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Time trend analysis and impacts of the COVID-19 pandemic on mammography and Papanicolaou test coverage in Brazilian state capitals

Alanna Gomes da Silva[1*], Thales Philipe Rodrigues da Silva[2], Nádia Machado de Vasconcelos[3], Filipe Malta dos Santos[4], Greice de Campos Oliveira[5] and Deborah Carvalho Malta[1]

Abstract

Background Breast and cervical cancer are major public health issues globally. The reduction in incidence and mortality rates of these cancers is linked to effective prevention, early detection, and appropriate treatment measures. This study aims to analyze the temporal trends in the prevalence of mammography and Papanicolaou test coverage among women living in Brazilian state capitals between 2007 and 2023, and to compare the coverage of these tests before and during the Covid-19 pandemic.

Methods A time series study was conducted using data from the Surveillance System for Risk and Protective Factors for Chronic Diseases by Telephone Survey from 2007 to 2023. The variables analyzed included mammography and Papanicolaou test coverage according to education level, age group, race/skin color, regions, and Brazilian capitals. The Prais-Winsten regression model was used to analyze the time series, and Student's t-test was employed to compare the prevalence rates between 2019 and 2023.

Results Between 2007 and 2023, mammography coverage showed a stationary trend (71.1% in 2007 and 73.1% in 2023; p-value = 0.75) with a declining trend observed among women with 12 years or more of education (APC= -0.52% 95%CI -1.01%; -0.02%). Papanicolaou test coverage for all women aged between 25 and 64 exhibited a downward trend from 82% in 2007 to 76.8% in 2023 (APC= -0.45% 95%CI -0.76%; -0.13%). This decline was also noticed among those with 9 years or more of education; in the 25 to 44 age group; among women with white and mixed race; and in the Northeast, Central-West, Southeast, and South regions. When comparing coverage before and during Covid-19 pandemic, a reduction was noted for both tests.

Conclusions Over the years, there has been stability in mammography coverage and a decline in Papanicolaou test. The COVID-19 pandemic negatively impacted the number of these tests carried out among women, highlighting the importance of actions aimed at increasing coverage, especially among the most vulnerable groups.

*Correspondence:
Alanna Gomes da Silva
alannagomessilva@gmail.com

Full list of author information is available at the end of the article

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Keywords Mammography, Papanicolaou test, Pandemics, Noncommunicable diseases, Disease prevention, Time series studies

Introduction

Cancer is one of the main public health issues globally, serving as a primary cause of death and a significant barrier to increasing life expectancy worldwide [1–3]. The impact of cancer incidence, morbidity, and mortality on a global scale is profound [1].

In 2022, female breast cancer was the second most common cancer globally, with an estimated 2.3 million new cases, accounting for 11.6% of all cancer cases [4]. It ranked as the fourth leading cause of cancer mortality worldwide, with 666,000 deaths (6.9% of all cancer deaths) [4]. The highest incidence rates were seen in France, and in Australia, Northern America, and Northern Europe, where incidence rates are four times higher than in South-Central Asia and Middle Africa [4]. However, mortality rates are higher in low- and middle-income countries [4]. Cervical cancer is ranked in both incidence and mortality among women, with an estimated 660,000 new cases and 350,000 deaths worldwide in 2022[4]. Incidence and mortality rates varied at least tenfold, with the highest rates found in sub-Saharan Africa and Melanesia, and the lowest in Northern America, Australia and Western Asia [4]. In several countries, the observed decline in cervical cancer incidence rates over the last few decades has been attributed to the implementation of screening and vaccination [3, 5–7].

Data from the National Cancer Institute (INCA) for 2023 showed that female breast cancer is the most common cancer in Brazil and in all Brazilian regions (excluding non-melanoma skin tumors), while cervical cancer is the third most incident cancer [8, 9]. In Brazil, 73,610 new cases of breast cancer were estimated annually for the period 2023–2025, representing an adjusted incidence rate of 41.89 cases per 100,000 women. The age-adjusted breast cancer mortality rate for the global population was 11.71 deaths/100,000 women in 2021[8]. For the same period, 17,010 new cases of cervical cancer were estimated annually in Brazil (15.38 cases per 100,000 women), with a mortality rate of 4.51 deaths/100,000 women in 2021, adjusted for the global population [9].

In high-income countries, the impact of cancer incidence and mortality rates is mitigated by effective prevention, early diagnosis, and appropriate treatment. However, in low- and middle-income countries, inequalities persist in access to health services and resources for health promotion and cancer detection [1].

In Brazil, since the 1980s, the Ministry of Health has established guidelines for the early detection of breast and cervical cancer [10]. However, inequalities persist in the country regarding access to screening for these cancers. The Unified Health System (SUS) guarantees universal and free access to mammography and cervical cytology tests, also known as the Papanicolaou test. The Brazilian Ministry of Health recommends screening mammography for women between 50 and 69 years of age every two years [11]. The screening method for cervical cancer and its precursor lesions is oncotic cytology, which should begin at the age of 25 for women who have already started sexual activity. Periodic examinations should continue until the age of 64, with the first two examinations conducted at annual intervals and. If both results are negative for malignancy, subsequent examinations should be carried out every three years [12].

Since 2020, with the outbreak of the COVID-19 pandemic, screening for breast and cervical cancer has been suspended in many locations around the world and in Brazil. Social distancing, isolation measures, and increased inequalities have also jeopardized access to health services [13].

Given the above context, the objectives of this study were to analyze the temporal trends in the prevalence of mammography and Papanicolaou test coverage among women living in Brazilian capitals between 2007 and 2023 and to compare the coverage of these tests before and during the Covid-19 pandemic.

Monitoring the coverage of these tests is essential to verify trends in the health situation, identify the evolution of inequalities, and analyze this information to support the monitoring of international commitments, such as the Global Action Plan for the Prevention and Control of Noncommunicable Diseases (NCDs) and the Agenda 2030 for Sustainable Development Goals.

