








Comparative analysis of epidemiological trends in breast cancer among Brazilian women*

Análise comparativa de tendências epidemiológicas relacionadas ao câncer de mama em mulheres brasileiras

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ABSTRACT

Objective: to identify associations between clinical and sociodemographic variables among women with breast cancer. **Methods:** ecological, retrospective study conducted in accordance with the Standards for Quality Improvement Reporting Excellence. Records from women with breast cancer (ICD-10 code C50) diagnosed between 2015 and 2021 were included. Descriptive analysis, chi-square tests ($\alpha = 5\%$), and simple correspondence analysis were performed to examine associations among age, educational attainment, marital status, race/skin color, state, and clinical stage, using Hospital-Based Cancer Registry data. **Results:** advanced-stage disease was associated with not completing elementary school, age 30–59 years, and being classified as Brown or Black ($p < 0.005$), whereas higher educational attainment and treatment in states located in the South and Southeast Regions were associated with early-stage disease. **Conclusion:** breast cancer in Brazilian women was more often diagnosed at an advanced stage among Brown and Black women, those with lower educational attainment, and those treated in the North and Northeast Regions. **Contributions to practice:** early diagnosis is especially needed for women with lower educational attainment, those aged 30 or older, and those in the North and Northeast Regions. **Descriptors:** Breast Neoplasms; Medical Oncology; Analytical Epidemiology; Social Determinants of Health.

RESUMO

Objetivo: identificar associações entre variáveis clínicas e sociodemográficas de mulheres com neoplasias malignas mamárias. **Métodos:** estudo ecológico e retrospectivo, conforme *Standards for Quality Improvement Reporting Excellence*. Participaram mulheres com neoplasias malignas mamárias (código C50) entre 2015 e 2021. Realizou-se análise descritiva, teste Qui-quadrado ($\alpha=5\%$) e Análise de Correspondência Simples entre idade, escolaridade, estado conjugal, raça, unidade federativa e estágio clínico pelo Sistema de Classificação de Tumores Malignos com dados dos Registros Hospitalares de Câncer. **Resultados:** houve associação entre estádios avançados e ensino fundamental incompleto, idade entre 30-59 anos e raça negra ($p<0,005$), enquanto maior grau de escolaridade e Unidade Federativa de tratamento localizada nas regiões Sul e Sudeste associam-se a estádios iniciais. **Conclusão:** neoplasias mamárias em mulheres brasileiras apresentam estadiamento avançado entre mulheres negras, com menor escolaridade e tratadas no Norte e Nordeste. **Contribuições para a prática:** é necessário diagnóstico precoce especialmente para mulheres com menor escolaridade, idade >30 anos, no Norte e Nordeste. **Descritores:** Neoplasias da Mama; Oncologia; Epidemiologia Analítica; Determinantes Sociais da Saúde.

Introduction

Malignant breast neoplasms are characterized by uncontrolled cell growth, the ability to evade immune mechanisms that regulate cell proliferation, metastatic potential, and heterogeneity in histologic features, clinical behavior, and prognosis⁽¹⁾. Thus, breast cancer comprises different subtypes.

Among Brazilian women, breast cancer is the second most common cancer, with 78,610 new cases projected annually through 2028⁽²⁾. This burden reflects increased life expectancy and sociodemographic and economic changes that have shifted the country's disease profile toward a higher incidence of chronic diseases such as breast cancer.

Breast cancer is amenable to screening and tends to have a more favorable prognosis, longer survival, and better quality of life when diagnosed at an early stage⁽³⁾. Delayed diagnosis is associated with higher costs for the health care system, more frequent hospitalizations, and lower remission rates⁽⁴⁾.

Access to screening and early detection measures such as mammography is influenced by structural features of the health care system, living conditions, and cognitive, social, financial, and psychological factors. The conditions in which people live, that is, the factors that shape how individuals live, work, grow, and age, are known as social determinants of health and are directly related to health outcomes⁽⁵⁻⁶⁾.

The social determinants of health range from the geographic region where a person lives to intrinsic characteristics such as hereditary factors, age, and sex, and are directly related to different patterns of illness and access to health services and interventions. These patterns can be measured using indicators such as incidence, prevalence, and mortality rates for conditions of public health relevance⁽⁴⁻⁵⁾.

Socioeconomic changes that alter exposure to risk factors and shift the population's health profile require the health care system to adapt. Analyzing epidemiological patterns and identifying individuals

at greater risk of developing neoplasms are essential to guiding how the health care network responds to events such as the COVID-19 pandemic, which directly affected cancer screening and early detection efforts in Brazil, reducing nationwide mammography coverage during this period⁽⁴⁾.

