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Trends in breast cancer mortality in Peru and its geographical areas from 2013 to 2022 and prediction until 2027

Melanie Kiara Terrel-Poccomo[1], Grecia Santillán-Romero[1], Carlos Quispe-Vicuña[2], Jorge Ybaseta-Medina[3] and J. Smith Torres-Roman[1*]

Abstract

Background In 2022, breast cancer was one of the most commonly diagnosed neoplasms and the leading cause of cancer death among women worldwide. In Peru, reports on mortality due to this neoplasm are scarce, especially after implementing strategies to reduce its impact. This study aimed to estimate mortality rates for breast cancer in Peru and its geographic regions from 2013 to 2022 and to project its evolution to 2027.

Methods An observational ecological study of multiple time series was conducted. Data were obtained from the Ministry of Health's death database via SINADEF. Mortality rates per 100,000 women were calculated using the direct method and Segi's world standard population. Mortality trends were analyzed using the Annual Percent Change (APC) calculated with Joinpoint regression software. Predictions for 2027 were also made using the Nordpred package in R Studio.

Results In 2013, the departments with the highest breast cancer mortality rates in Peru were Ica, Callao, Lambayeque and La Libertad. In 2022, Ancash and Tumbes were added, with Tumbes having the highest rates. For women under 50, Lambayeque and Madre de Dios led in 2013, while for women over 50, Tumbes had the highest mortality rate in 2022. Peru reported a significant increase of 3.97% on an annual basis for the entire period. According to regions, Rainforest region (APC = + 8.37) and the Rainforest region (APC = + 11.55) showed significant increases in mortality rates, while no significant changes were observed in the Coastal region. Moreover, an increase in breast cancer mortality in Peru is projected for the year 2027.

Conclusion Breast cancer mortality in Peru has shown a constant increase, with significant regional disparities. The highest rates were recorded in the coastal region, although the Andean and jungle regions experienced the most pronounced increases. These disparities may be attributed to data underreporting during the COVID-19 pandemic and unequal access to diagnostic and treatment services. The findings highlight the urgent need for focused public health interventions to reduce these regional gaps and improve breast cancer management outcomes.

*Correspondence:
J. Smith Torres-Roman
jstorresroman@gmail.com
[1]Cancer Research Networking, Universidad Cientifica del Sur, Lima, Peru
[2]Latin American Network for Cancer Research (LAN–CANCER), Lima, Peru
[3]Universidad Nacional San Luis Gonzaga de Ica, Ica, Peru

Introduction

Globally, in 2022, breast cancer was one of the most frequently diagnosed neoplasms and the leading cause of cancer mortality among women, with a mortality rate of 12.7 per 100,000 women [1, 2]. In Latin America and the Caribbean, between 1990 and 2015, some of the highest breast cancer mortality rates were reported [3]. However, various studies on the evolution of breast cancer mortality have revealed heterogeneous results across different countries in Latin America [4–6].

Some studies conducted in Chile, Argentina, and Colombia have reported increasing trends in breast cancer mortality rates in recent years [7–9]. In contrast, Peru has shown significant variations in mortality rates according to geographic regions [10]. Between 2013 and 2015, the Lima Metropolitan Cancer Registry reported a mortality rate of 12.7 per 100,000 women. Additionally, it documented a decline in mortality in the coastal region and a significant increase in the rainforest region in recent years [11].

At the end of 2012, the Peruvian government implemented the *Plan Esperanza* (Hope Plan) to improve access to oncological health services, including promotion, prevention, early detection, treatment, and palliative care nationwide [12]. However, to date, no studies have evaluated breast cancer mortality among Peruvian women following the implementation of this program. Although the National Institute of Neoplastic Diseases (INEN) conducted monitoring between 2011 and 2016 within the framework of the *Plan Esperanza*, updated data on mortality rates remain unavailable [13]. Despite improvements in access to comprehensive oncological care, the proportion of cases diagnosed at advanced stages of breast cancer has not shown a significant reduction.

Therefore, this study aimed to determine the evolution of breast cancer mortality rates in Peru between 2013 and 2022 and to predict mortality rates for 2027, considering age groups and the different geographic regions of the country.

