Ethnic Disparities in Breast Cancer Patterns in Brazil: Examining Findings from Population-Based Registries

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Research Article

Keywords: Breast cancer, race groups, incidence, mortality

Posted Date: February 6th, 2024

DOI: https://doi.org/10.21203/rs.3.rs-3921524/v1

Additional Declarations: No competing interests reported.

Version of Record: A version of this preprint was published at Breast Cancer Research and Treatment on April 21st, 2024. See the published version at https://doi.org/10.1007/s10549-024-07314-w.

Abstract

Purpose: To investigate breast cancer (BC) incidence and mortality rates among specific racial groups in Brazil.

Methods: BC incidence was evaluated from 2010 to 2015, using Brazilian Population-Based Cancer Registries, incorporating age-standardized ratios and annual average percentage change (AAPC). Clinical and sociodemographic data from 2000 to 2019 were obtained from Hospital-Based Cancer Registries. Mortality data from 2000 to 2020 were sourced from the National Mortality Information System, comparing White women and Black women.

Results: Across 13 Brazilian registries, 70,896 new BC cases were reported from 2010 to 2015. The median BC incidence rate was notably higher for White women (101.3 per 100,000) compared to Black women (59.7 per 100,000). In the general population, non-significant decrease in annual BC incidence was observed (AAPC = -1.2; p = 0.474). Black women were more likely to live in underdeveloped areas, have lower education levels, live without a partner, and have higher alcohol consumption as compared to White women. A higher proportion of Black women received advanced-stage diagnoses (60.1% versus 50.6%, p < 0.001). BC-related mortality analysis showed 271,002 recorded deaths, with significant increase in BC-specific mortality rates in both racial groups. Black women displayed an AAPC of +2.3% (p < 0.001), while White women demonstrated a moderately elevated AAPC of +0.6% (p < 0.001).

Conclusion: This study underscores the need for targeted policies to address disparities in access to early detection and proper treatment, particularly for Black women in underprivileged regions, aiming to improve the survival rates of Brazilian women grappling with BC.

Introduction

Breast cancer (BC) is the predominant malignant disease affecting women globally, with approximately 2,261,419 reported cases in 2020, making up 11.7% of the total cancer burden [1]. Projections from the GLOBOCAN Cancer Tomorrow prediction tool indicate a significant increase of over 46% in global incident cases by 2040 [1, 2]. Specifically in Brazil, for the triennial period from 2023 to 2025, a projection of 73,610 new BC cases annually is being anticipated, resulting in an approximate risk of 66.54 per 100,000 women [3]. This establishes BC as the most common malignancy in the country. Furthermore, BC ranks as the fourth most fatal cancer worldwide, with an estimated 684,996 global deaths in 2020, making up 6.9% of total deaths [4]. Notably, in Brazil, there were 19,363 deaths specifically attributed to BC in 2022, accounting for 1.3% of the overall mortality in the country [5].

The reasons behind the racial and ethnic disparities in BC incidence and mortality rates worldwide are still not fully understood [6]. However, potential risk factors include socioeconomic status, late-stage diagnosis, biological and genetic variations in tumors, differential access to healthcare, and molecular differences related to the disease [7]. Traditionally, BC incidence has been lower among Black women compared to White women. However, there has been a convergence of BC rates between these two ethnic

groups since 2012, indicating a slow and constant increase in BC incidence among Black women while the rate remains stable among White women [8]. Since 1975, there has been an annual increase of 0.4% in BC incidence among Black women [6].

Reports suggest that, in the United States, age-adjusted BC mortality is approximately 40% higher among Black women compared to non-Hispanic White women (27.6 versus 19.7 deaths per 100,000 women from 2016 through 2020) [9, 10]. Lack of health insurance or inadequate coverage is more common among Black women compared to White women, which limits their access to mammography screening and affects treatment decision-making [10]. Historically, there has been a marked disparity between Black and White women in terms of mammography screening rates, and this inequity remains a significant factor today [11]. Black women tend to be diagnosed with BC at a younger age than White women, with a median age of 59 for Black women and 63 for White women [9]. Hereditary elements likely account for the higher prevalence of hormone receptor-negative (HR-negative) and triple-negative breast cancer (TNBC) among Black women [12]. This could be attributed to the ancestral background of many Black women in the United States, who are descended from western sub-Saharan Africa where HR-negative BCs are predominant [13].