Identifying temporal and spatial trends in the incidence and mortality of epidemiologically relevant neoplasms can help shape public health interventions. In the Northeast Region, rising breast cancer mortality among women aged 45 and older reflects both increasing incidence among younger adult women and overall gains in life expectancy, which in turn have increased the number of cases among women aged 75 and older. It also reflects barriers such as limited access to early diagnosis, the time between diagnosis and staging tests, and access to appropriate treatment, especially in economically disadvantaged regions. These barriers further worsen mortality trends, whereas rates tend to remain stable in areas with a higher Human Development Index⁽⁷⁾.

This study builds on earlier broad analyses⁽⁷⁾ by incorporating breast cancer incidence data from all states, grouped by geographic region, and by examining associations between social determinants of health (SDH) and health outcomes relevant to public health. This focus aligns with Sustainable Development Goal 3, established by the United Nations (UN), which calls for a one-third reduction in premature mortality from noncommunicable diseases through prevention and treatment⁽⁸⁾. Accordingly, this study aimed to identify associations between clinical and sociodemographic variables among women with breast cancer.

Methods

Study design

This was an ecological, retrospective study using secondary data from the Brazilian Hospital-Based Cancer Registry system on breast cancer ca-

ses in Brazilian women. The study was carried out in three sequential stages: 1) retrieval of publicly available data from the Hospital-Based Cancer Registry Integrator Module, made available by the Brazilian National Cancer Institute José Alencar Gomes da Silva (INCA), followed by descriptive analysis; 2) analysis of patterns of association among the variables; and 3) generation of perceptual maps in R⁽⁹⁾. The study records were drawn from 321 Hospital-Based Cancer Registries across Brazil⁽¹⁰⁾. This study followed the Standards for Quality Improvement Reporting Excellence (SQUIRE), version 2.0.

Population

The analysis included records of women of all ages who were diagnosed with breast cancer (ICD10 code C50) and received care at facilities included in the system, provided that stage-at-diagnosis information was available⁽¹¹⁾. Cancer cases were staged using the eighth edition of the TNM Classification of Malignant Tumours, which is widely used for staging solid tumors⁽³⁾. Tumors diagnosed at stages III and IV were classified as advanced-stage disease, whereas tumors at stages 0, I, and II were classified as earlystage disease.

Accordingly, the study population comprised records of women with breast cancer entered into the Hospital-Based Cancer Registry Health Information System between 2015 and 2021. These data were retrieved from the Hospital-Based Cancer Registry Integrator Module for the Brazilian states.

Sample size calculation

Because this was an ecological study based on secondary data, all available records for the period of interest (2015–2021, with 2021 as the most recent year with complete records for all months) were included, making this a census of available records. Therefore, no sample size calculation was required, as the

study encompassed the full set of available data for the population of interest.

The year 2015 was selected as the starting point, since it was when the Ministry of Health published the Brazilian guidelines for early detection of breast cancer. This document is part of a broader set of actions developed by the Ministry of Health to expand and improve early detection of the disease, with the goal of reducing breast cancer mortality⁽¹²⁾.

Data collection

In the registry system, cases are classified as analytic or nonanalytic. Analytic cases are those in which the main treatment was provided at the institution that entered the case into the system, whereas nonanalytic cases are those in which the main treatment for the disease was provided at another institution⁽¹¹⁾. To reduce duplicate entries—because the same case may be entered into the system by different institutions and thus counted more than once—only cases classified as analytic were included in the analysis.

Data analysis

Statistical analysis was performed using data from analytic cases, including age group, educational attainment, marital status, race/skin color, the state where the reporting hospital was located, and clinical stage. Clinical stage was treated as the dependent variable, whereas age, educational attainment, marital status, race/skin color, and the state where the reporting hospital was located were treated as independent variables. These variables were selected because they are among the factors relevant to screening uptake and to timeliness or delays in diagnosis and treatment⁽¹³⁾.

The clinical stage variable was collected and analyzed according to the TNM Classification of Malignant Tumours, a standardized system for classifying solid malignant neoplasms. This system assesses the size and/or depth of the primary tumor (T), the extent

of spread to regional lymph nodes (N), and the presence or absence of distant metastasis (M). Staging is essential at diagnosis because it helps determine the most appropriate therapeutic approach and informs prognosis. It also facilitates information exchange across care centers and supports scientific research in oncology⁽³⁾.

The sociodemographic variables were grouped according to the classifications adopted by the Brazilian Institute of Geography and Statistics to ensure standardization and comparability with other studies and publications on the topic⁽¹⁴⁾.

Contingency tables were constructed for educational attainment, age group, race/skin color, marital status, and the state where the reporting hospital was all in relation to clinical stage. Chi-square tests were performed to investigate associations among the variables, using a significance level of 5%.

Simple correspondence analysis was then performed to examine the relationship between two qualitative variables and determine whether an association existed between them⁽¹⁵⁻¹⁶⁾. Accordingly, the association between clinical stage and sociodemographic characteristics was examined to generate perceptual maps in RStudio (version 1.4.1106), an integrated development environment for R. For this step, the “not applicable” and “missing” categories for cancer stage were excluded to facilitate the analysis.