Materials and methods

Data source

The data used in this study were obtained from the mortality database of the Ministry of Health for the years 2013 to 2022. This database is publicly accessible and can be requested through the following link: https://www.minsa.gob.pe/portada/transparencia/solicitud/. To identify breast cancer-related deaths in Peru, death certificates of all women with the code C50 (malignant neoplasm of the breast) according to the International Classification of Diseases, Tenth Revision (ICD-10) [14].

In Peru, cancer registry and mortality-related data collection is mainly managed through the mortality database of the Ministry of Health (SINADEF) [15]. Following the implementation of SINADEF in 2016, the quality of death data improved markedly by eliminating the effect of illegible handwriting, reducing the use of ill-defined conditions through a pop-up warning dialog box, not allowing blank spaces between event lines, and decreasing the use of abbreviations. However, the coverage and quality of these registries vary significantly between regions. While Lima and the coastal regions have a more developed health infrastructure and relatively complete registries, the highland and rainforest regions face challenges related to underreporting of cases and limited capacity for death certification due to shortages of medical personnel and technological resources.

The number of deaths was categorized into 18 age groups (0–4, 5–9, 10–14, 15–19… 85+). Additionally, ages were further classified into two major groups: women under 50 years of age and women aged 50 years or older.

The population data used for the analyses were obtained from the estimates provided by the National Institute of Statistics and Informatics (INEI) and can be accessed via the following link: https://www.inei.gob.pe/media/MenuRecursivo/publicaciones_digitales/Est/Lib1702/libro.pdf. Similarly, the population data used for pr edictions were obtained from the Demographic Analysis Bulletin No. 39, which can also be found at the same INEI link: https://www.inei.gob.pe/media/MenuRecursivo/publicaciones_digitales/Est/Lib0466/Libro.pdf [16].

Age adjusted mortality rates

Mortality rates were calculated per 100,000 woman-years using Segi's world standard population [17] through the direct method. This method is widely used and is essential for making meaningful comparisons between populations of different age distributions, as it helps determine whether observed differences in mortality rates are due to actual factors or merely reflect variations in age distribution among the populations being compared.

Mortality trends were calculated using the Joinpoint Regression software, version 4.7.0 [18]. This model identifies significant changes in trends by calculating the Annual Percent Change (APC). APCs were considered statistically significant when the p-value was less than 0.05.

For provinces with more than two changes through joinpoints, the Average Annual Percent Change (AAPC) was calculated. The significance levels used were based on the Monte Carlo permutation model and the percentage change calculation, utilizing the logarithm of the rate ratio [19].

Predictions of mortality rates

Mortality rate predictions up to 2027 will be calculated using the Nordpred package in the R Studio software [20]. Breast cancer mortality projections were made using historical data from three consecutive periods: 2008–2012, 2013–2017, and 2018–2022. For the projections, it was decided to report only the first projected period (2023–2027) because it is closer to the historical data and therefore more reliable. The projection for this period is based on the absolute levels observed in recent years, conservatively adjusted to minimize possible random fluctuations or atypical effects of the last historical period.

Results

For all ages, in 2013, the departments with the highest mortality rates were Ica (9.47), Callao (8.36), Lambayeque (8.33), La Libertad (8.27), Piura (8.18), and Lima (8.09). By 2022, the departments of Ancash (9.95) and Tumbes (11.06) were added, with Tumbes reporting the highest mortality rate (Fig. 1a). For women under 50 years of age, in 2013, the departments with the highest mortality rates were Lambayeque (3.95), Madre de Dios (3.84), Ica (3.04), and Callao (2.93) (Fig. 1b). Lastly, for women over 50 years of age, in 2013, the departments with the highest mortality rates were Ica (35.2), Lima (33.78), La Libertad (31.85), Piura (31.71), and Callao (30.1). By 2022, the departments of Ancash (31.49) and Tumbes (43.66) were added, with Tumbes having the highest mortality rate (Fig. 1c).