This study aimed to examine the long-term patterns of BC incidence among different racial groups over a period of six years. Additionally, it sought to analyze the trends in mortality rates over the period 2000 to 2020, specifically in the context of Brazil. The study also provided a detailed clinical and sociodemographic profile of BC patients in Brazil. The analysis prioritized a thorough exploration of the epidemiological inequalities between Black and White women, aiming to produce valuable insights for future research and assist public health administrators in formulating effective cancer control strategies.

Material and methods

Data sources

This study used data gathered from the Population-Based Cancer Registries (PBCRs), Hospital-Based Cancer Registries (HBCRs), and the Mortality Information System (MIS) in Brazil. The study exclusively relied on anonymous data acquired from these publicly available governmental sources, making the need for ethical review board approval and obtaining consent unnecessary. The study focused on BC cases and deaths recorded under the International Classification of Diseases for Oncology, third edition (ICD-O-3) codes C50.0-C50.9.

Data curation was executed by considering race/ethnicity, histological diagnosis, and year of diagnosis as primary factors. To ensure data accuracy and relevance, exclusion criteria were applied, which involved removing male patients, misidentifications, racial categories beyond white and black (such as yellow, indigenous, etc., due to low representation), non-malignant disease diagnoses, misdiagnoses, instances of diagnosis pre-dating the year 2000, and any information lacking year of diagnosis specified.

Data regarding the incidence of BC among women of different races were obtained in March 2023 from 13 PBCRs in various cities in Brazil, namely Aracaju, Belo Horizonte, Campo Grande, Curitiba, Florianópolis, Fortaleza, Goiânia, João Pessoa, Manaus, Palmas, Porto Alegre, Recife, and São Paulo. In Brazil, ethnicity is self-declared and classified according to the Brazilian Institute of Geography and Statistics (IBGE). In this study, individuals who self-identified as "Black" (in Portuguese: "preto") or "Mixed or Browns" (in Portuguese: "pardo") were categorized as Black. The temporal distribution of BC incidence was then analyzed using data from 2010 to 2015. The analysis focused on two racial groups, White and Black women. Incidence rates, measured per 100,000 women, were treated as independent variables and examined for any significant changes throughout the study period. Data from 2016 onwards were excluded due to insufficient population coverage (< 12%).

The study gathered comprehensive data on the clinical and sociodemographic characteristics of women diagnosed with BC between 2000 and 2019. These data were obtained from HBCRs, which are specialized centers responsible for the systematic and ongoing collection, storage, processing, and analysis of information on cancer patients treated in Brazilian hospitals. The integration system of HBCRs was accessed in June 2021 to retrieve the required data.

In March 2023, mortality data regarding women diagnosed with BC in Brazil between 2000 and 2020 were extracted from the MIS. These data were further categorized based on race and year of diagnosis, offering a comprehensive overview of BC mortality trends nationwide. To ensure the integrity of the data, BC-related deaths lacking complete or sufficient age information were excluded from the analysis.

Statistical analysis

The analysis of incidence and mortality rates involved the application of Joinpoint models. These models entailed fitting straight lines to the observed rates and selecting specific joinpoints to evaluate their statistical significance using permutation methodology. This approach facilitated the detection of trend changes (joinpoints) and the calculation of the average annual percent change (AAPC). The Joinpoint Regression Program, employed in the analysis, provided confidence intervals for the null hypothesis of AAPC = 0 and p-values to assess the potential rejection of the null hypothesis of zero joinpoints, indicating the presence of trend changes.

The crude incidence rates of BC, indicating the number of new cases per 100,000 women per year of diagnosis, were determined by dividing the total number of new cases by the female population covered by the PBCRs. Similarly, the crude mortality rates, also per 100,000 women, were calculated by dividing the number of deaths by the female population of the entire country, considering different race groups and year of death, and were age-adjusted using the world standard. Variability in the incidence and mortality rates over the years was assessed using multiple pairwise comparison tests. The distribution of clinical and sociodemographic variables across different race groups was analyzed using the chi-square test. A p-value below 0.05 was considered statistically significant. Given the large patient cohort in this study, disparities in clinical and sociodemographic factors among race groups were evaluated for their clinical significance. A criterion of more than 5% disparity in proportional values was used to identify

noteworthy differences. Data analysis was performed using Microsoft Excel (2007), the Joinpoint Regression Program version 4.9.1.0 (National Cancer Institute of USA, 2022), and SPSS Statistics version 24.0.0.0 (IBM, São Paulo, Brazil).