Correspondence analysis shows which categories are associated with one another, which are closest to the average profile, and which are most discriminating, that is, farthest from the origin. Thus, categories plotted near one another indicate a positive association, whereas categories on opposite sides indicate distinct profiles. To represent these relationships, perceptual maps were generated as two-dimensional graphical projections of the coordinates corresponding to the distances between the categories of the variables

analyzed. The maps were interpreted by examining the geometric proximity of the projected points, which represent the categories. The closer the category projections, the stronger the relationship between them, suggesting an association between the phenomena they represent⁽¹⁶⁻¹⁷⁾.

Ethical considerations

Ethics committee approval was not required because this study used publicly available secondary data from the Hospital-Based Cancer Registry system maintained by the Brazilian National Cancer Institute.

Results

A total of 214,074 records of women with breast cancer were analyzed. The distribution of registered cases by clinical stage according to marital status, race/skin color, age, educational attainment, and the location of the treating hospital showed a statistically significant association ($p < 0.001$), suggesting relationships among these variables.

Table 1 presents the distribution of cases by clinical and sociodemographic variables and the percentage distribution within each subgroup ($p < 0.001$), indicating that these variables were not randomly distributed but instead followed a pattern suggestive of association. A large number of records contained incomplete information, resulting in a prominent “missing” category across all sociodemographic variables. This category was excluded from the analyses. However, based on the complete information available in the analytic-case records included in the study, it is possible to identify categories with proportionally greater representation than the other categories within each variable of interest.

Table 1 – Association between sociodemographic variables and clinical stage (n = 214,074). Fortaleza, CE, Brazil, 2025

Variables	Total	0	I	II	III	IV	NA*	Missing [†]	p-value
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	
Marital status									
									<0.001
Married	64,427 (30.1)	2,055 (22.7)	9,560 (28.3)	16,924 (29.0)	13,053 (28.5)	4,303 (24.5)	3,213 (36.3)	15,319 (37.6)	
Missing	75,349 (35.2)	4,956 (54.8)	15,043 (44.6)	22,517 (38.6)	16,026 (35)	7,114 (40.5)	2,039 (23)	7,654 (18.8)	
Separated	12,163 (5.7)	413 (4.6)	1,932 (5.7)	3,251 (5.6)	2,529 (5.5)	881 (5.0)	571 (6.5)	2,586 (6.3)	
Never married	40,062 (18.7)	1,105 (12.2)	4,364 (12.9)	9,857 (16.9)	9,532 (20.8)	3,371 (19.2)	1,965 (22.2)	9,868 (24.2)	
Common-law marriage	4,310 (2.0)	71 (0.8)	429 (1.3)	1,053 (1.8)	1,061 (2.3)	371 (2.1)	310 (3.5)	1,015 (2.5)	
Widowed	17,763 (8.3)	443 (4.9)	2,410 (7.1)	4,717 (8.1)	3,628 (7.9)	1,518 (8.6)	753 (8.5)	4,294 (10.5)	
Race/skin color									
									<0.001
Asian	1,102 (0.5)	18 (0.2)	118 (0.3)	259 (0.4)	241 (0.5)	99 (0.6)	144 (1.6)	223 (0.5)	
White	67,269 (31.4)	1,887 (20.9)	11,476 (34)	17,782 (30.5)	12,452 (27.2)	4,944 (28.2)	3,993 (45.1)	14,735 (36.2)	
Indigenous	180 (0.1)	4 (0)	14 (0)	28 (0)	31 (0.1)	5 (0)	9 (0.1)	89 (0.2)	
Brown	68,435 (31.9)	1,846 (20.4)	7,503 (22.2)	17,646 (30.3)	16,064 (35.1)	5,148 (29.3)	2,728 (30.8)	17,500 (43.0)	
Black	9,607 (4.4)	299 (3.3)	1,008 (3)	2,513 (4.3)	2,528 (5.5)	849 (4.8)	385 (4.3)	2,025 (5.0)	
Missing	67,481 (31.5)	4,989 (55.2)	13,619 (40.4)	20,091 (34.5)	14,513 (31.7)	6,513 (37.1)	1,592 (18)	6,164 (15.1)	
Age (years)									
									<0.001
0-29	3,085 (1.4)	54 (0.6)	215 (0.6)	742 (1.3)	913 (2.0)	356 (2.0)	294 (3.3)	511 (1.3)	
30-59	127,931 (59.8)	5,642 (62.4)	18,308 (54.3)	35,295 (60.5)	29,463 (64.3)	10,093 (57.5)	5,296 (59.8)	23,834 (58.5)	
60+	83,023 (38.8)	3,347 (37.0)	15,215 (45.1)	22,282 (38.2)	15,452 (33.7)	7,109 (40.5)	3,260 (36.8)	16,358 (40.2)	
Missing	35 (0)	0 (0)	0 (0)	0 (0)	1 (0)	0 (0)	1 (0)	33 (0.1)	
Educational attainment									
									<0.001
Completed elementary school	31,853 (11.4)	1,390 (15.4)	5,329 (15.8)	9,151 (15.7)	7,222 (15.8)	2,872 (16.4)	1,252 (14.1)	4,637 (11.4)	
Incomplete elementary school	57,637 (26.9)	2,085 (23.1)	8,552 (25.3)	16,627 (28.5)	13,869 (30.3)	5,401 (30.8)	1,993 (22.5)	9,110 (22.4)	
No formal education	9,562 (4.5)	211 (2.3)	1,052 (3.1)	2,535 (4.3)	2,411 (5.3)	1,054 (6.0)	229 (2.6)	2,070 (5.1)	
High school	45,002 (21.0)	2,021 (22.3)	7,397 (21.9)	13,270 (22.8)	10,209 (22.3)	3,534 (20.1)	1,515 (17.1)	7,056 (17.3)	
Completed higher education	21,344 (10.0)	1,528 (16.9)	4,666 (13.8)	6,086 (10.4)	3,829 (8.4)	1,361 (7.8)	691 (7.8)	3,183 (7.8)	
Incomplete higher education	2,662 (1.2)	84 (0.9)	434 (1.3)	754 (1.3)	532 (1.2)	142 (0.8)	166 (1.9)	547 (1.3)	
Missing	46,014 (21.5)	1,724 (19.1)	6,308 (18.7)	9,896 (17)	7,757 (16.9)	3,191 (18.2)	3,005 (34)	14,133 (34.7)	
Region where the treating hospital was located									
									<0.001
Central-West	7,666 (3.6)	113 (1.2)	746 (2.2)	1,573 (2.7)	1,616 (3.5)	555 (3.2)	700 (7.9)	2,363 (5.8)	
Northeast	50,130 (23.4)	1,477 (16.3)	5,334 (15.8)	12,595 (21.6)	11,002 (24.0)	3,513 (20.0)	2,043 (23.1)	14,166 (34.8)	
North	9,150 (4.3)	49 (0.5)	513 (1.5)	2,117 (3.6)	2,268 (4.9)	636 (3.6)	308 (3.5)	3,259 (8.0)	
Southeast	103,651 (48.4)	6,469 (71.5)	19,520 (57.9)	30,971 (53.1)	23,318 (50.9)	9,579 (54.6)	2,404 (27.2)	11,390 (28.0)	
South	43,477(20.3)	935 (10.3)	7,625 (22.6)	11,063 (19.0)	7,625 (16.6)	3,275 18.7)	3,396 (38.4)	9,558 (23.5)	
Total	214,074(100.0)	9,043(100.0)	33,738 (100.0)	58,319(100.0)	45,829(100.0)	17,558(100.0)	8,851(100.0)	40,736(100.0)	

