BMC Cancer

RESEARCH

Open Access

How are we allocating physicians to deal with breast cancer in men and women in Brazil?

Jean Henri Maselli-Schoueri[1*], Luis Eduardo Werneck De Carvalho[2], Claudia Vaz De Melo Sette[3], Luiz Carlos de Abreu[4], Fernando Luiz Affonso Fonseca[5], Fernando Adami[1†] and Laercio da Silva Paiva[1]

Abstract

Background Female breast cancer (FBC) is a well-known public health issue worldwide. However, male breast cancer (MBC), though rare, may be overlooked by both public health authorities and clinicians. Both diseases exhibit similarities, and understanding their behavior over time is crucial to grasping their annual impact on many citizens. Furthermore, analyzing if medical personnel are well allocated and influence disease outcomes in a limited setting such as the Public Health System (PHS) is of utmost importance.

Methods This ecological study utilized secondary data from 2008 to 2020 to explore the relationship between the number of doctors per 100,000 inhabitants and mortality from FBC and MBC in Brazil. All data were sourced from Brazil's PHS. Mortality rates were analyzed by age and standardized according to the World Health Organization's population figures. The number of physicians was calculated per 100,000 inhabitants. A linear regression analysis was performed using a stepwise selection/backward elimination approach.

Results Between 2008 and 2020, Brazil recorded 195,969 breast cancer-related deaths among adults, including 2,220 male victims. The majority of these deaths occurred in the Southeast region among patients older than 50 years. Although both MBC and FBC demonstrated increasing trends over the study period, no correlation was found between the number of physicians and mortality rates for MBC. Conversely, an increase in primary care physicians over the years was positively correlated with mortality rates for FBC ($p < 0.05$). In addition, the number of physicians in the PHS (β = -0.163; 95% CI: -0.240 to -0.085; $p = 0.002$), oncologists (β = -0.507; 95% CI: -0.881 to -0.134; $p = 0.015$), and radiotherapists (β = -6.402; 95% CI: -12.357 to -0.446; $p = 0.039$) all showed an inverse association with FBC mortality.

Conclusions The increasing trends in FBC and MBC underscore the need for urgent monitoring. Lower FBC mortality correlates with higher numbers of physicians and specialized care, highlighting the critical role of healthcare workforce capacity and the strategic allocation of specialized personnel in enhancing patient outcomes.

Keywords Breast Cancer Mortality, Male breast Cancer Mortality, Inequality, Public Health, Brazil

†In memoriam.

*Correspondence:
Jean Henri Maselli-Schoueri
jean.schoueri@gmail.com
[1]Laboratório de Epidemiologia e Análise de Dados, Centro Universitário Saúde ABC, Av. Lauro Gomes 2000, Vila Sacadura Cabral, Santo André, São Paulo 09060-870, SP, Brazil
[2]Oncológica do Brasil Ensino e Pesquisa. Belém, Pará, Brasil
[3]Discipline of Oncology and Hematology, Centro Universitário FMABC. Santo André, São Paulo, Brasil
[4]province of Munster, University of Limerick - Sarsfield Ave. Limerick, Limerick, Ireland
[5]Laboratório de Análises Clínicas, Centro Universitário FMABC. Santo André, São Paulo, Brasil

Introduction

Female breast cancer (FBC) is a well-known public health issue worldwide, affecting over 2 million women and resulting in 670,000 deaths globally in 2022 [1]. For 2023, it was estimated that 297,790 new cases would be diagnosed, and approximately 43,170 women would succumb to the disease in the US alone [2]. In Brazil, breast cancer is not only the most common cancer among women but also the leading cause of cancer-related deaths in the female population [3].

Male breast cancer (MBC), however, is a rare condition, accounting for approximately 0.2% of all male malignancies [4] and a global estimated mortality risk of 0.34 per 100,000 inhabitants. Remarkably, MBC was omitted from the GLOBOCAN estimates for 185 countries in 2020 and 2022, complicating efforts to understand its behavior [5–7]. In the US, for instance, about 2,800 cases are expected annually, many of which are diagnosed late, leading to high mortality rates [8]. Although data are sparse, Brazil has noted an increase in MBC mortality from 2005 to 2015[9]. However, due to its rarity, MBC may still be overlooked by public health authorities and clinicians.