Results

During the analysis period from 2010 to 2015, a total of 70,896 new cases of BC were recorded across the 13 participating PBCRs. The annual crude incidence rates of BC varied notably, ranging from 76.44 per 100,000 (the lowest rate) to 89.21 per 100,000 (the highest rate) (see supplementary table 1). The median crude incidence rate for White women was calculated to be 101.3 per 100,000, while for Black women, the median rate was 59.7 per 100,000 (see Fig. 1).

During the period of analysis, as observed from supplementary tables 1 and 2, there was a non-significant decrease in annual BC incidence by 1.2% (AAPC − 1.2; 95% confidence interval, CI: -5.4 to 3.1; p = 0.474) within the general population. Among White women, there was a non-significant annual decrease in incidence rate by 1.7% (AAPC − 1.7; 95% CI: -7.9 to 4.9; p = 0.506), with rates declining from 106.09/100,000 to 97.38/100,000 (see Fig. 2). Similarly, the annual incidence rates for Black women (AAPC − 0.4; 95% CI: -5.0 to 4.5; p = 0.831) (see Fig. 2) did not exhibit any significant variations, ranging from 60.25/100,000 to 59.08/100,000.

Using the extensive HBCR dataset, comprising 393,487 carefully selected participants from 2000 to 2019, a comprehensive comparative analysis was conducted to examine the clinical and sociodemographic characteristics within the two pre-determined racial groups. Table 1 show cases that Black women exhibited a higher presence in less developed regions compared to White women (56.4% versus 14.1%; p < 0.001). Additionally, they displayed a greater proportion of women with educational attainment ≤ 8 years (68.7% versus 60.5%; p < 0.001), a higher percentage of women without a partner (50.9% versus 45.3%; p < 0.001), and increased exposure to alcohol consumption (20.9% versus 15.4%; p < 0.001). Furthermore, Black women had a significantly higher proportion of diagnoses identified at advanced stages (60.1% versus 50.6%; p < 0.001).

Table 1
Characteristics of breast cancer cases obtained from Hospital-Based Cancer Registries classified according to racial categories.

	Race[#]			
Variables	Black N (%)	White N (%)	Total N (%)	p-value
Year of diagnosis				< 0.001
2000–2004	19,104 (10.4)	27,162 (12.9)	46,266 (11.8)	
2005–2009	39,354 (21.5)	50,893 (24.2)	90,247 (22.9)	
2010–2014	62,055 (33.9)	72,357 (34.4)	134,412 (34.2)	
2015–2019	62,764 (34.2)	59,798 (28.4)	122,562 (31.1)	
Oncology units and centers geographic region*				< 0.001
More developed region	79,919 (43.6)	180,547 (85.9)	260,466 (66.2)	
Less developed region	103,358 (56.4)	29,663 (14.1)	133,021 (33.8)	
Patient Referral**				< 0.001
Brazilian public healthcare system	132,043 (79.0)	132,771 (72.3)	264,814 (75.5)	
Other	35,197 (21.0)	50,958 (27.7)	86,155 (24.5)	
Age. median (IQR)	53 (45–64)	56 (47–66)	55 (46–65)	< 0.001
Schooling. years				< 0.001
≤ 8 years	98,554 (68.7)	9,7120 (60.5)	195,674 (64.4)	
> 8 years	44,901 (31.3)	63,285 (39.5)	108,186 (35.6)	
Marital status				< 0.001

With a partner	84,197 (49.1)	100,098 (54.7)	184,295 (52.0)	
Without a partner	87,125 (50.9)	82,975 (45.3)	170,100 (48.0)	
Alcohol consumption				< 0.001
Yes (current or past consumption)	23,951 (20.9)	17,693 (15.4)	41,644 (18.2)	
Never	90,507 (79.1)	96,936 (84.6)	187,443 (81.8)	
Tobacco consumption				< 0.001
Yes (current or past consumption)	35,867 (29.4)	35,298 (28.2)	71,165 (28.8)	
Never	86,021 (70.6)	89,789 (71.8)	175,810 (71.2)	
Clinical stage				< 0.001
Initial (< IIB)	52,295 (39.9)	73,999 (49.4)	126,294 (45.0)	
Advanced (≥ IIB)	78,630 (60.1)	75,717 (50.6)	154,347 (55.0)	
Time from diagnosis to first treatment				0.712
≤ 60 days	69,017 (46.9)	78,126 (47.0)	147,143 (46.9)	
> 60 days	78,183 (53.1)	88,268 (53.0)	166,451 (53.1)	
Total	183,277 (46.6)	210,210 (53.4)	393,487 (100.0)	

According to the classification proposed by the Brazilian Institute of Geography and Statistics (In Portuguese: Instituto Brasileiro de Geografia e Estatistica - IBGE); excludes Yellow race (n= 3313) and Indigenous (n= 422).