*Not applicable; [†]Missing

Regarding marital status, married women accounted for the largest proportion (30.1%) and represented the largest category at every stage. The percentage varied slightly across stages, with a greater proportion of married women diagnosed at stage II (29.0%) than at stage IV (24.5%). Correspondence analysis showed that stage III was associated with never-married women and women in common-law marriages, whereas stage II was associated with separated, married, and widowed women ($p < 0.005$).

The most prevalent educational attainment category was incomplete elementary school (26.9%). Lower levels of educational attainment, such as incomplete elementary school and no formal education, accounted for 36.8% of cases diagnosed at stage IV,

compared with 25.4% of cases at stage I. A similar pattern was observed at stage III, with 30.3% of cases occurring in women with incomplete elementary school education, compared with 8.4% in women with completed higher education. By contrast, completed higher education accounted for the largest proportional share of cases diagnosed at stage I (16.9%). Among women with completed higher education, the number of early-stage cases was more than twice the number of stage IV cases. Correspondence analysis further showed that incomplete elementary school education clustered more closely with stages II and III, whereas completed higher education clustered with stage 0 ($p < 0.005$) (Figure 1).

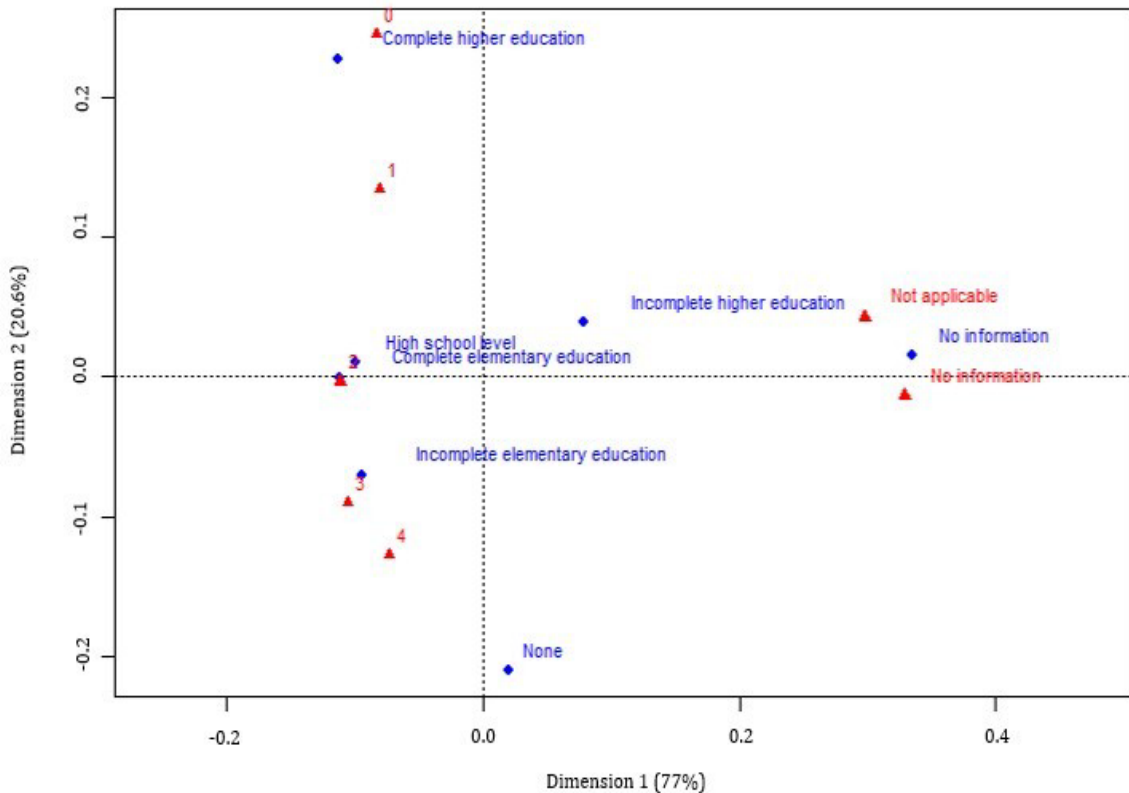


Figure 1 – Simple correspondence analysis between educational attainment and clinical stage (n = 214,074). Fortaleza, CE, Brazil, 2025

At all stages of breast cancer, cases were concentrated among women aged 30 to 59 years. Across subgroups, women aged 30 to 59 years accounted for the largest proportional share of cases diagnosed at

stages II and III. Correspondence analysis showed that women older than 60 years clustered with stages I and IV, whereas the 30-to-59-year age group clustered with stages 0, I, and III ($p < 0.005$) (Figure 2).

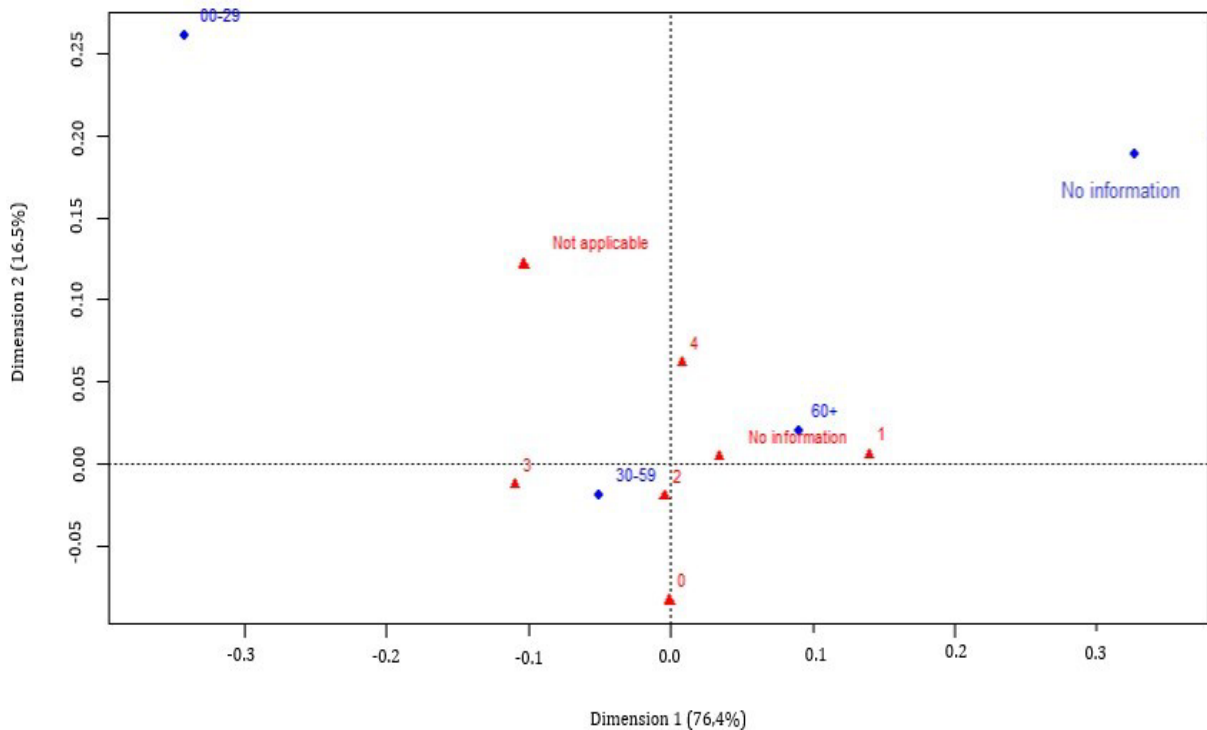


Figure 2 – Simple correspondence analysis between age and clinical stage (n = 214,074). Fortaleza, CE, Brazil, 2025