Methods

Study design

This is a time series study, conducted from 2007 to 2023, utilizing data from the Surveillance System of Risk and Protective Factors for Chronic Diseases by Telephone Survey (Vigitel).

Setting

Vigitel is a population-based telephone survey that has been monitoring the frequency and distribution of the main risk and protective factors for NCDs every year since 2006, including dietary consumption, overweight, sedentary behavior, physical activity levels, smoking habits, alcohol consumption, and cancer prevention.

The sampling process uses databases from the main fixed-line telephone operators in the country. In each

selected household, one adult resident is randomly chosen to participate in the survey. The interviews are conducted by a specialized company contracted by the Brazilian Ministry of Health, with interviewers continuously trained and supervised by technicians from the Ministry of Health and partnering universities (University of São Paulo and Federal University of Minas Gerais) [14].

The questionnaire used was specifically developed for Vigitel, comprising short and objective questions with predefined response options (closed questions). Interviews are conducted via the "Computer Assisted Telephone Interview" system, which allows for efficient execution [15].

Until 2021, the sampling procedures used by Vigitel aimed to obtain probabilistic samples of the population of adults (≥18 years of age) living in households with at least one fixed telephone line in each of the capitals of the 26 Brazilian states and the Federal District. In the editions held between 2006 and 2019, a minimum sample size of around 2,000 individuals was established in each city [16]. However, particularly in 2020 and 2021, due to the challenges imposed by the Covid-19 pandemic on data collection, a reduced sample size of around 1,000 individuals was established in each city. For 2023, due to operational and structural issues in conducting the survey, data was collected between December 26, 2022, and April 24, 2023 and a further reduction was necessary, establishing a minimum of 800 interviews in each location. Additionally, due to the rapid decline of landline coverage in the country, half of the interviews were conducted via mobile phone to ensure the collection of high-quality data, resulting in a final sample of 400 interviews by landline and 400 by mobile phone in each location. This sample size allows for estimating, with a 95% confidence level and a maximum error of 4% points, the frequency of any risk and protective factor in the adult population of each location. It should be noted that the survey was not carried out in 2022, which is why the data from that year is not presented [14].

The interviews conducted are weighted to be representative of the total adult population in each city. Each individual is assigned a weight to correct differences in the probability of selection of respondents (due to varying numbers of adults and telephone lines among households) and to align the sociodemographic composition of the population served by household telephone lines with that of the total adult population in each city for each survey year (post-stratification weight) [17].

More details about the Vigitel sampling and data collection process are provided in the annual system report [14, 16].

Participants

For this study, we considered the population of women aged between 25 and 69 years old, as this is the age recommended by the Ministry of Health for mammography and oncotic cytology tests for cervical cancer (Papanicolaou test) [11, 12].

Variables' description

The variables analyzed, as per Vigitel, included:

- **Percentage of women (aged 50 to 69) who have undergone mammography in the last two years**: This metric is determined by the ratio of the number of women aged 50 to 69 who have undergone mammography in the last two years to the total number of women in the same age group interviewed. This assessment is based on responses to the questions: "Have you ever had a mammography or breast X-ray?" and "How long has it been since you had a mammography?" (This variable was incorporated into Vigitel in 2007).
- **Percentage of women (aged 25 to 64) who have undergone oncotic cytology for cervical cancer in the last three years**: This metric is calculated by the ratio of the number of women aged 25 to 64 who have undergone oncotic cytology in the last three years to the total number of women in the same age group interviewed. This is based on responses to the questions: "Have you ever had a Papanicolaou test?" and "How long has it been since you had a Papanicolaou test?" (This variable was added to Vigitel in 2007).

These variables were further analyzed according to: educational level (0 to 8; 9 to 11; and ≥12 years), age groups (for mammography 50 to 54, 55 to 64, and 65 to 69; for Papanicolaou test 25 to 34, 35 to 44, 45 to 54, and 55 to 64 years); race/skin color (white, black, and mixed); region (North, Northeast, Southeast, South and Central-West); and the geographical location (26 Brazilian capitals and the Federal District).

Statistical analysis

The trends were analyzed using Prais-Winsten generalized linear regression, which corrects for the effect of first-order serial autocorrelation by addressing the heterogeneity of the variance of the residuals from time series regression analysis through logarithmic transformation of the outcome [18].

The dependent variables were the percentage of women who underwent a mammography and oncotic cytology for cervical cancer. The independent variables were the years of the study (2007 to 2023).

We also calculated the Annual Percent Change (APC) for each variable analyzed, using the following formula [19]:

$$APC = (-1 + 10^{\wedge}\beta 1) \times 100\%$$

Where $\beta 1$ refers to the angular coefficient of the Prais-Winsten regression.

The 95% confidence intervals (95%CI) of the APC measures were also calculated using the following formula:

$$\text{Minimum } 95\%\text{CI} = (-1 + 10^{\wedge}[\beta 1 - t \times e]) \times 100\%,$$
$$\text{Minimum } 95\%\text{CI} = (-1 + 10^{\wedge}[\beta 1 + t \times e]) \times 100\%,$$

In these formulas, t refers to the Student's t-test by degrees of freedom for the time periods and with a 95% confidence level, while e corresponds to the standard error. The values for $\beta 1$ and the standard error were generated by the statistical analysis program.

The regression results were interpreted as follows: significant trend was identified when the β of the regression differed from zero and the p-value was less than or equal to 0.05. The trend was considered increasing if β was positive, decreasing if β was negative and stationary if no statistically significant difference was identified (p-value > 0.05).

To evaluate differences in test coverage, 2019 was considered the last year before the Covid-19 Pandemic, and 2023 was considering the period close to the end of the Public Health Emergency, given that the data collection for the last year occurred between December 26, 2022, and April 24, 2023. Student's t-test was used to test the differences between the two surveys, with H_0: $\Delta = 0$ and H_1: $\Delta \neq 0$, and significance level (α) equal to 0.05. The variation was deemed significant when the 95% confidence interval did not contain zero.

The analyses were conducted using Stata software (Stata Corp LP, College Station, Texas, United States), version 14.2, and The QGIS software (version 3.18.3) was used to create the maps.