* Classified according to the Human Development Index (HDI) in More developed regions (Southeast = 0.676. South = 0.660 and Midwest = 0.639) versus Less developed regions (North = 0.527 and Northeast 0.516).

** Category of the oncology service: Center of Reference in High Complexity of Oncology (in Portuguese: Centros de Alta Complexidade em Oncologia – CACON) has multidisciplinary resources to treat any type

of cancer; Unit of High Complexity in Oncology (in Portuguese: Unidades de Alta Complexidade em Oncologia – UNACON) has resources to treat the five most common types of cancer in the country; Other services include radiotherapy isolated service. hospital complex radiotherapy service. hospital complex clinical oncology service or general hospital with oncology surgery.

An analysis of BC-related mortality using the MIS dataset from 2000 to 2020 revealed a total of 271,002 fatalities. Throughout this period, mortality rates varied, with the lowest rate recorded at 10.33/100,000 and the highest rate at 11.68/100,000 (see supplementary table 3). Notably, there was a significant increase in BC-specific mortality rates within the two racial groups under investigation. Among Black women, there was a substantially higher increase with an AAPC of + 2.3% (95% CI: 2.1 to 2.5; $p < 0.001$) (see Fig. 3b), while White women exhibited a modestly elevated AAPC of + 0.6% (95% CI: 0.5 to 0.8; $p < 0.001$) (see Fig. 3a).

Discussion

BC remains a significant burden on the Brazilian public healthcare system. The findings of the current study indicate that, over an analyzed period of 6 years, there were no significant variations in the incidence of BC among both White women and their Black counterparts. A comparative analysis between the two racial groups revealed considerable disadvantages related to sociodemographic and clinicopathological factors for Black women compared to White women. These differences may explain the significant 3.83-fold higher annual increase in mortality among Black women compared to White women over a period of 20 years.

Kaur et al. [14] studied data from the United States in the period spanning 2004 to 2017 and found a surge in BC incidence rates, particularly among non-Hispanic Black women. The most significant increases were observed in non-Hispanic Black women in lower-poverty areas (0.8%), rural areas (1.2%), and in all regions except the West (0.8–1.0%). Non-Hispanic Black women also experienced marked rises in early and advanced stage BC subgroups. Similarly, Hispanic women had notable increases, including in areas with higher poverty (0.6–1.2%) and in the West (0.8%), for early and advanced diseases. These results highlight the escalating burden of BC in specific subpopulations, some of which already face disproportionately high mortality rates.

Makhetha et al. [15] examined the global increase in BC incidence, particularly in low- and middle-income countries, and specifically studied hereditary BC patients in South Africa's KwaZulu-Natal province. The data collected from 2011 to 2021 included 645 patients, with significant increases in annual new cases, particularly among Black individuals. Black patients were diagnosed approximately 10 years earlier than White and Indian patients, with TNBC accounting for 20.3% of hereditary cases, disproportionately affecting Black individuals. Pathogenic *BRCA1/2* sequence variants were identified in 10.4% of all patients, with a higher prevalence among Black and Indian patients.

The Brazilian National Health Survey of 2013 revealed disparities in mammography rates, with 66.2% of White women, 54.2% of Black women, and 52.9% of mixed-race women having undergone screening. The

educational level also influenced mammography rates, with college-graduated women having higher coverage at 80.9% compared to 50.9% for those with incomplete schooling [16]. Additionally, disparities in educational attainment were observed between White and Black/mixed-race populations, as White women had almost double the access to college graduation compared to Black and Mixed-race women [17]. These findings suggest that White women may have better access to BC screening programs. This is supported by data collected from HBCRs in this study, which showed a significantly higher proportion of women with lower education levels and more advanced disease at diagnosis in the Black population compared to the White population.

Data from national inquiries in 2012 and 2022 show that Black and Mixed-race populations primarily reside in Brazil's North and Northeast regions, which have lower HDI scores compared to other regions [18]. Residents in these less developed areas may face challenges in accessing healthcare services, preventive screenings, and adequate BC treatments. The 2023 annual report on BC statistics from the Brazilian National Cancer Institute revealed significant disparities in mammography availability, with only 38.7% of women in the Northern region undergoing screening compared to 67.9% in the Southeastern region [19, 20]. Analysis in this study found that 56.4% of Black women with BC resided in these less developed regions, contrasting with 14.1% of White women, highlighting regional and structural imbalances contributing to differing incidence and mortality rates between the ethnic groups.