Women classified as Brown or Black accounted for most cases, representing 36.4% of the total. In the more advanced stages of the disease, Brown and Black women accounted for a greater proportion of cases, representing 36.6% of diagnoses at stage III and 34.1% at stage IV. However, at stage I, 34.0% of diagnosed cases were in White women, whereas 25.2% were in Brown and Black women. Indigenous and Asian women accounted for the smallest share of cases at every stage. Correspondence analysis between race/skin color and clinical stage (Figure 3) showed that stage III was associated with the Brown, Black, Indigenous, and Asian categories, indicating marked spatial proximity ($p < 0.005$). By contrast, the White category was more closely associated with stage I, in

dicating an association with diagnosis at an early stage of the disease.

The Southeast Region accounted for the largest share of cases, comprising 54.6% of stage IV records, followed by the Northeast Region, which ranked second at every stage except stage I, where the South Region had the second-largest proportional share (22.6%). The Southeast Region also accounted for the largest number of cases at stage 0 (71.0%). In the correspondence analysis (Figure 4), the Northeast Region was most closely associated with stage III, whereas the Southeast Region was associated with stage 0 ($p < 0.005$). Among the remaining regions, the Central-West Region was associated with stages II and IV, and the South Region with stage I ($p < 0.005$).

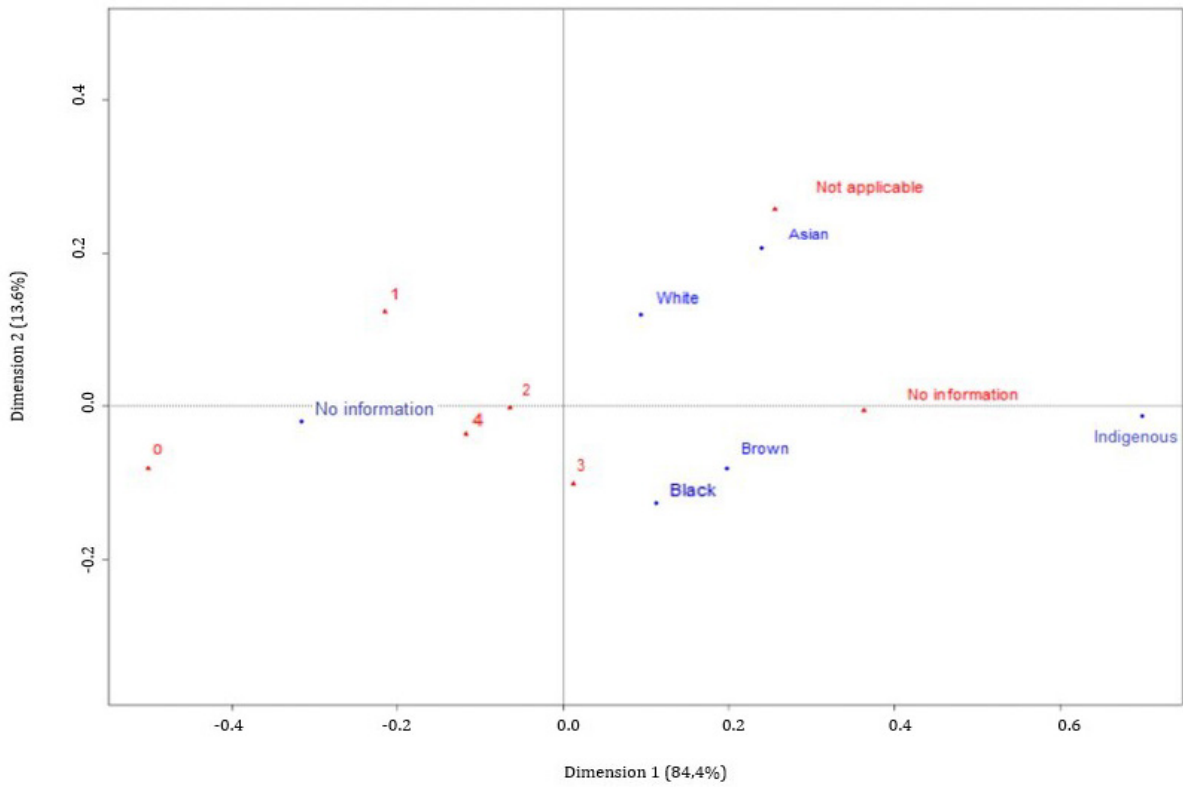


Figure 3 – Simple correspondence analysis between race/skin color and clinical stage (n = 214.074). Fortaleza, CE, Brazil, 2025