Figure 2 illustrates the mortality trends in Peru and its regions from 2013 to 2022. The Joinpoint analysis identified a significant increase in mortality in Peru (APC = + 3.97, $p < 0.05$). Regionally, the coastal region showed no significant changes during the study period, while the Andean region reported a significant increase in mortality (APC = + 8.37, $p < 0.05$). Similarly, the jungle region also exhibited a significant increase in mortality (APC = + 11.55, $p < 0.05$) over the entire period.

Table 1 shows the estimated Average Annual Percent Change (AAPC) in breast cancer (BC) mortality for all ages between 2013 and 2022. Among the results, 10 departments exhibited significant increases in breast cancer mortality rates, with the most notable being Huancavelica (30.59%), Ayacucho (19.19%), and Loreto (19.04%).

Table 2 presents the AAPC for women under 50 years of age between 2013 and 2022. Significant upward trends were observed in Ayacucho (18.54%), Ancash (14.94%), and Huánuco (14.29%) throughout the entire time

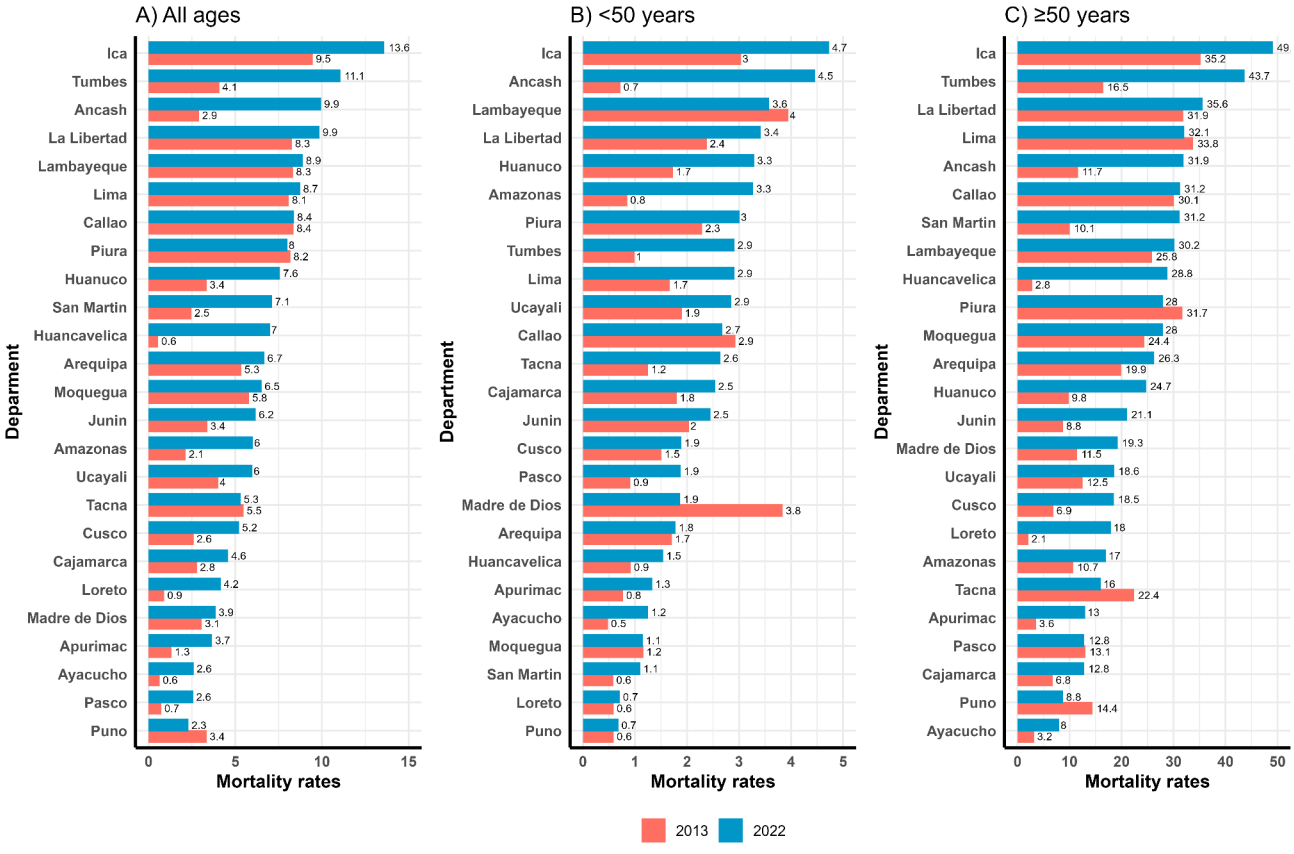

Fig. 1 Age-standardized (rates per 100,000 women-years, all ages, < 50 years, and ≥ 50 years) breast cancer in 2013 and 2022 in Peru