Nevertheless, Brazil is a large and diverse country, marked by significant regional variations in healthcare quality and disease mortality [10, 11]. These disparities are influenced by various factors, including socioeconomic status, access to medical services, and the availability of healthcare professionals. In the northern and northeastern regions, for example, limited resources and poorer infrastructure often lead to worse outcomes compared to the more developed southern and southeastern regions. This underscores the importance of examining any phenomenon not only nationwide but also at the regional level [12–15].

Thus, the aim of this study was to analyze the trends in breast cancer mortality among both males and females in Brazil and its administrative regions from 2008 to 2020. The study also sought to correlate these trends with the number of physicians available to assess their impact on breast cancer outcomes.

Methods

Study design, variables, and data source

This ecological study used secondary data from 2008 to 2020 to examine the relationship between the number of doctors per inhabitant and mortality from female and male breast cancer (FBC and MBC) in Brazil and its federative regions (North, Northeast, South, Southeast, and Midwest). All data were sourced from Brazil's public health system, which boasts a data coverage of over 96% for the country [16].

The study included all deaths registered in the Brazilian regions among the population aged 20 years and older—both male and female—from 2008 to 2020. These deaths were classified as breast cancer (C50) according to the 10th revision of the International Classification of Diseases (ICD-10) and recorded in the Mortality Information System. To ensure accuracy and avoid misrepresentation, all deaths were collected based on the residency of the deceased rather than the location of death [11].

The number of doctors was sourced from the National Registry of Health Establishments (*Cadastro Nacional dos Estabelecimentos de Saúde do Brasil, CNES, in Portuguese*), and included all medical specialties directly linked to treatment, such as oncologists, radiotherapists, primary care physicians, gynecologists, and mastologists. Additionally, the resident population of each federative region was obtained from the Brazilian Institute of Geography and Statistics (IBGE, *in Portuguese*) [17]. It is important to note that the absolute number of doctors in the country is updated monthly; therefore, the average number of doctors per year was used for this analysis. The study period was chosen to ensure all variables were available and standardized, facilitating a better understanding of their dynamics.

All data were collected by two independent researchers (JHMS and LSP) between December 2022 and March 2023. Although data were primarily extracted from public health system databases, some variables required manual categorization. In cases of discrepancies, a third researcher (FA) was consulted to resolve the issue.

Statistical analysis

The mortality rate was calculated by dividing the total number of deaths by the resident population—by year, federative region, sex, and age group—and then multiplying by 100,000 inhabitants. This rate was subsequently standardized using the World Health Organization (WHO) standard population [18]. Similarly, to enable more accurate comparisons, the number of physicians from the Public Health System (PHS) was converted into a rate per 100,000 inhabitants. For all variables studied, missing values were treated as null for calculation purposes.

Descriptive statistics were employed to characterize the rates by sex and age group for each federative region. The analysis utilized two measures of trend: the Percentage Change (PC) and the Annual Percentage Change (APC). To calculate the PC, the initial value of the adjusted rate for breast cancer mortality was subtracted from the final value; the result was then divided by the initial rate and multiplied by 100. For the APC, the slope (β) from the linear regression was used, as demonstrated by Fay et al., 2006, and in previous studies [9, 19].

Linear regression was applied to examine the mortality trends over time. We then used multivariate regression using the stepwise forward selection strategy, where

Table 1 Male and female breast cancer mortality in Brazil during 2008–2020 according to federative region

Male Breast Cancer Mortality	Standardized Mortality Rate			Absolute Number of Deaths	Proportion of Deaths	APC*	AAPC (β)	*p* value
	2008	2014	2020	2008–2020	2008–2020			
North	0,154	0,236	0,105	116	5,23%	-31,82	0,00	0,772
Northeast	0,320	0,333	0,298	574	25,86%	-6,83	0,01	0,044
Southeast	0,294	0,287	0,326	1047	47,16%	10,75	0,00	0,563
South	0,227	0,201	0,240	325	14,64%	5,51	0,00	0,472
Midwest	0,363	0,304	0,335	158	7,12%	-7,94	0,00	0,916
Brazil	0,285	0,282	0,293	2220	100%	2,84	0,00	0,088
Female Breast Cancer Mortality	Standardized Mortality Rate			Absolute Number of Deaths	Proportion of Deaths	APC*	AAPC (β)	p value
	2008	2014	2020	2008–2020	2008–2020			
North	12,666	14,233	15,766	7499	3,87%	24,48	0,41	< 0,001
Northeast	15,869	17,086	18,818	41,344	21,34%	18,58	0,31	< 0,001
Southeast	22,761	22,249	22,209	98,494	50,84%	-2,43	0,54	0,103
South	21,617	22,604	22,284	34,077	17,59%	3,09	0,73	0,057
Midwest	18,348	20,788	19,942	12,335	6,37%	8,69	0,23	0,001
Brazil	20,031	20,491	20,835	193,749	100%	4,01	0,15	< 0,001

