Revista Brasileira em Promoção da Saúde
Universidade de Fortaleza
Original Article
e-ISSN:1806-1230
http://doi.org/10.5020/18061230.2025.16907

Brazilian temporal trend of overweight and breast cancer mortality (2006-2018)

Tendência temporal brasileira de excesso de peso e mortalidade por câncer de mama (2006-2018)

Tendencia temporal brasileña del exceso de peso y mortalidad por cáncer de mama (2006-2018)

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ABSTRACT

Objective: To analyze the temporal trend and association between overweight and female breast cancer mortality in Brazil. **Methods:** This ecological time-series study investigated overweight data from the Surveillance of Risk and Protective Factors for Chronic Diseases by Telephone Survey (VIGITEL) and mortality data on malignant breast neoplasms from the Online Mortality Atlas. The analysis period comprised the years 2006 to 2018 and included the 26 state capitals and the Federal District, grouped according to the country's geographic regions. Percentage variation over the study period and biennial percentage changes were calculated using Prais-Winsten regression. **Results:** Overweight and obesity showed an increasing trend between 2006 and 2018 across all Brazilian regions, with the greatest increases observed in the North (PV = 51.6%; p = 0.001) and Southeast (PV = 97.2%; p = 0.001). At the national level, both excess body weight (PV = 1.34; p = 0.017) and obesity (PV = 2.27; p = 0.041) were positively associated with the increasing trend in breast cancer mortality. **Conclusion:** The findings indicate that increasing adiposity in Brazil is associated with worsening breast cancer mortality indicators, reinforcing the need for prevention strategies and weight management as public health priorities to mitigate this impact within the Brazilian context.

Descriptors: Obesity; Breast Cancer; Mortality.

RESUMO

Objetivo: *Analisar a tendência temporal e associação entre o excesso de peso e a mortalidade por câncer de mama feminino no Brasil.* ***Métodos:*** *Estudo ecológico de séries temporais que investigou dados sobre excesso de peso da Pesquisa Vigilância dos Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico (VIGITEL), e informações dos óbitos por neoplasia maligna da mama no Atlas On-line de Mortalidade. O período de análise compreendeu os anos de 2006 a 2018, incluindo as 26 capitais e Distrito Federal, agrupadas em suas regiões geográficas do país. Calculou-se o percentual de variação no período e as variações percentuais bienais por regressão de Prais-Winsten.* ***Resultados:*** *O excesso de peso e obesidade mostraram tendência de crescimento entre os anos de 2006 e 2018 em todas as regiões do Brasil, com maior incremento no Norte (PVP=51,6%; p=0,001) e Sudeste (PVP=97,2%; p=0,001). Em nível nacional, tanto o estado de peso corporal elevado*

(VP=1,34; p=0,017) quanto a obesidade (VP=2,27; p=0,041) mostraram associação positiva com a tendência de aumento da mortalidade por câncer de mama. ***Conclusão:*** *Os achados indicam que o aumento da adiposidade no país está relacionado a uma piora dos indicadores de mortalidade por câncer de mama, reforçando a necessidade de estratégias de prevenção e o controle do peso como prioridade de saúde pública, a fim de mitigar esse impacto no cenário brasileiro.*

Descritores: *Obesidade; Câncer de mama; Mortalidade.*

RESUMEN

Objetivo: *Analizar la tendencia temporal y la asociación entre el exceso de peso y la mortalidad por cáncer de mama femenino en Brasil.* ***Métodos:*** *Estudio ecológico de series temporales que investigó datos sobre exceso de peso provenientes de la Encuesta de Vigilancia de Factores de Riesgo y Protección para Enfermedades Crónicas por Encuesta Telefónica (VIGITEL), así como información sobre defunciones por neoplasia maligna de mama del Atlas en Línea de Mortalidad. El período de análisis comprendió los años de 2006 a 2018, incluyendo las 26 capitales y el Distrito Federal, agrupados en sus respectivas regiones geográficas del país. Se calculó el porcentaje de variación en el período y las variaciones porcentuales bienales mediante regresión de Prais-Winsten.* ***Resultados:*** *El exceso de peso y la obesidad mostraron una tendencia creciente entre los años 2006 y 2018 en todas las regiones de Brasil, con mayor incremento en el Norte (PVP=51,6%; p=0,001) y Sudeste (PVP=97,2%; p=0,001). A nivel nacional, tanto el estado de peso corporal elevado (VP=1,34; p=0,017) como la obesidad (VP=2,27; p=0,041) mostraron una asociación positiva con la tendencia de aumento de la mortalidad por cáncer de mama.* ***Conclusión:*** *Los hallazgos indican que el aumento de la adiposidad en el país está relacionado con un empeoramiento de los indicadores de mortalidad por cáncer de mama, reforzando la necesidad de estrategias de prevención y del control del peso como prioridad de salud pública, a fin de mitigar este impacto en el escenario brasileño.*