The current analysis of breast cancer-specific mortality rates using AAPC found a strikingly higher increase in mortality for Black women compared to White women. That said, the racial disparities in healthcare outcomes could be influenced by socioeconomic factors and potential implicit bias among healthcare professionals, impacting communication, clinical investigation, and treatment decisions for vulnerable patients [21]. In Brazil, dissatisfaction with healthcare and hospitalization was observed in 12.2% of White patients and 17.4% of Black and Brown patients. Black or Brown individuals seeking healthcare were twice as likely as White individuals to go untreated [22]. International literature does not strongly support biological plausibility for these differences. Studies have shown that Black individuals face higher mortality rates from certain tumors, even after considering factors like stage and tumor characteristics, suggesting that delayed or incomplete treatment may contribute to these disparities [23]. Additionally, racial disparities in diagnosis, treatment, and survival persist across different socioeconomic statuses and healthcare access [24].

The time from BC diagnosis to treatment onset significantly affects survival, with an increased risk of death if treatment is delayed beyond 60 days [25]. A study in Brazil from 2019–2020 found that over half of BC patients experienced delays of more than 60 days before starting oncology treatment, with age and travel distance to treatment sites influencing the likelihood of delay [26]. Another study in the city of Juiz de Fora in Brazil showed statistical differences in BC incidence between White and Black women. Most women treated in the private healthcare system were White and experienced shorter waiting times between diagnosis and treatment onset, averaging 52 days compared to 82 days in the public healthcare system [27]. These findings may contribute to the increasing BC mortality rate and the higher mortality

rates among Black women compared to White women in Brazil. Nonetheless, further research is needed to better understand this correlation.

Representing around 20% of Brazil's total population with reliable death registry notification, an epidemiological study in São Paulo from 2000 to 2017 found a decrease in BC mortality rates among White women, but an increasing trend among Black women in this region [28]. In contrast, the United States observed a 43% decline in BC mortality rates from 1989 to 2020, with an annual decrease of 1.9% from 1998 to 2011, and 1.3% from 2011 to 2020 [9]. Notably, while BC mortality rates were progressively lower in the United States, a persistent racial disparity was observed between Black and White women. This disparity is linked to systemic racism in cancer care, encompassing issues such as disparities in screening quality, longer intervals between mammograms and follow-up of abnormal findings, and substandard treatment. Biological factors also contribute to racial disparities, including a higher incidence of hormone receptor-negative BC in Black women, known for lower survival rates. Despite these intrinsic factors, Black women continue to exhibit higher mortality rates, suggesting difficulties in accessing more effective treatments for HER2-positive and TNBC [29–33].

The recently published nationwide cohort study performed by Lemos et al. [34] focused on women receiving breast cancer treatment within Brazil's public healthcare system, Sistema Único de Saúde. The study employed a comprehensive approach by linking administrative and mortality information systems, enabling the assessment of survival outcomes based on race or skin color. The results indicated a significant disparity in 5-year survival probability and all-cause mortality risk between Black and White women, with the former experiencing a notably lower survival rate and higher risk of all-cause death. Even after adjusting for covariates, including hormone therapy, the elevated risk for Black women persisted.

In 2023, the American Cancer Society released an updated report on racial, ethnic, socioeconomic, and geographic inequalities in cancer occurrence and outcomes, as well as provided insights into initiatives that have effectively mitigated these disparities. The report revealed significant disparities in risk factors, diagnosis stages, care provision, survival, and cancer mortality based on race/ethnicity, educational attainment, and metropolitan status. Black and American Indian/Alaska Native individuals faced persistently higher cancer mortality rates, especially among those with 12 years or fewer of education[35].

The present study demonstrates several notable strengths, including its population-based design encompassing extensive national coverage and the comprehensive analysis of a substantial time period capturing incidence and mortality rates recorded in national databases. Nonetheless, it is imperative to consider certain methodological constraints that may impact the interpretation of the data. Firstly, the accuracy and reliability of the data collected from registries and information systems may exhibit regional variability. Secondly, inherent limitations associated with observational studies, such as the inability to establish causality and account for unmeasured variables, should be considered when interpreting the findings. Furthermore, the absence of information on lifestyle factors, socioeconomic status, health insurance, screening practices, and family history could potentially influence the outcomes of the disparity analyses among the racial groups. Lastly, the utilization of Population-Based Cancer

Registries (PBCRs) was based on the availability of female population data categorized by race. Nevertheless, the calculation of adjusted incidence rates was unfeasible due to the unavailability of race- and age-group-stratified population data for the PBCRs featured in the study.