Table 2 Male and female breast cancer mortality in Brazil during 2008–2020 according to standardized age group

Male Breast Cancer Mortality Standardized by age	Absolute number of deaths	Proportion of deaths	APC	AAPC (β)	*p* value
	2008–2020	2008–2020			
20–39 years old	75	3,38%	30,56	0,003	0,833
40–49 years old	185	8,33%	12,16	0,359	0,262
50–69 years old	1008	45,41%	-10,35	0,091	0,277
70 years and older	952	42,88%	20,37	0,132	0,060
Brazil	2220	100%	2,84	0,003	0,088
Female Breast Cancer Mortality Standardized by age	Absolute number of deaths	Proportion of deaths	APC	AAPC (β)	p value
	2008–2020	2008–2020			
20–39 years old	14,152	7,30%	35,50517	2,739	< 0,001
40–49 years old	31,587	16,30%	6,593562	1,397	0,005
50–69 years old	88,504	45,68%	0,708872	3,321	0,005
70 years and older	59,506	30,71%	7,833479	4,578	< 0,001
Brazil	193,749	100%	4,01	0,146	< 0,001

mortality was the dependent variable, to evaluate its interaction with physician availability. The confidence level was set at 95%. Data tabulation and transformation were conducted using Microsoft Excel®, and statistical analysis was performed with Stata® (Stata Corp., College Station, USA) 15.0.

Ethical aspects

All data utilized in this project are secondary, sourced from the Brazilian Government. Given that the data are publicly accessible and available for unrestricted use, an ethical assessment by the Research Ethics Committee is not required, in accordance with the terms of Resolution No. 510 of the National Health Council (CNS), dated April 7, 2016 [20].

Results

Between 2008 and 2020, a total of 195,969 deaths from breast cancer were recorded among adults in Brazil, with 2,220 of these fatalities occurring in males. During this period, the Southeast region accounted for nearly 50% of all recorded mortalities for both sexes, starkly contrasting to the North region, where less than 5% of deaths were recorded. (Table 1) Additionally, age-wise analysis reveals that the majority of deaths occurred in individuals older than 50 years: 88.3% of male victims were over 50, with 45.41% between 50 and 69 years of age; similarly, 76.39% of female victims were over 50, with 45.68% in the 50 to 69 age range. (Table 2)

Regarding the variation in mortality rates across the country, both male and female breast cancer showed upward trends over time; however, only the increase in male breast cancer was statistically significant (β = 0,146; CI95% 0,093–0,200; adjusted r^2 = 0,746; $P < 0,001$). (Fig. 1)

Finally, multiple regression models indicated divergent findings for each type of cancer. No association was found between the number of physicians and mortality rates for male breast cancer, suggesting no fit for the model. Conversely, both the year and the number of primary care physicians were positively associated with mortality rates for female breast cancer (β = 0.751; 95% CI 0.429–1.073; p-value = 0.001 and β = 0.174; 95% CI 0.091–0.258; p-value = 0.002, respectively). In contrast, the total number of physicians in the Unified Health System (β = -0.163; 95% CI -0.240 to -0.085; p-value = 0.002), the number of oncologists (β = -0.507; 95% CI -0.881 to -0.134; p-value = 0.015), and radiotherapists (β = -6.402;