Descriptores: *Obesidad; Cáncer de mama; Mortalidad.*

INTRODUCTION

Breast cancer is the malignant neoplasm with the greatest impact on female morbidity and mortality worldwide and was the most frequent cancer among women in 2022, accounting for more than 2 million new cases and over 660 thousand deaths[1]. In Brazil, the estimated number of new cases for each year of the 2023-2025 triennium is 73,610, with an estimated risk of 66.54 cases per 100,000 women[2]. In low- and middle-income countries, this neoplasm has a greater impact due to delayed diagnoses[3]. In addition, its development involves numerous risk factors, including lifestyle-related factors such as unhealthy diet, alcohol consumption, tobacco use, physical inactivity, and obesity[4].

Obesity is one of the major expanding public health problems worldwide, and it is estimated that by 2030, 50% of adults will have an elevated body mass index (BMI) (> 25 kg/m^2), while 22% of women will be living with obesity (BMI > 25 kg/m^2)[5]. In Brazil, 2019 data indicated that 62.7% of women had excess body weight, of whom 29.5% were classified as obese[6]. This epidemiological scenario likely contributes to the incidence of new cancer cases, as obesity is a risk factor for several malignant neoplasms, including breast cancer, particularly after menopause[7]. Obesity accounts for 9.9% of cancer cases among Brazilians of both sexes and 5.2% of cases among women, including malignant breast tumors[8]. Mortality attributable to this exposure among women in Brazil corresponds to 6.46%[9].

Despite this clinically established relationship, no national epidemiological studies have been identified to date that simultaneously and comprehensively analyze temporal trends, variations, and associations between excess body weight/obesity and breast cancer mortality. This gap highlights the need for investigations exploring this relationship in the Brazilian context, considering the growing evidence supporting the association between these two conditions. Therefore, this study aimed to analyze the temporal trend and association between overweight and female breast cancer mortality in Brazil.

METHOD

This ecological time-series study used the 26 Brazilian state capitals and the Federal District (FD) as units of analysis, using publicly available secondary data. Ecological and time-series studies allow the analysis of the evolution of health events over time and their associations with contextual factors at the population level, enabling the identification of trends, patterns, and social determinants of health conditions[10,11].

The prevalence of overweight and obesity was investigated using self-reported weight and height information obtained from the Surveillance of Risk and Protective Factors for Chronic Diseases by Telephone Survey (VIGITEL) [12] database. VIGITEL is a national survey conducted in the 26 Brazilian state capitals and the FD by the Ministry of Health (MH), in which approximately 2,000 adults are interviewed by telephone. Based on such data, BMI was calculated (kg/m^2), which was used to classify participants and estimate the prevalence of overweight (BMI ≥ 25.0 kg/m^2) and obesity (BMI ≥ 30.0 kg/m^2).

Information regarding mortality rates (International Classification of Diseases, 10th Revision [ICD-10] C50) was extracted from the Online Cancer Mortality Atlas[13] of the National Cancer Institute (INCA) of the MH. This Atlas uses data derived from the Mortality Information System (SIM), generating information on cancer deaths in Brazil[14]. For this study, age-adjusted mortality rates of adult women residing in the state capitals and FD were used, considering the 2010 Census population, since the Atlas adopts the direct standardization method. This process aims to minimize the effects of population age structure so that geographic differences cannot be attributed to variations in age distribution[15].

The prevalence of overweight and obesity and adjusted mortality rates in the Brazilian capitals were represented as yearly averages and grouped into the country's five geographic regions for the years 2006, 2008, 2010, 2012, 2014, 2016, and 2018. Their respective values were presented in trend line graphs and tables describing comparisons among regions. The FD was included in the average for the Midwest Region.

Based on SIM data[16], the percentage variation of the analyzed variables was calculated to identify potential reductions (negative values) or increases (positive values) between 2006 and 2018. The calculation was obtained using the following formula: the variable value in 2018 minus the variable value in 2006, divided by the variable value in 2006 and multiplied by 100.