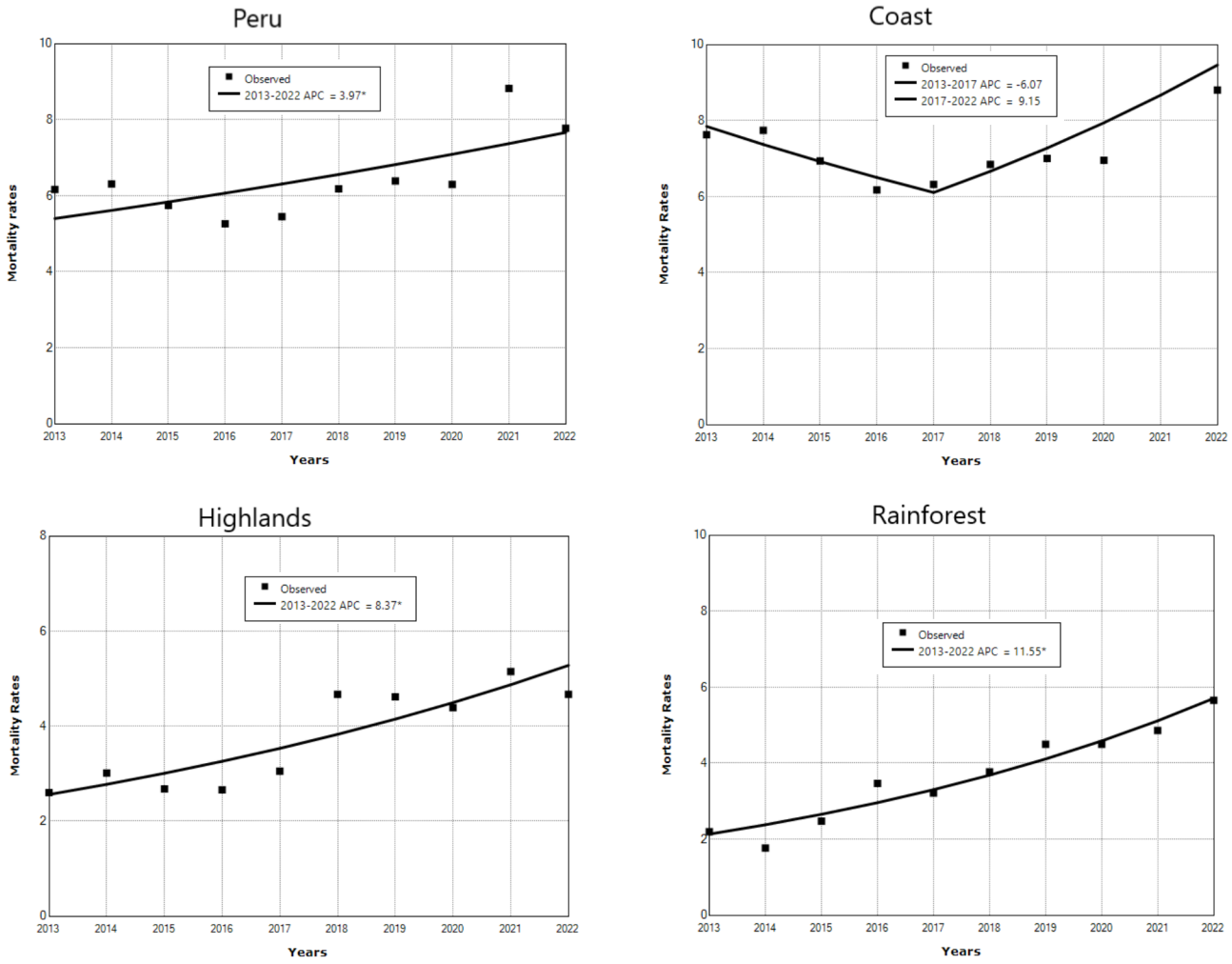

Fig. 2 Joinpoint analysis for breast cancer mortality in Peru, 2013–2022

interval. Lima experienced a significant downward trend from 2013 to 2017 (-16.69%), followed by an upward trend by 2022.

Table 3 highlights mortality rates and AAPC for women aged 50 years or older between 2013 and 2022. Significant upward trends were reported in Huancavelica (34.11%), Loreto (19.94%), Ayacucho (18.42%), Ancash (15.3%), Callao (13.05%), San Martín (10.77%), and Huánuco (9.54%).

Figure 3 shows the prediction for Peru in 2027. It shows that, for the next few years, Peru's mortality rate will increase to 8.7 deaths per 100,000 women.

Discussion

This study provides a detailed analysis of breast cancer mortality rates in Peru over the past decade, highlighting both observed trends and projections up to 2027. Our findings revealed an increase in mortality rates in most of the country's departments. The jungle and coastal regions reported the highest mortality rates during the study period, while the Andean region, despite initially showing lower rates, exhibited an upward trend. These results emphasize the heterogeneity in the evolution of breast cancer mortality rates across the country's regions, underscoring the need for strategies tailored to each area's specific characteristics to address existing disparities.

In contrast to our findings in Peru, where most regions have experienced an increase in breast cancer mortality rates over the past decade, studies conducted in Europe have documented a steady reduction in mortality over recent decades. For example, the European Union reported a decline in mortality rates, from 15.0 to 14.4 deaths per 100,000 women between 2012 and 2017, with projections for stabilization by 2025. The United Kingdom is expected to have the greatest reduction, with an estimated rate of 12.2 deaths per 100,000 women by 2025. Since 1994, approximately 470,000 deaths have been avoided in the European Union due to medical advances and early detection [21]. Furthermore, a study highlights