In conclusion, the current analysis of epidemiological data on BC by race from national population-based public databases indicates marked differences in the pattern of cancer incidence and mortality according to race. Furthermore, there was a notable frequency of Black women in regions with limited access to early detection exams. These women often exhibit lower educational levels and are more susceptible to advanced-stage diagnoses, leading to reduced access to timely diagnosis and appropriate treatment, ultimately contributing to lower survival rates. This systemic issue within the Brazilian healthcare system has broader implications, presenting a significant national challenge that affects the sustainability of the healthcare system, particularly within the context of the Brazilian public health system. The inadequacy of resources for providing comprehensive care to Brazilian women diagnosed with BC, as indicated by the findings, emphasizes the critical need for research that informs public health policies, facilitating more effective allocation of resources towards screening, prevention, and cancer treatment.

Declarations

Acknowledgments

We express our gratitude to the public data source in Brazil for their invaluable contribution in supplying the comprehensive dataset utilized in this research endeavor. It is important to emphasize that the authors bear full responsibility for the content presented in this publication, and any viewpoints or opinions expressed herein are solely those of the authors and should not be construed as official stances endorsed by governmental authorities.

Funding

The authors declare that this study has received no financial support for this paper.

Competing interests

The authors declare they have no conflicts of interest related to this paper.

Ethical approval

This is a retrospective observational study performed with openly accessible datasets and so no ethical approval is required.

Informed consent

Not applicable.

Contributions:

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Jessé Lopes da Silva, Lucas Zanetti de Albuquerque, Mariana Espírito Santo rodrigues, Luiz Claudio Santos Thuler and Andréia Cristina de Melo. The first draft of the manuscript was written by Jessé Lopes da Silva and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Data availability

The datasets used in this study are openly accessible and can be found at the subsequent sources. For data concerning the incidence, please visit https://www.inca.gov.br/BasePopIncidencias/Home.action. For data regarding clinical and sociodemographic, please refer to https://irhc.inca.gov.br/RHCNet/. Lastly, data related to mortality is available at http://tabnet.datasus.gov.br/cgi/deftohtm.exe?sim/cnv/obt10uf.def.