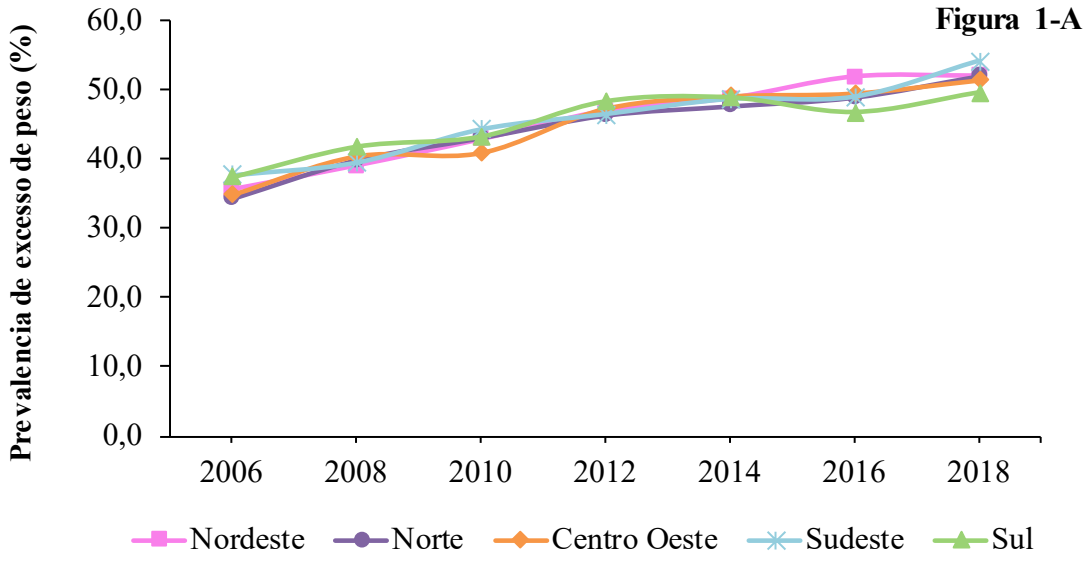
To assess temporal trends, Biennial Percentage Variation (BPV)[10], 95% confidence intervals, and p-values were calculated using Prais-Winsten regression models. The outcome variables were the prevalence of overweight/obesity and mortality, analyzed by region, while time measured in biennia (2006-2018) was considered the independent variable. Dependent variables were previously transformed into a logarithmic scale, and regression beta coefficients (β) were subsequently transformed into an exponential scale, resulting in BPV.

Subsequently, linear regression models were applied by region to evaluate the association between the prevalence of overweight and obesity (independent variables) and mortality rates on a logarithmic scale (dependent variable). Beta coefficients were transformed into an exponential scale, expressing the percentage variation in mortality associated with a 1-unit increase in the independent variables. Analyses were conducted using Stata®, version 16, and graphs were constructed using Excel®.

Data analyzed in this study originated from publicly available secondary databases with unrestricted access and aggregated information, without any nominal or personal identification of individuals. Therefore, submission to and approval by a Research Ethics Committee (REC) were not required, according to National Health Council (CNS) Resolution No. 510/2016.

RESULTS

The prevalence of overweight increased between 2006 and 2018 across all Brazilian regions, and obesity followed the same upward trend (Figure 1A and B, respectively).