Table 1 Average annual percentage change and 95% confidence intervals (CI) for Age-Adjusted mortality rates from breast Cancer in Peru and its regions for women of all ages, 2013–2022

Geographical areas	Trend 1	APC 1	Trend 2	APC 2	Years	AAPC(95% CI)
Amazonas	2013-2022	8.5*(0.4,17.2)			2013-2022	8.5*(0.4,17.2)
Ancash	2013-2022	16.1*(8.9,23.9)			2013-2022	16.1*(8.9,23.9)
Apurímac	2013-2022	10.2(−0.6,22.1)			2013-2022	10.2(−0.6,22.1)
Arequipa	2013-2022	3.3(−1.6,8.6)			2013-2022	3.3(−1.6,8.6)
Ayacucho	2013-2022	19.2*(5.4,34.8)			2013-2022	19.2*(5.4,34.8)
Cajamarca	2013-2022	6.9*(3.3,10.7)			2013-2022	6.9*(3.3,10.7)
Callao	2013-2022	1.8(−1.5,5.3)			2013-2022	1.8(−1.5,5.3)
Cusco	2013-2022	12.7*(2.1,24.4)			2013-2022	12.7*(2.1,24.4)
Huancavelica	2013-2022	30.6*(16.1,46.8)			2013-2022	30.6*(16.1,46.8)
Huánuco	2013-2022	11.7*(5.9,17.8)			2013-2022	11.7*(5.9,17.8)
Ica	2013-2022	2.5(−1.5,6.7)			2013-2022	2.5(−1.5,6.7)
Junín	2013-2022	2.7(−3.1,8.9)			2013-2022	2.7(−3.1,8.9)
La Libertad	2013-2022	1.1(−1.6,3.9)			2013-2022	1.1(−1.6,3.9)
Lambayeque	2013-2022	−2.5(−8.5,3.9)			2013-2022	−2.5(−8.5,3.9)
Lima	2013-2018	−9.7(−22.6,5.3)	2013-2018	21.4*(0.6,46.4)	2013-2018	3.0(−6.0,12.8)
Loreto	2013-2022	19.0*(7.8,31.4)			2013-2022	19.0*(7.8,31.4)
Madre de Dios	2013-2022	1.0(−16.7,22.5)			2013-2022	1.0(−16.7,22.5)
Moquegua	2013-2022	7.6(−3.4,19.8)			2013-2022	7.6(−3.4,19.8)
Pasco	2013-2022	5.7(−7.1,20.3)			2013-2022	5.7(−7.1,20.3)
Piura	2013-2022	0.7(−3.1,4.7)			2013-2022	0.7(−3.1,4.7)
Puno	2013-2022	0.2(−8.9,10.2)			2013-2022	0.2(−8.9,10.2)
San Martín	2013-2022	10.3*(4.7,16.2)			2013-2022	10.3*(4.7,16.2)
Tacna	2013-2022	0.6(−7.8,9.8)			2013-2022	0.6(−7.8,9.8)
Tumbes	2013-2022	12.4*(1.2,24.9)			2013-2022	12.4*(1.2,24.9)
Ucayali	2013-2022	7.3(−3.5,19.4)			2013-2022	7.3(−3.5,19.4)