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Figures

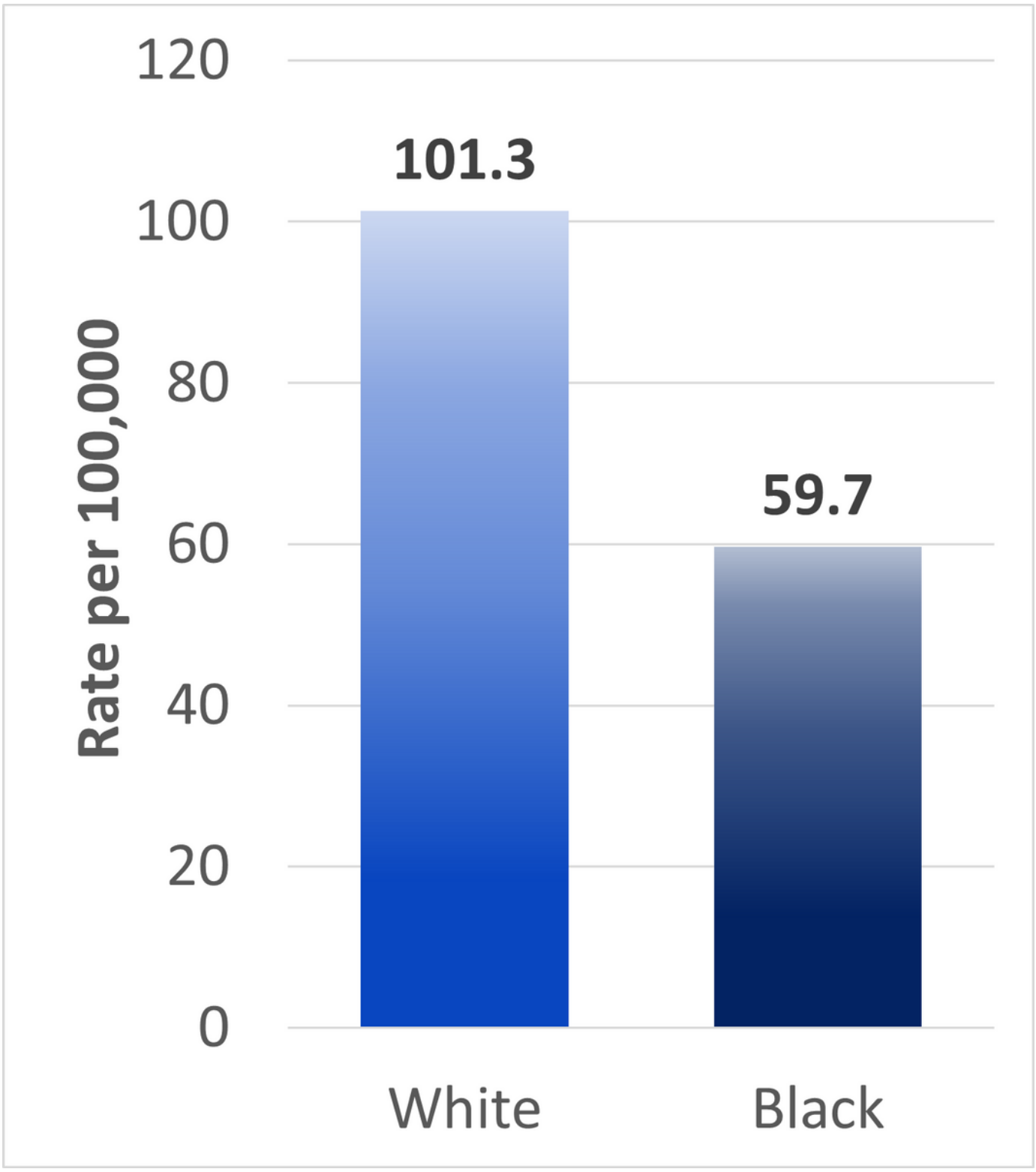

Figure 1

Adjusted mean incidence rates of breast cancer stratified by race/ethnicity in Brazil for the period spanning 2010 to 2015