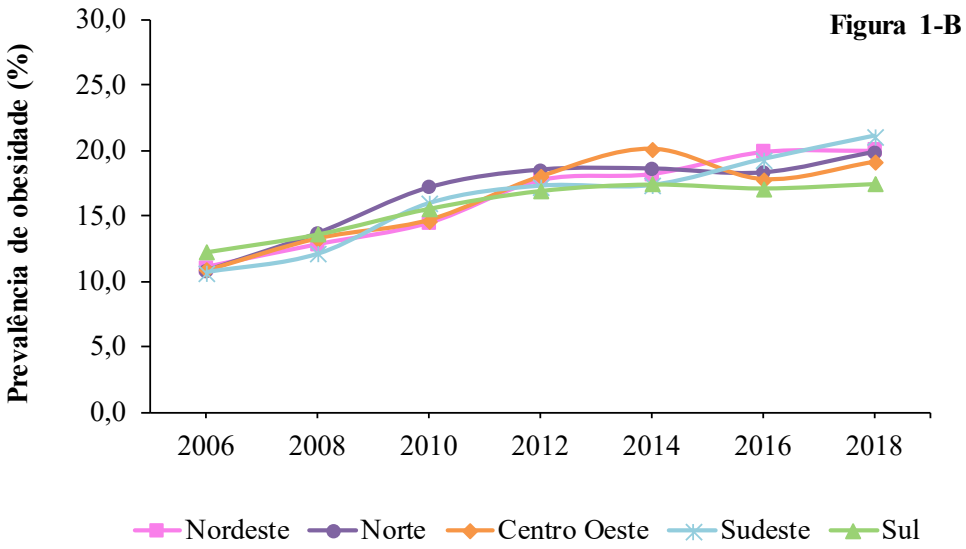


Figure 1 – Prevalence of overweight (A) and obesity (B) among adult women between 2006 and 2018, according to the geographic regions of Brazil.

Source: VIGITEL, Brasil, 2006-2018;
[a]Mean prevalence values of overweight and obesity by year and geographic region;
[b]Figure prepared by the authors.

Regarding overweight, the North Region showed the highest percentage increase in this condition between 2006 and 2018 (PV = 51.6%; p = 0.001), as well as the highest biennial growth (BPV = 6.7%; p = 0.001). For obesity, the Southeast Region exhibited the greatest percentage increase (PV = 97.2%; p = 0.001) and the highest biennial growth (BPV = 11.6%; p = 0.001) (Table 1).

Table 1 – Percentage variation in the prevalence of overweight and obesity among adult women between 2006 and 2018 according to the geographic regions of Brazil.

Regions of Brazil	Prevalence		PV (%)[a]	BPV (%)[b]	95% CI[c]		p-value	Trend
	2006	2018						
Overweight								
Northeast	35.6	51.9	45.8	6.6	4.36	9.00	**0.001**	Increasing
North	34.3	52.0	51.6	6.6	4.05	9.38	**0.001**	Increasing
Midwest	34.8	51.4	47.7	6.5	4.17	8.83	**0.001**	Increasing
Southeast	37.6	54.1	43.8	5.9	4.47	7.41	**< 0.001**	Increasing
South	37.4	49.5	32.4	4.4	1.59	7.27	**0.010**	Increasing
Brazil	35.6	51.9	45.6	6.4	4.11	8.65	**0.001**	Increasing
Obesity								
Northeast	11.1	20.1	81.1	10.8	6.65	15.01	**0.001**	Increasing
North	10.8	19.9	84.3	10.1	2.62	18.07	**0.017**	Increasing
Midwest	10.9	19.1	75.2	9.7	3.07	16.82	**0.012**	Increasing
Southeast	10.7	21.1	97.2	11.6	6.91	16.50	**0.001**	Increasing
South	12.3	17.5	42.3	6.1	1.78	10.56	**0.014**	Increasing
Brasil	11.1	19.7	78.4	10.0	4.69	15.65	**0.004**	Increasing

Source: VIGITEL, Brasil, 2006 and 2018;
[a]Percentage Variation (PV) = variation between 2006 and 2018. Calculation: variable value in 2018 minus variable value in 2006, divided by the variable value in 2006 × 100.
[b]Biennial Percentage Variation (BPV) = Prais-Winsten regression (dependent variable = prevalence of overweight and obesity for each Region; independent variable = biennia between 2006 and 2018).
[c]95% CI: 95% confidence interval.
[d]Table prepared by the authors.

Temporal analysis of mortality revealed behavioral fluctuations across the Brazilian regions between 2006 and 2018. The South and Southeast Regions had the highest mortality rates during most of the analyzed period. The North Region exhibited the lowest rates but showed the greatest percentage variation over the study period (PV = 69.1%), with a BPV increase of 11.92% (p = 0.001) every 2 years (Figure 2; Table 2).