APC: Annual Percentage change

AAPC: Average Annual Percentage change

* p-value <0.05

the positive impact of organized breast cancer screening programs in Europe, emphasizing their effectiveness in increasing early detection and reducing mortality [22].

In comparison, the situation in Peru may reflect limited implementation of organized screening programs or inequitable access to oncology services. Although Plan Esperanza aimed to improve these areas, the results suggest that challenges remain in terms of coverage and effectiveness of interventions, particularly in regions with limited access to health services. Furthermore, it is important to consider that in some regions, the initial low rates likely reflect underreporting of mortality due to multiple factors, including limitations in health infrastructure and the COVID-19 pandemic in 2020.

The patterns observed in Peru also reflect heterogeneous trends in breast cancer mortality rates reported in Latin America. A study covering 1997 to 2017 on breast cancer mortality in the region revealed important differences between countries: while Guatemala, El Salvador, and Nicaragua experienced increases in mortality rates, Argentina, Chile, and Uruguay showed declining trends over the same period [4]. Additionally, a study covering 1990 to 2019 emphasized how demographic inequalities and healthcare infrastructure have shaped these trends [23]. For example, countries like Argentina, with more robust healthcare systems and widespread access to organized screening programs, have significantly reduced breast cancer mortality rates. In contrast, in Central American countries with limited healthcare infrastructure, mortality rates continue to rise [23].

These differences highlight disparities in healthcare systems, access to oncological services, and early detection approaches in the region. In the case of Peru, our findings align with challenges observed in countries with restricted access to timely detection and treatment services. The persistent inequality in mortality rates across the country's geographical regions suggests the need to strengthen healthcare infrastructure and expand effective prevention and cancer management programs, drawing inspiration from strategies successfully implemented in countries such as Argentina and Uruguay.

In Peru, a study conducted between 2003 and 2017 reported significant regional variations. During this period, the highest rates were observed in the coastal regions, particularly in Lima, Callao, and Tumbes, while the lowest rates were recorded in Apurímac and

Table 2 Average annual percentage change and 95% confidence intervals (CI) for Age-Adjusted mortality rates from breast Cancer in Peru and its regions for women under 50 years of age, 2013–2022