Ethical considerations

The data is available for public access and use and its collection was approved by the Ministry of Health's National Research Ethics Committee for Human Beings (CAAE: 65610017.1.0000.0008). Informed consent was obtained orally when the interviewees were contacted by telephone.

Results

The trend and APC analyses of mammography coverage between 2007 and 2023 showed a stationary trend for all women aged 50 to 69, with a prevalence of 71.1% in 2007 and 73.1% in 2023 (p-value = 0.75). Regarding educational level, there was a downward trend in mammography coverage among women with 12 years or more of schooling, decreasing from 87.6% in 2007 to 82.4% in 2023 (APC= -0.52% 95%CI -1.01%; -0.02%). For the other variables, the trend was stationary (p-value > 0.05) (Table 1).

Papanicolaou test coverage for all women aged between 25 and 64 showed a downward trend (APC= -0.45% 95%CI -0.76%; -0.13%), decreasing from 82.0% in 2007 to 76.8 in 2023. This decline in Papanicolaou test coverage also occurred among women with 9 to 11 years (APC= -0.84, 95%CI -1.38; -0.31) and 12 years or more of schooling (APC= -0.60, 95%CI-0.81; -0.38); in the 25 to 34 (APC= -0.78, 95%CI -1.07;-0.48) and 35 to 44 (APC= -0.48, 95%CI -0.84; -0.11) age groups; among those with white (APC= -0.24, 95%CI -0.41; -0.07) and mixed race (APC= -0.74, 95%CI -1.13;-0.35); and in the North-East (APC= -0.58, 95%CI -0.91; -0.24), Southeast (APC= -0.36, 95%CI -0.58; -0.13) and South (APC= -0.63, 95%CI -1.14; -0.13) regions (Table 2).

Regarding mammography coverage in Brazilian capitals, a downward trend was observed in Belo Horizonte (APC= -0.42%, 95%CI -0.79%; -0.04%). Conversely, an upward the trend was identified in Belém (APC=1.19%, 95%CI 0.23%; 2.17%), Macapá (APC=1.37%, 95%CI 0.35%; 2.40%), Natal (APC=0.72%, 95%CI 0.42%; 1.03%); Palmas (APC=2.03%, 95%CI 0.33%; 3.77%), Rio Branco (APC=1.43%, 95%CI 0.67%; 2.20%) and São Luis (APC=0.42%, 95%CI 0.06%; 0.78%) (Fig. 1A; Supplementary material 1).

For Papanicolaou test coverage, an upward trend was noted only in Manaus (APC=0.55%, 95%CI 0.26%; 0.85%). A downward trend was observed in Aracaju (APC= -0.77%, 95%CI -1.10%; -0.43%), Belo Horizonte (APC= -0.43%, 95%CI -0.81%; -0.05%), Boa Vista (APC= -0.44, 95%CI -0.85;-0.04), Cuiabá (APC= -0.41%, 95%CI -0.52%; -0.29%), Florianópolis (APC= -0.33%, 95%CI -0.55%; -0.11%), Fortaleza (APC= -0.60%, 95%CI -1.14%; -0.07%), João Pessoa (APC= -0.98%, 95%CI -1.28; -0.68%), Maceió (APC= -0.91%, 95%CI -1.49%; -0.33%), Palmas (APC= -0.47%, 95%CI -0.73%; -0.21%), Porto Alegre (APC= -0.46%, 95%CI -0.91%; -0.01%), São Luis (APC= -0.64%, 95%CI -1.07%; -0.21%), São Paulo (APC= -0.48%, 95%CI -0.65%; -0.31%), Teresina (APC= -0.51%, 95%CI -0.88%; -0.14%) and Vitória (APC= -0.67%, 95%CI -1.03%; -0.30%). In the other capitals, the trend remained stable (Fig. 1B; Supplementary material 2).

When comparing mammography coverage before and during the Covid-19 pandemic, there was a percentage reduction of -3.8% (95%CI -6.9; -0.7), from 76.9% in 2019 to 73.1% in 2023. This reduction also occurred among women with 12 years or more of schooling, in the 50–54 and 65–69 age groups, and those living in the North, Northeast and Central-West regions (Table 3).

Table 1 Time trend of mammography coverage prevalence and annual percent change. Vigitel, 2007 to 2023

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2023	APC (95%CI)
Total	71.1	71.7	72.4	73.4	74.4	77.4	78.0	77.8	78.1	78.2	78.5	78.0	76.9	78.0	72.8	73.1	0,12(-0,65;0.89)
Education (years)																	
0–8	66.1	66.5	66.4	67.5	67.8	71.4	72.9	71.8	71.9	71.2	72.3	73.5	71.8	72.0	68.7	67.5	0,16(-0,58;0.9)
9–11	77.3	77.6	79.4	77.3	80.5	81.8	81.4	80.9	81.5	82.4	81.9	77.6	76.5	79.5	74.2	72.1	-0,47(-1,13;0.2)
≥12*	87.6	88.8	87.9	87.8	87.6	90	88.3	91.8	89.3	90.5	87.3	87.9	86.8	86.9	78.7	82.4	-0,52(-1,01;-0.01)
Age (years)																	
50–54	75.6	74.5	75.5	77.6	78.2	79.9	79.7	77.9	78.8	78.1	79.8	78.0	77.1	76.1	70.7	70.5	-0,51(-1,31;0.3)
55–64	69.8	71.0	71.7	72.7	73.8	78.1	78.0	79.7	79.2	78.0	78.7	78.6	77.4	79.5	75.4	76.0	0,46(-0,23;1.16)
65–69	64.1	67.5	68.1	65.7	68.0	69.2	73.5	71.7	73.0	79.0	73.8	75.4	74.3	77.8	68.2	68.1	0,45(-0,35;1.26)
Race/color																	
White	74.1	75.9	76.8	78.8	80	80.1	80.8	81.7	80.8	80.5	80.8	80.9	78.3	79.6	73.1	74.1	-0,15(-0,98;0.68)
Black	66.0	69.5	66.0	68.8	71.4	76.0	75.3	75.6	78.9	80.0	77.1	76.4	74.9	77.1	75.3	67.1	0,61(-0,89;2.13)
Mixed	89.9	83.0	70.5	77.9	69.1	76.1	76.2	75.8	77.4	76.4	79.4	77.4	76.9	77.3	72.7	75.0	-0,40(-1,12;0.32)
Region																	
North	60.2	59.0	60.3	63.7	64.4	70.7	70.9	70.9	72.6	77.5	72.4	74.4	75.1	72.1	66.8	66.6	0,62(-0,79;2.05)
North-East	71.6	71.6	70.9	71.9	72.6	76.9	77.1	76.4	77.4	77.6	78.3	76.2	77.5	77.7	71.7	73.0	0,07(-0,62;0.77)
Central-West	72.3	70.0	69.6	79.2	72.9	73.4	79.6	78.2	79.6	79.2	79.6	75.6	77.2	76.5	68.7	70.1	-0,16(-1,04;0.73)
Southeast	70.9	73.0	74.5	73.4	75.7	78.2	78.3	78.4	78.3	77.8	78.9	79.2	76.2	79.1	75.5	74.1	0,22(-0,34;0.78)
South	79.2	76.2	76.3	79.9	81.7	84.5	82.7	83.4	81.6	81.2	80.5	82.0	80.0	79.7	72.0	77.6	-0,33(-1,1;0.45)