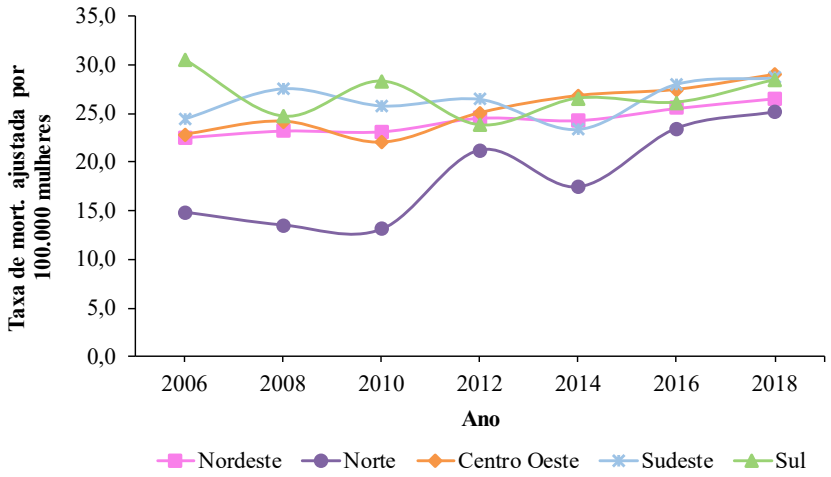


Figure 2 – Mortality rate from malignant breast neoplasms among adult women between 2006 and 2018 according to the geographic regions of Brazil.

Source: Atlas On-line de Mortalidade por câncer, Brasil, 2006, 2008, 2010, 2012, 2014, 2016, and 2018;

[a]Age-adjusted female breast cancer mortality rates per 100,000 women, standardized to the 2010 Brazilian population, including women aged 20 to 99+ years, based on data from the 26 Brazilian state capitals and the FD, grouped according to their respective Geographic Regions of Brazil.

[b]Figure prepared by the authors.

Table 2 – Percentage variation in breast cancer mortality rates among adult women between 2006 and 2018 according to the geographic regions of Brazil.

Regions of Brazil	Rate 2006	Rate 2018	PV (%) [a]	BPV (%) [b]	95% CI[c]		p-value	Trend
Northeast	22.5	26.5	17.9	2.6	2.10	3.12	**< 0.001**	Increasing
North	14.8	25.1	69.1	11.9	6.98	17.08	**0.001**	Increasing
Midwest	22.8	29.0	27.0	4.3	2.13	6.51	**0.004**	Increasing
Southeast	24.4	28.6	17.2	1.2	−1.74	4.24	0.344	Stable
South	30.4	28.4	−6.6	−0.3	−2.86	2.30	0.766	Stable
Brazil	21.7	27.0	24.5	3.9	2.30	5.67	**0.002**	Increasing

Source: Atlas On-line de Mortalidade por câncer, Brasil, 2006 to 2018.

[a]Percentage Variation (PV): variation between 2006 and 2018. Calculation: variable value in 2018 minus variable value in 2006, divided by the variable value in 2006 × 100.

[b]Biennial Percentage Variation (BPV): Prais-Winsten regression (dependent variable = age-adjusted breast cancer mortality rate for each Region; independent variable = biennia between 2006 and 2018).

[c]95% CI: 95% confidence interval.

[d]Table prepared by the authors.

At the national level, overweight (PV = 1.34; p = 0.017) and obesity (PV = 2.27; p = 0.041) showed a positive association with breast cancer mortality. In the North and Midwest Regions, only overweight was associated with increased mortality rates (PV = 3.88; p = 0.013; PV = 1.49; p = 0.012, respectively). In the Northeast Region, this positive association was also observed for obesity (PV = 0.86; p = 0.002) (Table 3).

Table 3 – Association between the prevalence of overweight and obesity and female breast cancer mortality rates according to Brazilian regions. Brazil, 2006-2018.

Exposures	Age-adjusted breast cancer mortality rate			
	PV[a]	95% CI[b]		p-value
Northeast				
Overweight	0.86	0.49	1.23	**0.002**
Obesity	1.61	0.81	2.40	**0.003**
North				
Overweight	3.88	1.23	6.60	**0.013**
Obesity	5.87	−1.00	13.22	0.080
Midwest				
Overweight	1.49	0.48	2.50	**0.012**
Obesity	2.33	−0.10	4.82	0.057
Southeast				
Overweight	0.41	−0.74	1.57	0.404
Obesity	0.70	−1.05	2.48	0.354
South				
Overweight	−0.52	−1.57	0.54	0.259
Obesity	−1.00	−3.14	1.19	0.290
Brazil				
Overweight	1.34	0.36	2.33	**0.017**
Obesity	2.27	0.13	4.46	**0.041**

Fonte: Atlas On-line de Mortalidade por câncer; VIGITEL. Brasil, 2006 e 2018;
[a]Percentage Variation (PV) = linear regression (outcome variable = age-adjusted breast cancer mortality rate on a logarithmic scale; independent variable = prevalence of overweight and obesity). Beta coefficients were transformed to an exponential scale and multiplied by 100 to generate PV.
[b]95% CI: 95% confidence interval.
[c]Table prepared by the authors.