Regions	Trend 1	APC 1	Trend 2	APC 2	Years	AAPC (95% CI)
Amazonas	2013-2022	9.5(−2.4,23.0)			2013-2022	9.5(−2.4,23.0)
Ancash	2013-2022	14.9*(5.3,25.5)			2013-2022	14.9*(5.3,25.5)
Apurímac	2013-2022	6.0(−9.0,23.4)			2013-2022	6.0(−9.0,23.4)
Arequipa	2013-2020	14.4*(3.1,27.0)	2020-2022	−29.7(−67.2,50.5)	2013-2022	2.7(−11.0,18.5)
Ayacucho	2013-2022	18.5*(3.7,35.6)			2013-2022	18.5*(3.7,35.6)
Cajamarca	2013-2022	4.5(−3.2,12.8)			2013-2022	4.5(−3.2,12.8)
Callao	2013-2022	3.8(−4.3,12.7)			2013-2022	3.8(−4.3,12.7)
Cusco	2013-2022	11.5(−1.0,25.7)			2013-2022	11.5(−1.0,25.7)
Huancavelica	2013-2022	−0.3(−13.4,14.8)			2013-2022	−0.3(−13.4,14.8)
Huánuco	2013-2022	14.3*(1.3,29.0)			2013-2022	14.3*(1.3,29.0)
Ica	2013-2022	−0.0(−8.3,9.0)			2013-2022	−0.0(−8.3,9.0)
Junín	2013-2022	0.3(−7.0,8.1)			2013-2022	0.3(−7.0,8.1)
La Libertad	2013-2022	1.5(−2.0,5.1)			2013-2022	1.5(−2.0,5.1)
Lambayeque	2013-2022	−3.4(−12.5,6.6)			2013-2022	−3.4(−12.5,6.6)
Lima	2013-2017	−16.7(−46.6,29.9)	2017-2022	35.7*(4.9,75.6)	2013-2022	9.3(−9.3,31.6)
Loreto	2013-2022	15.2(−2.3,35.9)			2013-2022	15.2(−2.3,35.9)
Madre de Dios	2013-2020	7.1(−5.5,21.3)	2020-2022	−43.6(−85.9,124.8)	2013-2022	−7.2(−27.4,18.7)
Moquegua	2013-2022	−0.2(−11.6,12.7)			2013-2022	−0.2(−11.6,12.7)
Pasco	2013-2022	−0.0(−9.4,10.3)			2013-2022	−0.0(−9.4,10.3)
Piura	2013-2022	1.6(−1.9,5.3)			2013-2022	1.6(−1.9,5.3)
Puno	2013-2022	1.9(−12.3,18.3)			2013-2022	1.9(−12.3,18.3)
San Martín	2013-2022	12.2(−0.5,26.5)			2013-2022	12.2(−0.5,26.5)
Tacna	2013-2022	6.5(−6.0,20.7)			2013-2022	6.5(−6.0,20.7)
Tumbes	2013-2022	7.3(−3.9,19.8)			2013-2022	7.3(−3.9,19.8)
Ucayali	2013-2022	7.1(−4.2,19.9)			2013-2022	7.1(−4.2,19.9)

APC: Annual Percentage change

AAPC: Average Annual Percentage change

* p-value <0.05

Huancavelica. However, the analysis of our study period (2013–2022) revealed a shift in patterns, with Ica, La Libertad, and Tumbes showing the highest mortality rates, while Ayacucho, Pasco, and Puno recorded the lowest [10]. These findings underline the need to develop regionally differentiated strategies focused on strengthening healthcare systems in the most vulnerable regions to address disparities in breast cancer mortality in the country.

Our results showed regional disparities in the evolution of breast cancer mortality. These differences could be influenced by the socioeconomic characteristics and level of development of each region. The coastal region, which includes cities such as Lima and Callao, is the most urbanized in the country and concentrates a higher proportion of specialized medical facilities [24], which could explain its relatively high rates of early detection, resulting in a reduction in mortality. On the contrary, in the highlands and rainforest regions, where significant increases in breast cancer mortality have been shown, it could be mainly influenced by access to health services [25], due to its rugged geography, greater population dispersion and limited resources in medical infrastructure [26]. In addition, these regions have been historically underserved [27], contributing to under-reporting of deaths and late diagnosis. In recent years, the COVID-19 pandemic exacerbated these disparities, disrupting health services across the country [28], but with a disproportionate impact on the most underserved regions. These differences highlight the need for targeted public interventions to address inequities in access to early detection and treatment of breast cancer. In addition, these regional disparities may be due to the Human Development Index (HDI). According to the HDI, the coastal region has high values due to its urbanization, better sanitation infrastructure and higher per capita income. In contrast, the highlands and jungle region have significantly lower HDI values [29], reflecting lower levels of human development, limited access to specialized medical services, and higher poverty rates. These disparities in human development correlate with the lack of timely access to early detection and treatment programs for breast cancer [30], which contributes to differences in mortality trends. Globally, studies in Latin America and other developing regions have highlighted how fragile health systems and socioeconomic inequalities affect