*P-value< 0.05

Papanicolaou test coverage fell by -4.68 (95%CI -6.88; -2.48), from 81.5% (95%CI 80.4; 82.6) in 2019 to 76.8% (95%CI 74.9; 78.7) in 2023. The reduction occurred among women with 9 to 11 years of schooling, aged 25 to 44, those with black and mixed race and residents of the North, Northeast, and South regions (Table 4).

Discussion

The results of this study indicated that between 2007 and 2023, mammography coverage for women aged 50 to 69 exhibited a stationary trend. However, there was a declining trend among women with 12 years or more of education. The coverage of the Papanicolaou test for women aged 25 to 64 also showed a decreasing trend, particularly among women with 9 or more years of education, those aged 25 to 44, those with white and mixed race, and those residing in the Northeast, Southeast, and South regions. The Covid-19 pandemic significantly impacted coverage, resulting in reduced rates for both tests when comparing 2019 and 2023.

The national target for non-communicable disease (NCD) prevention aims to increase mammography coverage among women aged 50 to 69 to 70% by 2030. Despite a stationary trend, prevalence rates have exceeded this target, peaking at 78.5% in 2017.

Screening mammography is not available in primary care centers. In primary health care (PHC), doctors or nurses assess and refer patients to specialized services. However, the integration between the primary and secondary levels of care is inadequate, with poorly coordinated care flows and insufficient regulatory centers for appointments and exams [20, 21]. As of August 2023, Brazil had 6,588 mammography machines available for the SUS, with 6,334 in use, predominantly in the Southeast and Northeast regions [8]. Consequently, some municipalities lack sufficient mammography machines, limiting access for SUS users and perpetuating regional inequalities [21, 22].

The national target for Papanicolaou test coverage aims to reach an 85% increase among women aged 25 to 64. Until 2019, coverage rates ranged from 81.0 to 83.9%. However, from 2020 onwards, coverage declined, reaching 76.8% in 2023.

The Papanicolaou test is provided free of charge in SUS primary care services. Over the past three decades, Brazil has expanded PHC coverage, strengthening it as the gateway and coordinator of SUS care. This expansion has improved access to and utilization of health services, leading to better health outcomes. However, this expansion has been uneven across the country, with persistent inequalities in access, infrastructure, and outcomes between Brazilian municipalities. Additionally, the economic and political crisis, austerity measures, and changes in funding and health team configurations have threatened the progress made, compromising social and health rights [23, 24]. Health inequalities and insufficient investment in service expansion and quality improvement contribute to reduced access and utilization of health services, including screening tests.

Despite the declining trend in mammography and Papanicolaou test coverage among more educated women, the highest prevalence was observed among those with 12 or more years of education. Women with 0 to 8 years of education had the lowest prevalence over the years. The inequality related to educational level in screening coverage is a socioeconomic determinant that can affect the perception of risk, influence behavioral factors in the decision to seek health services, and impact the importance placed on adopting health promotion and disease prevention measures [25–27]. Education is also associated with higher income and greater purchasing power to acquire health insurance and seek health services more frequently [28, 29].

There was a reduction in Papanicolaou test coverage among women aged 25 to 44, with the lowest proportion observed among those aged 25 to 34 over the historical series. These results can be explained by the activities undertaken by these women that limit or prevent access to health services. Considering that these ages include women who are more active in the labor market, this may be a factor that hinders attendance at health services during operating hours [30, 31]. Additionally, other factors such as household chores and childcare, along with a daily routine filled with tasks traditionally seen as women's responsibilities, contribute to this issue [31]. These results highlight the need to explore strategies to improve access for specific age groups and address the realities of these women, particularly since this age range is recommended for the initiation of screening [32].

In the context of social determinants of health, skin color also influences the uptake of these tests. This study showed a declining trend in Papanicolaou tests among white and mixed race, while mammography showed stability across all racial groups. However, black-skinned women consistently had the lowest prevalence for both tests across all years. Other studies have also highlighted inequities, showing greater restrictions and lower frequency of test uptake among black-skinned women compared to their white-skinned counterparts [21, 33, 34]. Black-skinned individuals tend to have worse working conditions, lower wages, higher poverty rates, and face more barriers to accessing health services, along with higher morbidity and limitations due to non-communicable diseases (NCDs) [35–37]. This reflects structural and institutional racism within society.