DISCUSSION

The present study, using time-series analyses, aimed to evaluate the relationship between adiposity and female breast cancer mortality in Brazil. The findings demonstrate a continuous upward trend in nutritional status indicators in the country (overweight and obesity) and show that this condition among adult women was associated with increased mortality rates, especially in the North, Northeast, and Midwest Regions, reinforcing regional disparities and suggesting a more pronounced impact in historically vulnerable areas.

National studies, such as the Household Budget Survey (POF, 2008-2009)[18], the National Health Survey (PNS, 2019)[19], and VIGITEL (2023)[20], confirm the progressive increase in obesity in Brazil, with higher prevalence among women. As obesity is a relevant risk factor for breast cancer, particularly in the postmenopausal period, the metabolic mechanisms explaining this relationship have been increasingly clarified in the literature and indicate that excess adipose tissue promotes chronic low-grade inflammation, increased inflammatory cytokines, and biological alterations that favor carcinogenesis[17]. In light of this evidence, international[4] and national guidelines[21] recommend weight management as an essential measure for primary prevention and reducing recurrence risk.

Evidence demonstrates that multimodal interventions combining a balanced diet, regular physical activity, and mental health care promote weight reduction, metabolic improvement, and better quality of life among breast cancer survivors[22]. However, addressing adiposity remains a global public health challenge because its determinants are structural and influenced by political, economic, social, and cultural factors, extending beyond the concept of individual responsibility alone[23]. The transformation of the global food system, characterized by the widespread availability of processed and ultra-processed foods that are inexpensive and easily accessible, is another major determinant contributing to the increase in this condition[25].

The implications of this reality have been widely discussed[4] and represent one of the factors with the greatest impact on public health risk, contributing substantially to noncommunicable diseases (NCDs), including breast cancer[26]. In 2021, increased BMI accounted for more than 1 million disability-adjusted life years (DALYs) related to breast cancer globally, and this burden is expected to continue, especially in regions experiencing rapid increases in obesity[27]. In Brazil, this complexity is compounded by the regional asymmetries observed in our study between 2006 and 2018, with marked differences across regions. These disparities are likely influenced by socioeconomic inequities, variations in access to healthy foods, and distinct urbanization patterns, reinforcing the need for region-specific prevention and health promotion strategies.

In Brazil, estimates indicate that increased BMI alone accounted for 6.46% of breast cancer-attributable mortality among women in 2013[9], and eliminating this exposure among women aged ≥ 50 years could have prevented 2,022 deaths in 2019[24]. Counterfactual analyses estimate that, in the absence of excess body weight, approximately 1,020 deaths in the Southeast Region and 416 deaths in the Northeast Region could have been prevented in 2019[24]. Rezende et al.[9] also estimated mortality attributable to lifestyle-related factors (physical inactivity, diet, smoking, alcohol consumption, and increased BMI), demonstrating that approximately 22% of breast cancer deaths in Brazil could potentially be prevented if these determinants were modified.

However, despite reinforcing the role of excess body weight in disease burden, these studies did not explore temporal trends. The present study advances this field by demonstrating that, over time, Brazilian Regions with higher prevalence of elevated body weight also exhibited higher breast cancer mortality rates, reinforcing the temporal nature of this relationship within the country. These findings add an additional dimension to existing national evidence and strengthen the need to incorporate structured nutritional interventions and weight management as essential components of breast oncology care pathways in Brazil. This has direct implications for women's public health, as nutritional surveillance policies, primary prevention measures, and healthy lifestyle promotion should be incorporated as collective priority strategies rather than solely individual actions.

Furthermore, Brazil presents profound regional inequalities in access to breast cancer screening, early diagnosis, and appropriate treatment(28). In these regions, the impact of adiposity tends to be amplified because the combination of an established modifiable risk factor with barriers to health care increases the likelihood of unfavorable outcomes, delayed diagnosis, and higher mortality. Reducing disparities in health care access and expanding access to secondary and tertiary prevention services are essential to modifying risk trajectories, improving prognosis, and reducing preventable deaths among women in situations of nutritional vulnerability.

