocultural and economic factors influence BC diagnosis[9,10]. In many LMICs, stigma surrounding cancer and limited health literacy contribute to delayed medical consultation[9]. Additionally, workforce participation and caregiving responsibilities may deter women from seeking timely care[9]. Overcoming these barriers necessitates culturally tailored educational initiatives that emphasize the importance of early detection and reduce the social stigma associated with cancer screening[10].

At a biological level, variations in BC outcomes may stem from differential exposure to risk factors such as obesity, alcohol consumption, and sedentary lifestyles[11,12]. High body mass index (BMI) is particularly relevant, as adiposity contributes to estrogen-driven tumor proliferation and chronic inflammation[11]. Similarly, excessive alcohol consumption elevates estradiol levels and increases oxidative stress, further promoting carcinogenesis[12]. While high-income countries have implemented widespread awareness campaigns and prevention strategies, LMICs often lack the resources to address these modifiable risk factors effectively[11,12].

Political and historical contexts also shape BC outcomes[13,14]. The legacy of underfunded healthcare systems in post-colonial nations and the effects of contemporary political instability hinder the development of comprehensive cancer control policies[13]. In Brazil, regional disparities in healthcare funding and infrastructure perpetuate inequalities, making it crucial for policymakers to prioritize equitable resource distribution[14].

To mitigate disparities in BC mortality, future research should explore the molecular pathways linking socioeconomic stressors to tumor progression[15,16]. Investigating the roles of chronic stress, cortisol dysregulation, and estrogen receptor activation could provide insights into biologically driven disparities[15]. Additionally, longitudinal studies assessing the impact of healthcare policy changes on BC outcomes would help inform targeted interventions[16].

The study is limited by its reliance on secondary data, which may be subject to underreporting or misclassification of breast cancer mortality in specific regions. One potential solution is to integrate multiple data sources, such as hospital records, cancer registries, and mortality databases, to improve data completeness. Although the data were adjusted for age and demographic variations, socioeconomic and cultural factors that influence breast cancer outcomes were not incorporated, introducing potentially unmeasured confounders. Future studies may benefit from including these variables through linkage with census or survey data. Furthermore, the lack of granular data on screening practices or treatment protocols limits the ability to infer causal relationships.

This study provides a comprehensive evaluation of BC mortality trends in Brazil over an extensive 43-year period, utilizing robust statistical methods and a publicly accessible national dataset. The analysis offers valuable insights into regional disparities, serving as an evidence base for policymakers to address inequities in BC outcomes. Furthermore, the use of age-adjusted APCs ensures methodological rigor, enhancing the comparability of results over time and across regions.

CONCLUSIONS

This study identified significant temporal trends in breast cancer mortality across Brazil, revealing considerable regional disparities that reflect an evolving epidemiological landscape. The results emphasize the need for strategic public health interventions tailored to address these inequities. For example, expanding breast cancer screening initiatives in the North and Northeast regions of Brazil, strengthening early detection programs, and improving access to treatment in underserved areas, as well as ensuring a more equitable distribution of resources and specialized professionals, shifting the focus away from certain regions, such as the Southeast and South. We suggest that future research focus on applying these elements and assessing their impact on the Brazilian epidemiological profile.

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