Brazil is a country of continental dimensions, with regions that exhibit economic, social, and health disparities. The Southeast and South regions have the highest

Table 2 Time trend of the prevalence of Papanicolaou test coverage and annual percent change. Vitabgitel, 2007 to 2023

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2023	APC (95%CI)
Total*	82.0	83.3	82.2	82.2	81.8	82.3	82.9	81.4	81.0	82.0	82.8	81.7	81.5	80.1	77.2	76.8	-0.45(-0.76;-0.13)
Education (years)																	
0–8	78.0	79.6	77.6	78.6	77.4	78.3	78.6	77.9	77.7	76.7	78.9	79.2	78.3	78.3	74.7	75.5	-0.16(-0.33;0.0)
9–11*	83.9	83.6	83.2	81.4	81.5	81.7	83.6	80.9	80.4	82.6	83.1	80.2	79.7	78.5	76.5	71.9	-0.84(-1.38;-0.31)
≥12*	87.9	90.1	89.1	89.3	88.5	88.6	87.2	86.4	85.3	85.9	85.6	85.2	85.6	83.0	79.3	82.7	-0.60(-0.81;-0.38)
Age (years)																	
25–34*	77.6	80.2	78.2	78.1	78.4	78.2	78.8	76.8	75.1	75.9	76.6	74.5	76.9	71.8	69.9	69.1	-0.78(-1.07;-0.48)
35–44*	86.0	86.5	85.2	83.9	83.9	84.3	85.2	82.5	83.9	86.1	85.7	84.9	84.0	83.3	78.1	79.9	-0.48(-0.84;-0.11)
45–54	85.6	85.6	84.6	87.2	85.0	85.0	86.5	85.7	83.9	85.8	87.1	85.7	85.1	84.8	82.7	82.7	-0.16(-0.32;0.0)
55–64	78.2	80.5	81.7	80.5	80.5	83.5	81.8	82.5	83.3	82.0	83.8	84.1	81.1	84.4	81.6	79.3	-0.18(-0.04;0.39)
Race/color																	
White*	84.6	86.0	84.9	85.3	85.9	85.2	85.4	84.5	83.6	86.1	85.4	85.2	83.2	84.7	79.1	81.9	-0.24(-0.41;-0.07)
Black	82.3	83.0	78.3	75.8	74.5	79.9	78.5	77.7	78.3	77.6	82.2	75.8	81.8	81.1	72.0	71.1	-0.48(-1.02;0.06)
Mixed*	90.2	88.8	77.8	83.6	79.9	81.4	82.8	81.0	80.5	79.9	82.6	80.7	80.6	77.0	76.9	74.8	-0.74(-1.13;-0.35)
Region																	
North	78.6	79.9	78.1	80.0	77.0	78.4	81.2	79.3	81.9	81.7	82.9	82.1	81.6	80.4	76.8	76.3	-0.15(-0.63;0.32)
North-East*	75.7	78.2	75.3	76.5	75.3	75.5	76.5	75.4	75.0	75.8	76.1	74.7	75.7	72.9	70.5	68.9	-0.58(-0.91;-0.24)
Central-West	80.3	79.3	80.8	78.3	78.6	81.5	79.5	79.1	77.6	79.8	80.2	79.4	79.4	73.7	77.1	78.3	-0.23(-0.47;0.00)
Southeast*	85.5	87.1	86.3	85.6	86.1	86.5	86.8	84.5	83.9	84.9	86.5	85.5	84.8	85.1	81.0	80.8	-0.36(-0.58;-0.13)
South*	87.5	87.6	87.6	88.8	88.0	86.4	88.3	89.2	87.6	89.5	87.4	86.8	85.7	85.6	78.6	80.4	-0.63(-1.14;-0.13)