In this context, obesity diagnosis and treatment should be understood as structural components of public health integrated into the continuum of care for women with breast cancer. Their effectiveness depends on intersectoral collaboration, health promotion, and addressing social determinants[29], guided by recommendations from the Dietary Guidelines for the Brazilian Population[30] and the Third Report of the World Cancer Research Fund (WCRF)[4].

Despite its relevant findings, this study has limitations because it used self-reported weight and height data from VIGITEL, which may be subject to classification bias. The ecological design also imposes inherent limitations, including the inability to establish direct causal inference at the individual level and the possibility of ecological fallacy. Additionally, there is no consensus regarding the ideal interval between prolonged exposure to adiposity and breast cancer development or mortality, making it difficult to precisely define risk windows.

However, the study has broad territorial coverage, including all Brazilian state capitals and the FD, grouped by Brazilian Regions, enabling the analysis of regional inequalities relevant to the national epidemiological context. The use of a historical series observing 6 biennial periods between 2006 and 2018 strengthens temporal trend assessment and reduces the influence of annual fluctuations. Furthermore, integrating official datasets widely used in population-based research (VIGITEL and the Online Cancer Mortality Atlas) enhances the consistency and comparability of findings. The originality of this investigation lies in the simultaneous analysis of trends and associations between adiposity and breast cancer mortality in Brazil, helping to address an important gap in the literature and providing evidence that may support public health actions.

Although national studies have already demonstrated an association between obesity and cancer risk/mortality, this evidence has primarily been derived from non-temporal analyses. To our knowledge, this study is the first national time-series analysis demonstrating that increases in population adiposity over time parallel increases in breast cancer mortality. These findings reinforce the epidemiological plausibility of this relationship and strengthen the robustness of Brazilian evidence. Moreover, they highlight the urgent need for effective prevention strategies and weight management as essential components of breast cancer control in the country.

CONCLUSION

In summary, the findings indicate that in Brazil, increasing overweight and obesity prevalence over time parallels rising breast cancer mortality, supporting the hypothesis that adiposity plays an important role in the burden of this disease in the country. Temporal analysis reinforces that this relationship follows an evolving trend, highlighting the need for continuous and structured prevention policies, health promotion, nutritional surveillance, and weight management, emphasizing the importance of incorporating obesity reduction strategies as a central component of breast cancer control.

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APPENDIX – EDITORIAL GUIDELINES

Submission History
Received: 09/02/2024.
Accepted: 11/14/2025.

How to Cite
Carneiro PL, Bezerra IN, Aguiar IWO, Costa FN, Leonardo GMN, Pinheiro LGP, et al. Brazilian temporal trends in overweight and breast cancer mortality (2006-2018). Rev Bras Promoç Saúde. 2025;38: e16907. https://doi.org/10.5020/18061230.2025.16907

Acknowledgments and Conflicts of Interest
The authors declare no conflicts of interest.

Funding Sources
Fundação Cearense de Apoio ao Desenvolvimento Científico e Tecnológico/CNPq/Ministério da Saúde – Research Program for the Unified Health System (PPSUS) Call (Call 02/20220) – Process Number: 07900143/2022.
Fundação Cearense de Apoio ao Desenvolvimento Científico e Tecnológico – Academic Training Scholarship Program (BFA) – Process Number: BMD-0008-02527.01.05/23.

Author Contributions
Priscilla de Lima Carneiro and **Fernando Natalense da Costa** contributed to study conception, data collection, interpretation of findings, manuscript drafting, review, and final approval. **Ilana Nogueira Bezerra** contributed to concept development, interpretation of findings, and manuscript review. **Italo Wesley Oliveira Aguiar** contributed to data analysis, interpretation of findings, manuscript drafting, review, and final approval. **Geórgia de Mendonça Nunes Leonardo**, **Luís Gonzaga Porto Pinheiro**, and **Cícera Chaves Lôbo** contributed to interpretation of findings and final manuscript approval. **Sara Maria Moreira Lima Verde** contributed to study conception and design, interpretation of findings, manuscript drafting, review, and final approval.

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Use of Artificial Intelligence
The authors declare that they did not use any artificial intelligence tools in the preparation or writing of this paper.

Peer Review Process
Double-blind peer review.

Reviewers
This article was evaluated by two reviewers who did not authorize the disclosure of their identities.

Editor in charge: Ana Mattos Brito de Almeida ; rbps@unifor.br ;
https://orcid.org/0000-0002-6140-0695 ; http://lattes.cnpq.br/4899711651204481