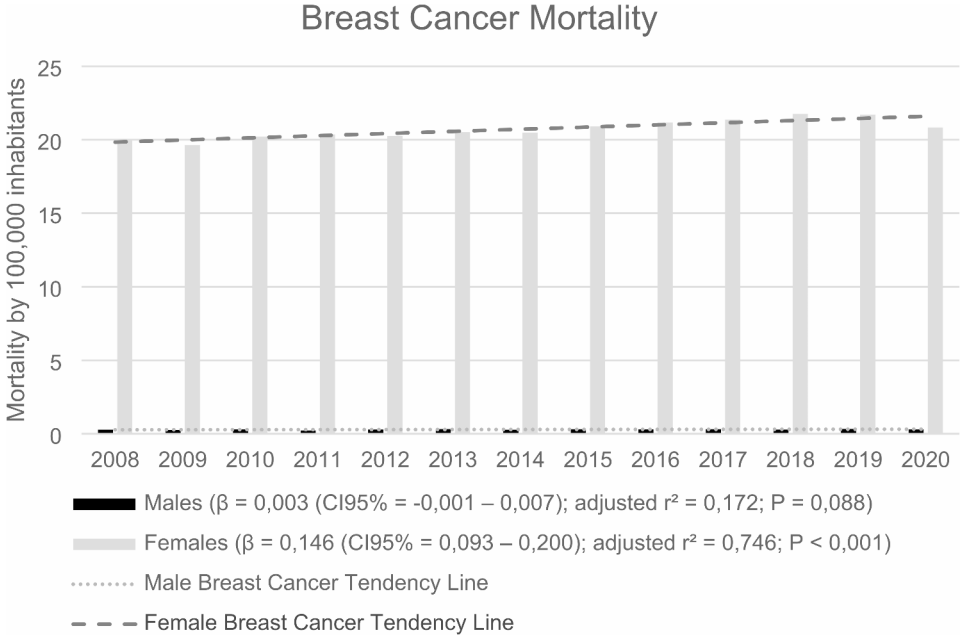

Fig. 1 Time Trend on Breast Cancer Mortality for women and men in Brazil during 2008–2020

Table 3 Multiple regression models for breast cancer mortality in men and women in Brazil during 2008–2020

Multiple regression.				
Adjusted r^2 0,000				
Male Breast Cancer Mortality	**No tendency fit for the model**			
Multiple regression				
Adjusted r^2 0,923				
Female Breast Cancer Mortality	**β**	**CI95%**		**p value**
Amount of Physicians in the Unified Health System in Brazil	-0,163	-0,240	-0,085	0,002
Oncologists	-0,507	-0,881	-0,134	0,015
Radiotherapists	-6,402	-12,357	-0,446	0,039
Primary Care Physicians	0,174	0,091	0,258	0,002
Year	0,751	0,429	1,073	0,001

95% CI -12.357 to -0.446; p-value = 0.039) were all inversely associated with mortality from female breast cancer. (Table 3)

Discussion

Breast cancer remains a significant public health concern internationally, affecting both women and men [21]. This paper analyzes male and female breast cancer mortality among adults in Brazil from 2008 to 2020, finding a disproportionate number of deaths in the South region of Brazil, with the majority occurring in individuals older than 50 years of age, regardless of sex. The multivariate regression model for female breast cancer identified multiple associations between physician numbers and mortality rates.

Several considerations are necessary to interpret these findings. Firstly, the proportion of MBC deaths, approximately 1%, aligns with the literature [22]. However, the reported disproportion of deaths in the South region may reflect the uneven distribution of public health resources. Given that the Southeast is the wealthiest region, it is common for individuals to migrate there for better treatment upon diagnosis, leading to an overrepresentation of deaths in this area—a phenomenon also observed with other diseases and neoplasms [11, 23, 24]. Although collecting data based on residency rather than the location of death, as performed in this study, helps mitigate this effect, it is plausible that long-term migrants still artificially inflate mortality figures in more affluent regions.

Nevertheless, the prevalence of cases among older men aligns with current knowledge, as the average age of diagnosis is slightly younger than 71 years [22, 25–27]. Additionally, male breast cancer mortality has shown a positive trend across Brazil, indicating a gradual increase over time, although it did not reach statistical significance. This trend corroborates findings from a previous time-trend analysis by our group, which also noted rising MBC mortality nationwide [9].

Furthermore, the vast majority of female deaths occurred in the 50–69 age group, which is the target demographic for breast cancer screening recommended by the country's health guidelines [28]. However, the analysis reveals that all age groups experienced a rise in mortality from 2008 to 2020, confirming a general upward trend in breast cancer deaths nationwide. This has sparked discussions about broadening the screening age range to potentially reduce mortality rates [29].