*P-value < 0.05

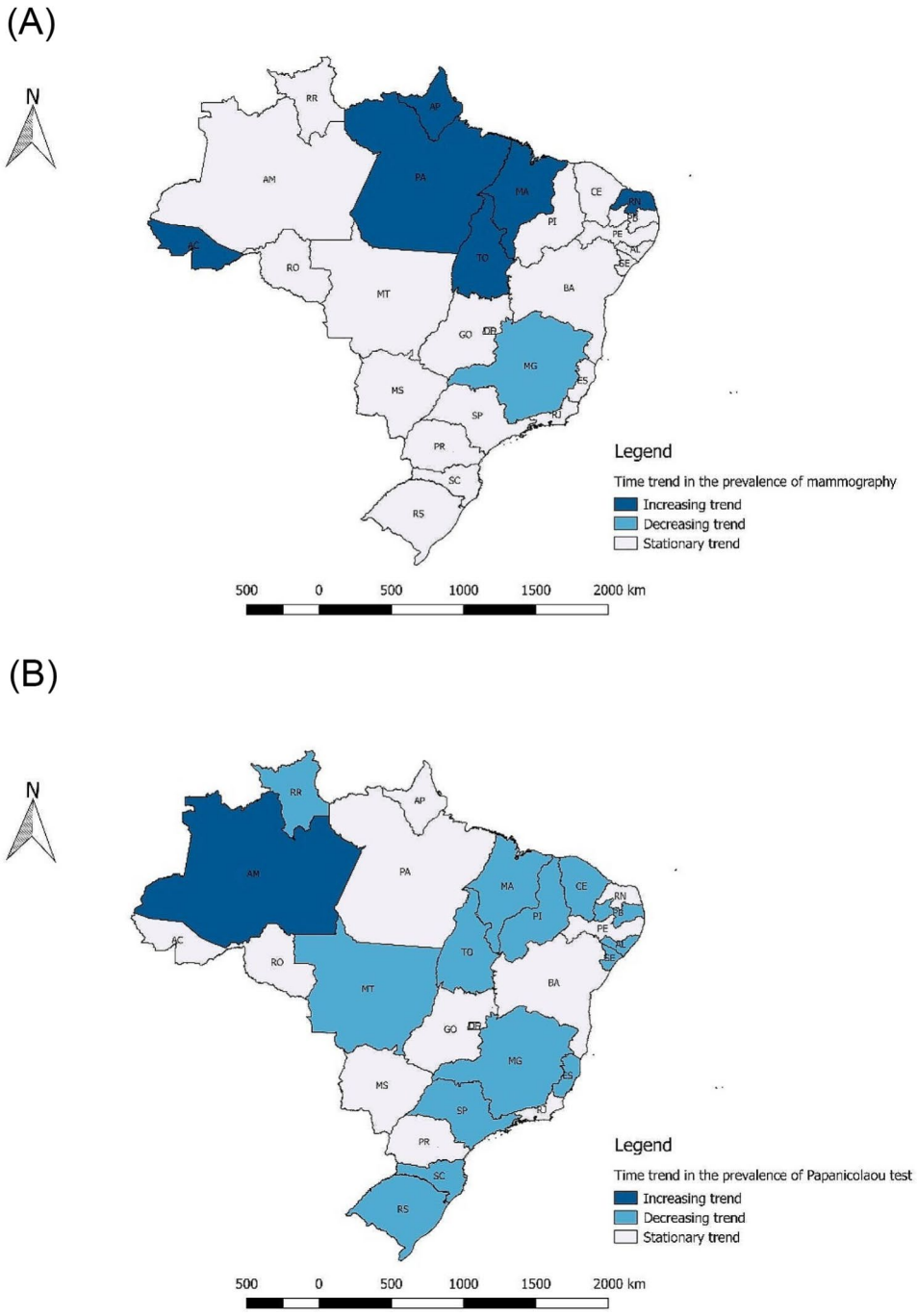

Fig. 1 Time trend in the prevalence of mammography (**A**) and Papanicolaou test (**B**) coverage in Brazilian state capitals. Vigitel, Brazil, 2007 to 2023. Source Prepared by the authors. *Note* Acre – AC; Alagoas – AL; Amapá – AP; Amazonas – AM; Bahia – BA; Ceará – CE; Distrito Federal – DF; Espírito Santo – ES; Goiás – GO; Maranhão – MA; Mato Grosso – MT; Mato Grosso do Sul – MS; Minas Gerais – MG; Pará – PA; Paraíba – PB; Paraná – PR; Pernambuco – PE; Piauí – PI; Rio de Janeiro – RJ; Rio Grande do Norte – RN; Rio Grande do Sul – RS; Rondônia – RO; Roraima – RR; Santa Catarina – SC; São Paulo – SP; Sergipe – SE; Tocantins – TO

breast cancer mortality rates (12.43 and 12.69 deaths per 100,000 women, respectively), followed by the Northeast (10.75 deaths per 100,000 women), Central-West (10.90 deaths per 100,000 women), and North (8.59 deaths per 100,000 women) [8]. Cervical cancer is the second most common in the North (20.48 per 100,000) and Northeast (17.59 per 100,000) and third in the Central-West (16.66 per 100,000). In the South (14.55 per 100,000), it ranks fourth, and in the Southeast (12.93 per 100,000), it ranks fifth [9].

Mammography coverage showed a stable trend in all regions, while Papanicolaou test coverage declined in the

Table 3 Comparison of mammography coverage before and during the Covid-19 pandemic. Vigitel, Brazil, 2019 and 2023

	2019	2023		
	% (95%CI)	% (95%CI)	Percentage of variation (95%CI)	*P*-Value
Total	76.9% (75.4;78.3)	73.1 (70.3;75.9)	-3.8 (-6.9; -0.7)	0.02
Education (years)				
0–8	71.8 (69.3;74.4)	67.5 (62;73)	-4.4 (-10.54; 1.76)	0.16
9–11	76.5 (74.2; 78.9)	72.1 (68.2; 76.0)	-4.45 (-8.99; 0.1)	0.06
≥ 12	86.8 (84.7; 88.9)	82.4 (78.8; 86.0)	-4.36 (-8.51; -0.21)	0.04
Age (years)				
50–54	77.1 (74.4; 79.9)	70.5 (64.5;76.5)	-6.67 (-13.24; -0.11)	0.05
55–64	77.4 (75.4; 79.4)	76.0 (72.7; 79.3)	-1.37 (-5.22; 2.49)	0.5
65–69	74.3 (71.3; 77. 4)	68.1 (62.6;73.6)	-6.27 (-12.55; 0.02)	0.05
Race/color				
White	78.3 (76.2; 80.5)	74.1 (69.7;78.5)	-4.21 (-9.1; 0.68)	0.09
Black	74.9 (69.4; 80.4)	67.1 (56.2; 77.9)	-7.83 (-20.06; 4.39)	0.21
Mixed	76.9 (74.5; 79.3)	75.0 (71.4;78.6)	-1.9 (6.21; 2.41)	0.39
Region				
North	75.1 (72.0; 78.2)	66.6 (61.5; 71.6)	-8.52 (-14.42; -2.62)	0.01
North-East	77.5 (75.8; 79.3)	73.0 (69.6; 76.4)	-4.53 (-8.36; -0.7)	0.02
Central-West	77.2 (73.9; 80.5)	70.1 (65.3; 75)	-7.07 (-12.94; -12.0)	0.02
Southeast	76.2 (73.4; 78.9)	74.1 (68.6; 79.6)	2.05 (-8.21; 4.12)	0.52
South	80.0 (77.1;82.8)	77.6 (72.8; 82.5)	-2.35 (-7.97; 3.26)	0.41

Table 4 Comparison of Papanicolaou test coverage before and during the Covid-19 pandemic. Vigitel, Brazil, 2019 and 2023