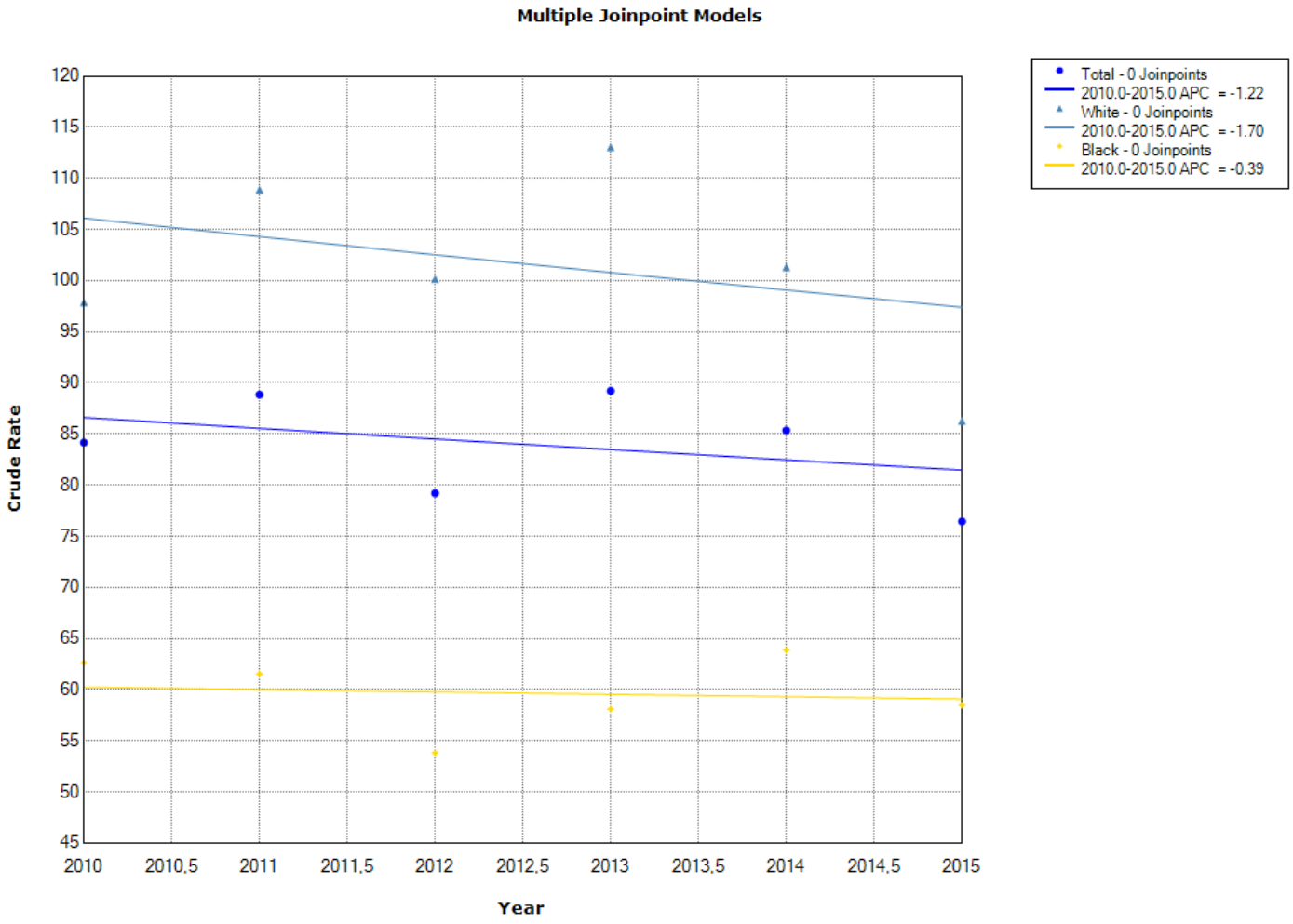

Figure 2

Temporal variation in crude breast cancer incidence rates among the two racial groups in the female population, 2010-2015

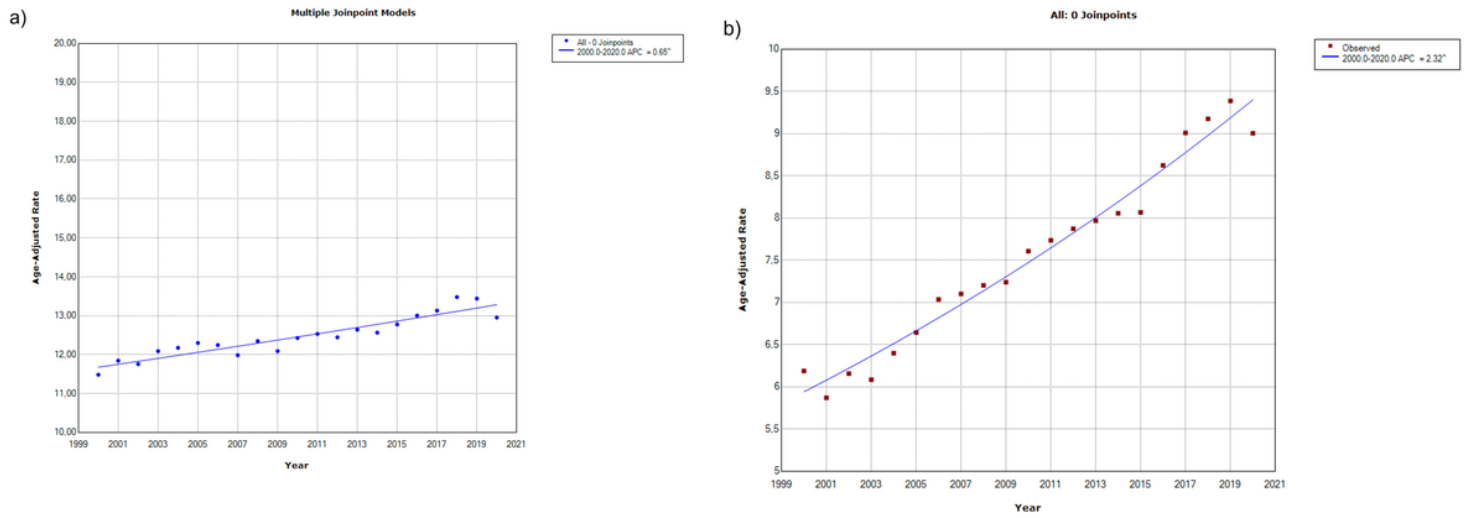

Figure 3

Temporal patterns of adjusted breast cancer mortality rates in the female cohort segmented by two racial groups, 2000-2020: a. White women; b. Black women

* Indicates that the Annual Percent Chance (APC) is significantly different from zero at the alpha = 0.05 level

Supplementary Files

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- Supplementarytables.docx