Currently, there is a discrepancy in screening recommendations: the Ministry of Health advises mammograms for women aged 50–69—accounting for approximately 45% of all deaths in our study—while the Gynecology Society recommends screening for all women over 40, which would cover more than 92% of cases [28, 30]. This difference underscores the need for further investigation into screening guidelines, considering factors like neoplasm aggressiveness associated with age and the cost-effectiveness of expanding screening [31]. Moreover, treatment options and availability must also be considered, especially in light of significant advancements in breast cancer therapies, such as the use of targeted therapies, CDK 4/6 inhibitors, and immunotherapy in selected cases. These treatments, while beneficial, come at a cost and pose challenges for integration into the public health system and ensuring equitable access [32–39].

Third, it is noteworthy that the multiple regression model for male breast cancer did not reveal any association between the number of doctors and mortality rates nationwide. Given the rarity of MBC and the consequently low number of cases—even over more than a decade—the detection of statistically significant trends remains challenging. In contrast, the model for female breast cancer mortality demonstrated high accuracy, with an adjusted R-squared greater than 0.9, and yielded several compelling findings: positive associations with the progression over the years and the number of primary care physicians, alongside negative associations with the number of physicians in the unified health system, oncologists, and radiotherapists. Although these associations seem contradictory, they may indeed be complementary; a higher number of primary care doctors could correlate with increased death rates due to previously undiagnosed conditions, while more specialists likely lead to earlier and more effective treatments, thus reducing mortality rates. This suggests that the quantity and distribution of doctors might reflect broader disparities in healthcare across the country [40].

Finally, this paper has both strengths and limitations. To our knowledge, this is the first study to simultaneously examine the trends in female and male breast cancer mortality over time in Brazil and its regions in relation to the number of physicians. However, being an ecological study, any extrapolation of these findings must be approached with caution: the results are not individualized, and the models should serve as a foundation for future research to deepen understanding of the national context of breast cancer in Brazil rather than as definitive conclusions.

Conclusion

The observed trends of increasing female and male breast cancer (FBC and MBC) rates over time highlight the urgent need for continuous monitoring and enhanced interventions. Although the number of physicians did not correlate with mortality rates for MBC, a significant association was found between a lower FBC mortality rate and the overall number of physicians, as well as the availability of oncologists and radiotherapists. These findings underscore the critical role that medical workforce capacity and specialized care play in improving patient outcomes, emphasizing the necessity for strategic resource allocation within the public healthcare system. These insights should inform future healthcare policies and support targeted efforts to reduce breast cancer mortality rates for both men and women.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12885-025-13742-8.

Supplementary Material 1

Acknowledgements
Conselho Nacional de Desenvolvimento Científico e Tecnológico– CNPq. Brazil.

Author contributions
JHMS, LEWC, CVMS, LCA, FLAF, FA and LSP participated in the study design. FA, LSP and JHMS participated in data gathering and statistical analysis. LEWC, CVMS, LCA, JHMS, FA and LSP contributed to the initial writing and revision of the manuscript. All authors have read, critically revised and approved the final version of the manuscript.

Funding
There was no funding for the presente research article.

Data availability
The datasets generated and/or analyzed during the current study are publicly available and may also be obtained from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
According to the Brazilian National Health Council's Resolution No. 466 of December 12, 2012, there is no need for ethical assessment by an ethics committee because public and unrestricted data was used in this analysis. Therefore, by law, once there was no experimental protocols, there is no need for approval by an institutional and/or licensing committee.

Consent for publication
Not applicable. All data are public, unidentified and of unrestricted access. Therefore, according to the Brazilian National Health Council's Resolution No. 466 of December 12, 2012, there is no need for an informed consent.

Competing interests
The authors declare no competing interests.

Received: 19 December 2023 / Accepted: 14 February 2025
Published online: 04 March 2025