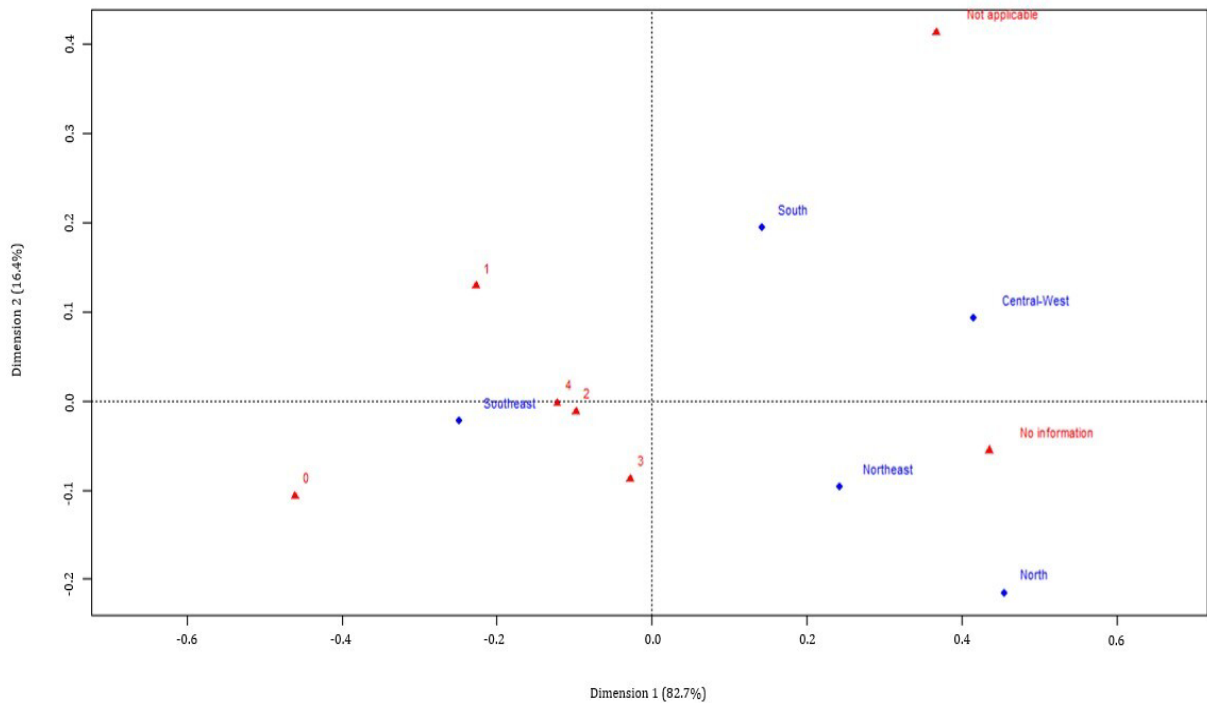


Figure 4 – Simple correspondence analysis between region and clinical stage (n = 214.074). Fortaleza, CE, Brazil, 2025

Discussion

Breast cancer is a complex, multifactorial disease involving biological, environmental, and social determinants⁽¹¹⁾. The findings allowed us to examine variables associated with disease stage. Despite the rising incidence of breast cancer, mortality has declined in developed countries. In Brazil, however, mortality remains high, likely because barriers to health care hinder early diagnosis and timely treatment, thereby reducing survival^(2,11).

Women with lower educational attainment are more likely to receive a delayed diagnosis because of barriers to mammography and medical visits, lower awareness, and limited knowledge of symptoms⁽⁶⁾. Consistent with this, the findings showed a higher percentage of women with incomplete elementary school education at stages III and IV.

With regard to marital status, data were incomplete, and the associations were unclear. Evidence on the relationship between marital status and screening practices is heterogeneous and limited by potential publication bias and methodological shortcomings, such as suboptimal control selection, insufficient exploration of confounding factors, and inadequate ascertainment of marital status⁽¹⁸⁾.

Thus, more than marital status itself, the quality of the support women receive appears to have a considerable influence on adherence to screening measures such as mammography. Factors such as a partner's higher educational attainment may facilitate mammography uptake, even in cultural contexts shaped by gender-related issues⁽⁶⁾. More broadly, the presence of a support network, including both the husband and other family members, positively influences care-seeking and test uptake⁽¹⁹⁾.

The risk of breast cancer diagnosis increases after the age of 50, due to the cumulative exposures over the life course and biological changes associated with aging. However, epidemiological analyses over the past three decades have shown a substantial increase in malignant breast neoplasms among younger women. An annual increase in incidence rates of 1.5%

has been observed among women around 30 years of age, and 0.9% among those in their 40s. Additionally, there is a higher proportion of hormone-dependent tumors in this group⁽²⁰⁾.