	2019	2023		
	% (95%CI)	% (95%CI)	Percentage of variation (95%CI)	*P*-Value
Total	81.5 (80,4; 82,6)	76.8 (74,9; 78,7)	-4,68 (-6,88; -2,48)	< 0,001
Education (years)				
0–8	78.3 (76,0; 80,5)	75.5 (71,3; 79,7)	-2,77 (-7,53; 1,99)	0.25
9–11	79.7 (77,9;81,4)	71.9 (68,7; 75,1)	-7,77 (-11,46; -4,08)	< 0,001
≥ 12	85.6 (83,9; 87,3)	82.7 (80,0; 85,4)	-2,89 (-6,12; 0,34)	0.08
Age				
25–34	76.9 (74,3;79,5)	69.1 (64,6; 73,6)	-7,79 (-12,97; -2,62)	0.003
35–44	84.0 (82,1;85,8)	79.9 (77,2; 82,7)	-4,07 (-7,39; -0,74)	0.02
45–54	85.1 (83,3; 86,9)	82.7 (79,5;86.0)	-2,39 (-6,07; 1,29)	0.20
55–64	81.1 (79,3; 83.0)	79.3 (76.1; 82.5)	-1,8 (-5,52; 1,93)	0.34
Race/color				
White	83.2 (81.5;85.0)	81.9 (79.1; 84.7)	-1,31 (-4,6; 1,97)	0.43
Black	81.8 (78.1;85.5)	71.1 (64.0;78.3)	-10,67 (-18,7; -2,65)	0.01
Mixed	80.6 (80.0; 82.3)	74.8 (72.1;77.5)	-5,85 (-8,99; -2,71)	< 0,001
Region				
North	81.6 (79.6;83.6)	76.3 (73.3; 79.2)	-5,38 (-8,96; -1,79)	0.003
North-East	75.7 (74.2;77.2)	68.9 (66.4;71.4)	-6,83 (-9,77; -3,89)	< 0,001
Central-West	79.4 (76.7;82.2)	78.3 (74.8;81.8)	-1,12 (-5,56 ;3,33)	0.62
Southeast	84.8 (82.7;86.8)	80.8 (76.9;84.7)	-4,01 (-8,42; 0,39)	0.07
South	85.7 (83.5;88.0)	80.4 (76.5;84.3)	-5,3 (-9,82; -0,79)	0.02

Northeast, Southeast, and South. However, the North and Northeast regions consistently exhibited the lowest prevalence rates for both exams over the years, likely reflecting poorer living and health conditions, lower resource availability, and lower primary care coverage. These regions also have higher mortality and morbidity rates from NCDs [38]. One study indicated that the likelihood of undergoing mammography was higher in all regions compared to the North, with women in the Southeast having twice the odds of undergoing mammography [28]. Moreover, the North region has the highest proportion of women who have never had a preventive exam [39].

Inequalities in access to mammograms and Papanicolaou tests have been highlighted in the literature [21, 40, 41]. Factors associated with not undergoing these tests include values, beliefs, fear, and lack of knowledge about the disease and lifestyles; socioeconomic issues such as income and education; and health services factors such as scheduling difficulties, operating hours, distance, and professional reception [21, 40, 41].

This study identified differences in social, demographic, and economic structures that create distinct social groups with unequal health conditions, influencing the uptake of mammography and Papanicolaou tests. Reducing these inequalities is crucial to ensuring equitable access to screening, early diagnosis, and treatment, especially for socially disadvantaged women, to reduce the incidence and mortality from these diseases.

The Covid-19 pandemic had a significant impact on coverage, reducing the rates of both tests. In addition to

affecting lifestyles and social, economic, and emotional aspects, the pandemic also influenced the demand for, use of, and supply of health services. Routine services were reorganized or discontinued, interrupting care for people with NCDs, and prevention and health promotion services. Isolation and social distancing measures further restricted access to preventive care [42–44]. The pandemic affected the delivery of cancer screening services globally, as healthcare resources were redirected to combat the COVID-19, categorizing cancer prevention and control services as non-urgent medical procedures [45, 46].

In Brazil, the National Cancer Institute (INCA) recommended at the beginning of the pandemic that screening tests should be postponed, and that positive or symptomatic cases should be investigated and, if confirmed, treated [47]. Subsequently, considering the epidemiological scenario and the response capacity of the healthcare network, it was recommended that screening actions be resumed, provided local Covid-19 incidence indicators were considered and protective measures were respected [48].

The World Health Organization (WHO) has pointed out that public screening programmes (e.g., breast and cervical cancer) have been postponed in more than 50% of the world's countries, resulting in delays in the diagnosis and treatment of cancers and potentially increasing morbidity and mortality [49].

The consequences of the pandemic extend beyond the reduction in the number of tests conducted in the country, as there is a possibility that women will lose their access to health services and not attend them even after the pandemic, hindering access to other services such as health promotion and education [13, 50].

It is also noteworthy that services have gradually resumed following the health emergency caused by the pandemic. However, there is still a low level of adherence to scheduled appointments and preventive, and health promotion services. Therefore, strategies to increase adherence to screening tests are urgent and necessary. This will require a well-coordinated effort to proactively reach out to the community, alleviate concerns of apparently healthy individuals about returning to routine healthcare, and reorganize clinical services to minimize backlogs [51]. Active outreach actions are crucial for screening, diagnosis, and initiating treatment; educational activities to clarify doubts about the exams; community mobilization and effective communication strategies, especially since the infodemic associated with COVID-19 has generated many myths and misconceptions likely to have a lasting impact on cancer screening services; partnerships with companies and institutions to facilitate access to gynecological consultations for their employees; expanding schedules for consultations and exams as well as the operating hours of health services; identifying and supporting women who have difficulty accessing health services; improving the opportunistic screening model; and restoring public trust in the efficiency and safety of services, which should be a key mandate for the reorganization of screening programs. Governments also need to increase spending on healthcare and social protection [13, 40, 51]. Additionally, it is strongly recommended that future studies investigate the impact of the pandemic on breast and cervical cancer outcomes.

To guarantee the success of a screening program, in addition to achieving high screening coverage, the subsequent stages of diagnostic investigation and treatment need to be well-organized and available within healthcare network. Furthermore, the quality of screening examinations must be ensured, as it is fundamental for identifying precursor lesions of cervical cancer and detecting any breast abnormalities, even those that are small or have a low density [11, 52]. It is also important to raise awareness among the population and health professionals about the warning signs and symptoms of certain types of cancer and to organize the health system to expedite the diagnostic investigation of clinically suspicious cases [47, 48]. It is important to mention that vaccination against the human papillomavirus (HPV) is crucial, as it significantly prevents the development of cervical cancer [6]. Opportunistic screening, early diagnosis, and adequate follow-up can increase coverage and the identification of cancer cases at early stages, aiming to reduce the morbidity and mortality caused by these diseases.