References

1. World Health Organization. Available at: www.who.int/news-room/fact-sheets/detail/breast-cancer#:~:text=In%202022%2 C%20there%20were%20 2.3,increasing%20rates%20in%20later%20life>. Last accessed on May 25, 2024.
2. Siegel RL, Miller KD, Wagle NS, Jemal A, Cancer statistics. 2023. CA Cancer J Clin. 2023;73(1):17–48. doi: 10.3322/caac.21763. PMID: 36633525.
3. Brazil. National Cancer Institute (Instituto Nacional do Câncer– INCA). Available at: < https://www.inca.gov.br/sites/ufu.sti.inca.local/files/media/document/relatorio_dados-e-numeros-ca-mama-2023.pdf. Last accessed on December 17, 2023.
4. Gautam S, Joshi BR, Adhikary S, Regmi S, Pradhan A. Male breast Cancer: a rare entity. JNMA J Nepal Med Assoc. 2018 Jul-Aug;56(212):804–7. https://doi.org/10.31729/jnma.3662. PMID: 30387474; PMCID: PMC8827535.
5. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, Bray F, Global Cancer S. 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. CA Cancer J Clin. 2021;71(3):209–249. doi: 10.3322/caac.21660. Epub 2021 Feb 4. PMID: 33538338.
6. Bray F, Laversanne M, Sung H, Ferlay J, Siegel RL, Soerjomataram I, Jemal A. Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin. 2024 May-Jun;74(3):229–263. doi: 10.3322/caac.21834. Epub 2024 Apr 4. PMID: 38572751.
7. Institute for Health Metrics and Evaluation. Healthdata.org. (s.d.). Global Burden of Disease Compare| Viz Hub. Recuperado de https://hub.healthdata.org/gbd-compare/
8. Khattab A, Kashyap S, Monga DK, Male Breast C. 2022 Sep 26. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan–. PMID: 30252292.
9. Maselli-Schoueri JH, Affonso-Kaufman FA, de Melo Sette CV, Dos Santos Figueiredo FW, Adami F. Time trend of breast cancer mortality in BRAZILIAN men: 10-year data analysis from 2005 to 2015. BMC Cancer. 2019;19(1):23. https://doi.org/10.1186/s12885-018-5261-1. PMID: 30616526; PMCID: PMC6323830.
10. Winter dos Santos Figueiredo F, Adami F. Income inequality and mortality owing to breast cancer: evidence from Brazil. Clin Breast Cancer. 2017. https://doi.org/10.1016/j.clbc.2017.11.005.
11. Cubero DIG, Sette CVM, Piscopo BCP, Monteiro CRA, Schoueri JHM, Tavares HDA, Argani IL, Garcia MA, Passarela K, Del Giglio A. Epidemiological profile of Brazilian oncological patients seen by a reference oncology center of the public health system and who migrate in search of adequate health care. Rev Assoc Med Bras (1992). 2018;64(9):814–818. https://doi.org/10.1590/1806-9282.64.09.814. PMID: 30673002.
12. Coube M, Nikoloski Z, Mrejen M, Mossialos E. Inequalities in unmet need for health care services and medications in Brazil: a decomposition analysis. Lancet Reg Health Am. 2023;19:100426. https://doi.org/10.1016/j.lana.2022.100426. PMID: 36950032; PMCID: PMC10025415.
13. Borges GM. Health transition in Brazil: regional variations and divergence/convergence in mortality. Cad Saude Publica. 2017;33(8):e00080316. https://doi.org/10.1590/0102-311X00080316. PMID: 28832781.
14. de Souza BC, dos Santos Figueiredo FW, de Alcantara Sousa LV, et al. Regional disparities in the flow of access to breast cancer hospitalizations in Brazil in 2004 and 2014. BMC Womens Health. 2020;20:137. https://doi.org/10.1186/s12905-020-00995-7.
15. Rodrigues W, da Costa Frizzera H, Trevisan DMQ, Prata D, Reis GR, Resende RA. Social, Economic, and Regional determinants of mortality in hospitalized patients with COVID-19 in Brazil. Front Public Health. 2022;10:856137. https://doi.org/10.3389/fpubh.2022.856137. PMID: 35433600; PMCID: PMC9008306.
16. Brazil. Coordenação Geral de Informações e Análise Epidemiológica—CGIAE. Available at: < http://tabnet.datasus.gov.br/cgi/sim/Consolida_Sim_2011.pdf. Last accessed on December 17, 2023.
17. Brasil. Ministério da Saúde. Available at: wiki.saude.gov.br/cnes/index.php/P%C3%A1gina_principal. Last accessed on December 17, 2023.
18. Ahmad OB, Boschi-Pinto C, Lopez AD, Murray CJL, Lozano R, Inoue M. Age standardization of rates: a new who standard. In: GPE Discussion Paper Series: No.31 EIP/GPE/EBD World Health Organization; 2001.
19. Fay MP, Tiwary RC, Feuer EJ, Zou Z. Estimating average annual percent change for disease rates without assuming constant change. Biometrics September. 2006;62:847–54. https://doi.org/10.1111/j.1541-0420.2006.00528.x.
20. Brazil. National Health Council. Available at: < https://conselho.saude.gov.br/images/comissoes/conep/documentos/NORMAS-RESOLUCOES/Resoluo_n_510_-_2016_-_Cincias_Humanas_e_Sociais.pdf. Last accessed on May 25, 2024.