The risk of developing breast cancer is directly related to lifetime estrogen exposure, and associated factors may contribute to tumor cell growth. These factors include early menarche, late menopause, first pregnancy after age 30, nulliparity, use of oral contraceptives, and postmenopausal hormone replacement therapy, among others^(11,20). The increase in incidence among young women may be associated with greater hormonal exposure, in addition to genetic and epigenetic factors compounded by lifestyle changes⁽²⁰⁾.

Screening was recommended only for women aged 50 years and older for many years. However, the growing incidence of breast cancer among younger women has led many health agencies to broaden the recommended age range for screening, encouraging mammography beginning at age 40 or 45⁽²⁰⁾. In Brazil, the Ministry of Health recommends biennial mammography for women aged 50 to 69 years, whereas the Brazilian Society of Mastology recommends screening beginning at age 40^(3,9).

Across the racial subgroups analyzed, the distribution of stage at diagnosis was heterogeneous. The clinical characteristics of the tumors alone are not sufficient to explain these discrepancies; the contribution of social determinants of health to patterns of illness among populations affected by structural racism must also be considered⁽²¹⁻²²⁾.

In a population of 863 women, of whom 35.9% self-identified as White, 21.3% as Black, and 42.8% as Brown, Black race was associated with advanced stage at diagnosis. This finding was attributed to racial disparities in access to health services and early breast cancer detection⁽²²⁻²³⁾. A similar pattern was observed in the present study: the more advanced stages included a higher proportion of women classified as Brown or Black, whereas stage I was composed mostly of White women.

These inequities are reflected in the high breast cancer mortality among Brown and Black women,

which is linked to delayed diagnosis because of differences in access to services and psychosocial factors such as low perceived risk of developing the disease and limited knowledge of risk factors and screening guidelines⁽²⁴⁾.

The Comorbidities and Reducing InEquities initiative, a multilevel strategy that included interventions such as a home-monitoring device linked to a mobile app and follow-up by a community health worker for Black patients with breast and prostate cancer, showed improved health outcomes, including better control of comorbidities⁽²⁵⁾.

With respect to geographic location, breast cancer incidence and mortality are higher in Brazil's more economically developed states. Although levels vary across regions, the Southeast Region has the highest breast cancer mortality rates among women, followed by the Northeast, Central-West, and North Regions⁽²⁶⁾.

The North and Central-West Regions already had lower mammography coverage before the COVID19 pandemic. However, the pandemic led to a marked reduction in mammography coverage in both regions. There was a slight recovery in 2021, although coverage still did not return to prepandemic levels⁽²⁷⁾.

Persistent disparities in access to mammography remain evident and are associated mainly with being classified as Brown or Black, lower socioeconomic status, living in the North Region and in non-metropolitan areas, having incomplete elementary school or equivalent as the highest level of education, and age, among other factors⁽²⁸⁾.

The present findings reinforce this pattern, showing that the Southeast Region accounted for the largest share of cases at all stages, followed by the Northeast Region, which ranked second at every stage except stage I, where the South Region ranked second.

Study limitations

Data incompleteness limits this study, as the analyses were restricted to the information available in the Hospital-Based Cancer Registries. A high pro-

portion of records contained missing values; therefore, the findings apply only to the study population and cannot be generalized to all women receiving treatment for breast cancer.

Contributions to practice

The findings presented here are part of a broader picture showing that the health care system does not provide screening and early detection equitably across regions and population groups in Brazil, with direct implications for breast cancer incidence. This picture should inform the development of public policies designed to put the principles and guidelines of the Brazilian Unified Health System into practice through intersectoral coordination and regionalized service delivery across levels of care.

In addition, these findings provide health professionals and managers with a basis for planning and implementing strategic actions to expand screening and early detection for individuals facing greater barriers to access. This may help promote equity and universality through a fair distribution of opportunities for breast cancer diagnosis, especially in the North and Northeast Regions and among women older than 30 years and those with lower educational attainment.

Conclusion

The high frequency of advanced-stage breast cancer was strongly associated with the state where treatment was provided, low educational attainment, age, and race/skin color. These social determinants of health may influence access to health services, especially breast cancer care.

Effective monitoring of breast cancer screening and early detection efforts is therefore essential, as is incorporating this information into the planning of health actions and services in Brazil. In addition, improving information systems and ensuring consistent data entry provide an accurate and reliable basis for developing public policies in health promotion,

surveillance, and care within the Brazilian Unified Health System.

Authors' contributions

Conception and design, or data analysis and interpretation; drafting of the manuscript or critical revision of important intellectual content; final approval of the version to be published; and agreement to be accountable for all aspects of the manuscript, ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved: **Martins MCT, Souza GL, Castro RCMB, Santos CPRS, Teodoro VA, Ramos HFB, Sousa MVTB.**

Data availability

The authors declare that the data are fully available within the article.

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