The limitations of this study include the self-reported nature of the data, which may result in underestimation or overestimation of prevalence. However, validation studies of the Vigitel questionnaire have shown satisfactory results in the reproducibility and validity analyses [53–56]. The Vigitel sample consists of individuals living in the capital cities of Brazil and the Federal District, who reside in households with landlines, representing a potential risk to representativeness. However, this issue is mitigated by using data weighting factors that aim to align the demographic characteristics of the Vigitel sample to those of the Brazilian population [17]. In 2022, no survey data was collected, leading to an interruption in the historical series; data has been collected continuously since 2007, which makes it possible to analyze trends. The concentration of interviews in certain months of the year requires caution when comparing the estimates generated in 2023 with those from previous years, as interviews were not distributed throughout the entire year of 2023 due to the seasonal influence on some of the system's indicators. The reduction in sample size in each city decreases the precision of the estimates; however, this situation received special consideration in the analyses.

Nevertheless, the estimates should be treated with caution until a future edition of the system, under more favorable conditions, can confirm the observed trends.

Conclusion

From 2007 to 2023, mammography coverage remained stable among women aged 50 to 69 nationwide, although it declined among more educated women and those residing in Belo Horizonte, while there was an upward trend in six capital cities in the North. In contrast, Papanicolaou test coverage showed a downward trend among women aged 25 to 64 across all education levels and among those with white and mixed race. This trend was observed in the Northeast, Central-West, Southeast, and South regions, as well as in several Brazilian capitals. The Covid-19 pandemic has significantly contributed to the reduction in coverage of these tests.

Breast and cervical cancer remain a significant public health challenge, and strategies aimed at changing this scenario emphasize the establishment of organized screening programs. These programs aim to increase coverage among recommended age groups and ensure follow-ups for all women with abnormal test results, thereby reducing social inequalities in health.

Organizing screening also entails addressing inequalities in access. Therefore, it is crucial to develop strategies focused on enhancing coverage through interventions targeting vulnerable groups. This requires increased training, investment, and expansion of the services offered by the SUS, the Health Care Network, and health teams.

In the post-pandemic context, the importance of discussing policies to address NCDs and promote preventive and health actions is underscored. These efforts should not be interrupted but rather resumed and adapted to the new reality. The PHC services need to adapt to support and manage increased health risks within the population, ensuring uninterrupted care for individuals with NCDs. Health teams should actively participate in strategizing to effectively meet the needs of individuals, families, and communities.

Abbreviations

APC	Annual Percent Change
PHC	Primary Health Care
NCDs	Noncommunicable Diseases
SUS	Unified Health System
Vigitel	Surveillance System of Risk and Protective Factors for Chronic Diseases by Telephone Survey

Supplementary Information

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Supplementary Material 1

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Author contributions

AGS conception and design of the study; analysis and interpretation of the data; draft; revision; approval of the final version; responsible for all aspects of the work, to ensure that issues relating to the accuracy or completeness of any part of the work are thoroughly investigated and resolved. TPRS study design; data analysis and interpretation; revision; approval of the final version; responsible for all aspects of the work, to ensure that issues relating to the accuracy or completeness of any part of the work are investigated and resolved. NMV revision; approval of the final version; responsible for all aspects of the work, to ensure that issues relating to the accuracy or completeness of any part of the work are thoroughly investigated and resolved. FMS revision; approval of the final version; responsible for all aspects of the work, to ensure that issues relating to the accuracy or completeness of any part of the work are investigated and resolved. GCO revision; approval of the final version; responsible for all aspects of the work, to ensure that issues relating to the accuracy or completeness of any part of the work are thoroughly investigated and resolved. DCM study design; data interpretation; revision; approval of the final version; responsible for all aspects of the work, to ensure that issues relating to the accuracy or completeness of any part of the work are investigated and resolved.

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Data availability

The datasets generated and/or analysed during the current study are available in the [Ministério da Saúde, Secretaria de Vigilância em Saúde] repository [https://svs.aids.gov.br/download/Vigitel/].

Declarations

Ethics approval and consent to participate

National Research Ethics Committee for Human Beings of the Ministry of Health (CAAE: 65610017.1.0000.0008). Verbal informed consent was obtained prior to the interview.

Consent for publication

We authors of this study give our consent to information about "Figure 1 Time trend in the prevalence of mammography and Papanicolaou test coverage, according to Brazilian state capitals. Vigitel, Brazil, 2007 to 2023" this manuscript to be published on BMC Women's Health. We understand that the figure published in the article will be freely available on the internet and may be seen by the general public. The figure may also appear on other websites or in print, may be translated into other languages ??or used for commercial purposes. We have been offered the opportunity to read the manuscript.

Competing interests

The authors declare no competing interests.

Author details

[1]School of Nursing, Graduate Program in Nursing, Department of Maternal-Child and Public Health Nursing, Federal University of Minas Gerais (UFMG), Avenida Professor Alfredo Balena, 190, Santa Efigênia, Belo Horizonte 30130-100, Minas Gerais, Brazil
[2]Women's Health Nursing Department, Paulista School of Nursing, Federal University of São Paulo (Unifesp), Rua Napoleão de Barros,754, Vila Clementino, São Paulo 04023-062, Brazil
[3]Graduate Program in Public Health at the Medical School, Federal University of Minas Gerais (UFMG), 190, Santa Efigênia, Belo Horizonte 30130-100, Minas Gerais, Brazil
[4]Faculty of Medical Sciences of Minas Gerais (CMMG), Alameda Ezequiel Dias, 275, Centro, Belo Horizonte 30130-110, Minas Gerais, Brazil
[5]Sofia Feldman Hospital, Rua Antônio Bandeira 1060, Tupi, Belo Horizonte 31844-130, Minas Gerais, Brazil

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