21. Wilkinson L, Gathani T. Understanding breast cancer as a global health concern. Br J Radiol. 2022;95(1130):20211033. https://doi.org/10.1259/bjr.20211033. Epub 2021 Dec 14. PMID: 34905391; PMCID: PMC8822551.
22. Khattab A, Kashyap S, Monga DK. Male Breast Cancer. [Updated 2022 Sep 26]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK526036/
23. Jean Henri Maselli Schoueri, Kaufman FAA. Celeste Rodovalho Soares De Camargo, Claudia Vaz De Melo Sette, Fernando Adami, Francisco Winter dos Santos Figueiredo, Time trend and regional variability of mortality rate due to ovarian cancer in Brazil: a 15-year analysis. J Public Health. December 2018;40(4):e474–81. https://doi.org/10.1093/pubmed/fdy080.
24. da Silva Paiva L, Schoueri JHM, de Alcantara Sousa LV, Raimundo RD, da Silva Maciel E, Correa JA, Adami F. Regional differences in the temporal evolution of stroke: a population-based study of Brazil according to sex in individuals aged 15–49 years between 1997 and 2012. BMC Res Notes. 2018;11(1):326. https://doi.org/10.1186/s13104-018-3439-x. PMID: 29784031; PMCID: PMC5963170.
25. Konduri S, Singh M, Bobustuc G, Rovin R, Kassam A. Epidemiology of male breast cancer. Breast. 2020;54:8–14. https://doi.org/10.1016/j.breast.2020.08.010. Epub 2020 Aug 22. PMID: 32866903; PMCID: PMC7476060.
26. Abdelwahab Yousef AJ. Male breast Cancer: epidemiology and risk factors. Semin Oncol. 2017;44(4):267–72. https://doi.org/10.1053/j.seminoncol.2017.11.002. Epub 2017 Nov 9.
27. Cutuli B, Le-Nir CC, Serin D, et al. Male breast cancer. Evolution of treatment and prognostic factors. Analysis of 489 cases. Crit Rev Oncol Hematol. 2010;73(3):246–54. https://doi.org/10.1016/j.critrevonc.2009.04.002. Epub 2009 May 12.
28. Brasil. Ministerio da Saude. Available at: www.gov.br/saude/pt-br/assuntos/noticias/2022/julho/prevencao-do-cancer-feminino-pesquisa-do-ministerio-da-saude-revela-aumento-de-exames-de-mamografia-nos-ultimos-13-anos#:~:text=No%20Brasil%2 C%20o%20Minist%C3%A9rio%20da,entre%2050%20e%2069%20an>. Last access on November 16, 2023.
29. Bonadio RC, Moreira OA, Testa L. Breast cancer trends in women younger than 40 years in Brazil. Cancer Epidemiol. 2022;78:102139. https://doi.org/10.1016/j.canep.2022.102139. Epub 2022 Mar 12. PMID: 35290906.
30. Federação das Sociedades de Ginecologia e Obstetrícia. Available ar: <https://www.febrasgo.org.br/pt/noticias/item/1607-dia-nacional-da-mamografia#:~:text=Para%20essas%20mulheres%2C%20a%20FEBRASGO,%C3%A9%20a%20idade%20mais%20recomendada. Last accessed on May 25, 2024.
31. Fabiano V, Mandó P, Rizzo M, Ponce C, Coló F, Loza M, Loza J, Amat M, Mysler D, Costanzo MV, Nervo A, Nadal J, Perazzo F, Chacón R, RCM Database Contributors4. Breast Cancer in Young Women presents with more aggressive pathologic characteristics: retrospective analysis from an Argentine National Database. JCO Glob Oncol. 2020;6:639–46. https://doi.org/10.1200/JGO.19.00228. PMID: 32315233; PMCID: PMC7193768.
32. Seung SJ, Saherawala H, Moldaver D, Shokar S, Ammendolea C, Brezden-Masley C. Survival, treatment patterns, and costs of HER2 + metastatic breast cancer patients in Ontario between 2005 to 2020. Breast Cancer Res Treat. 2024;204(2):341–57. https://doi.org/10.1007/s10549-023-07185-7. Epub 2023 Dec 21. PMID: 38127177.
33. Baselga J, Cortés J, Kim SB, Im SA, Hegg R, Im YH, Roman L, Pedrini JL, Pienkowski T, Knott A, Clark E, Benyunes MC, Ross G, Swain SM, CLEOPATRA Study Group. Pertuzumab plus Trastuzumab plus Docetaxel for metastatic breast cancer. N Engl J Med. 2012;366(2):109–19. https://doi.org/10.1056/NEJMoa1113216. Epub 2011 Dec 7. PMID: 22149875; PMCID: PMC5705202.
34. von Minckwitz G, Huang CS, Mano MS, Loibl S, Mamounas EP, Untch M, Wolmark N, Rastogi P, Schneeweiss A, Redondo A, Fischer HH, Jacot W, Conlin AK, Arce-Salinas C, Wapnir IL, Jackisch C, DiGiovanna MP, Fasching PA, Crown JP, Wülfing P, Shao Z, Rota Caremoli E, Wu H, Lam LH, Tesarowski D, Smitt M, Douthwaite H, Singel SM, Geyer CE Jr. KATHERINE investigators. Trastuzumab Emtansine for residual invasive HER2-Positive breast Cancer. N Engl J Med. 2019;380(7):617–28. https://doi.org/10.1056/NEJMoa1814017. Epub 2018 Dec 5. PMID: 30516102.
35. Turner NC, Slamon DJ, Ro J, Bondarenko I, Im SA, Masuda N, Colleoni M, DeMichele A, Loi S, Verma S, Iwata H, Harbeck N, Loibl S, André F, Puyana Theall K, Huang X, Giorgetti C, Huang Bartlett C, Cristofanilli M. Overall survival with Palbociclib and fulvestrant in advanced breast Cancer. N Engl J Med. 2018;379(20):1926–36. https://doi.org/10.1056/NEJMoa1810527. Epub 2018 Oct 20. PMID: 30345905.

36. Spring LM, Wander SA, Zangardi M, Bardia A. CDK 4/6 inhibitors in breast Cancer: current controversies and future directions. Curr Oncol Rep. 2019;21(3):25. https://doi.org/10.1007/s11912-019-0769-3. PMID: 30806829; PMCID: PMC6573012.
37. Robson M, Im SA, Senkus E, Xu B, Domchek SM, Masuda N, Delaloge S, Li W, Tung N, Armstrong A, Wu W, Goessl C, Runswick S, Conte P. Olaparib for Metastatic Breast Cancer in Patients with a Germline BRCA Mutation. N Engl J Med. 2017;377(6):523–533. https://doi.org/10.1056/NEJMoa1706450. Epub 2017 Jun 4. Erratum in: N Engl J Med. 2017;377(17):1700. PMID: 28578601.
38. Schmid P, Cortes J, Pusztai L, McArthur H, Kümmel S, Bergh J, Denkert C, Park YH, Hui R, Harbeck N, Takahashi M, Foukakis T, Fasching PA, Cardoso F, Untch M, Jia L, Karantza V, Zhao J, Aktan G, Dent R, O'Shaughnessy J. KEYNOTE-522 Investigators. Pembrolizumab for Early Triple-Negative Breast Cancer. N Engl J Med. 2020;382(9):810–821. https://doi.org/10.1056/NEJMoa1910549. PMID: 32101663.
39. Barrios C, Freitas-Junior R, Martins S, Bines J, Estevez-Diz MDP, Caleffi M. Challenge of incorporating new drugs for breast Cancer in Brazil: a proposed Framework for improving Access to innovative therapies. JCO Glob Oncol. 2021;7:474–85. PMID: 33822641; PMCID: PMC8081546.
40. Gonzaga CMR, Freitas-Junior R, Curado MP, et al. Temporal trends in female breast cancer mortality in Brazil and correlations with social inequalities: ecological time-series study. BMC Public Health. 2015;15:96. https://doi.org/10.1186/s12889-015-1445-7.

Publisher's note