Table 3 Average annual percentage change and 95% confidence intervals (CI) for Age-Adjusted mortality rates from breast Cancer in Peru and its regions for women ≥50 years of age, 2013–2022

Regions	Trend 1	APC 1	Trend 2	APC 2	Years	AAPC (95% CI)
Amazonas	2013-2022	5.0(−4.0,14.9)			2013-2022	5.0(−4.0,14.9)
Ancash	2013-2022	15.3*(6.2,25.2)			2013-2022	15.3*(6.2,25.2)
Apurímac	2013-2022	12.5(−2.3,29.5)			2013-2022	12.5(−2.3,29.5)
Arequipa	2013-2022	2.3 (−2.3,7.1)			2013-2022	2.3 (−2.3,7.1)
Ayacucho	2013-2022	18.4*(1.9,37.7)			2013-2022	18.4*(1.9,37.7)
Cajamarca	2013-2022	8.2*(2.8,13.8)			2013-2022	8.2*(2.8,13.8)
Callao	2013-2022	1.1(−2.4,4.8)			2013-2022	1.1(−2.4,4.8)
Cusco	2013-2022	13.1*(2.3,25.0)			2013-2022	13.1*(2.3,25.0)
Huancavelica	2013-2022	34.1*(20.7,49.0)			2013-2022	34.1*(20.7,49.0)
Huánuco	2013-2022	9.5*(1.6,18.1)			2013-2022	9.5*(1.6,18.1)
Ica	2013-2022	3.4(−0.3,7.2)			2013-2022	3.4(−0.3,7.2)
Junín	2013-2022	3.6(−2.7,10.3)			2013-2022	3.6(−2.7,10.3)
La Libertad	2013-2022	0.9(−2.3,4.2)			2013-2022	0.9(−2.3,4.2)
Lambayeque	2013-2022	−2.1(−8.2,4.4)			2013-2022	−2.1(−8.2,4.4)
Lima	2013-2018	−9.5(−20.1,2.4)	2018-2022	16.1(−0.5,35.5)	2013-2022	1.1(−6.1,8.9)
Loreto	2013-2022	19.9*(6.4,35.2)			2013-2022	19.9*(6.4,35.2)
Madre de Dios	2013-2022	−8.4(−23.9,10.2)			2013-2022	−8.4(−23.9,10.2)
Moquegua	2013-2022	6.9(−6.2,21.9)			2013-2022	6.9(−6.2,21.9)
Pasco	2013-2022	6.0(−5.5,18.8)			2013-2022	6.0(−5.5,18.8)
Piura	2013-2022	0.5(−4.5,5.7)			2013-2022	0.5(−4.5,5.7)
Puno	2013-2022	−0.7(−9.3,8.7)			2013-2022	−0.7(−9.3,8.7)
San Martín	2013-2022	10.8*(3.8,18.2)			2013-2022	10.8*(3.8,18.2)
Tacna	2013-2022	−2.2(−12.1,8.8)			2013-2022	−2.2(−12.1,8.8)
Tumbes	2013-2022	11.6(−2.4,27.6)			2013-2022	11.6(−2.4,27.6)
Ucayali	2013-2022	5.0(−7.3,18.9)			2013-2022	5.0(−7.3,18.9)

APC: Annual Percentage change

AAPC: Average Annual Percentage change

* p-value <0.05

early detection and treatment of cancer diseases [31, 32]. Incorporating indicators such as the HDI allows us to place Peruvian disparities in an international framework, facilitating a broader discussion of inequalities and fragilities in health systems. This approach also highlights the need for integrated strategies that combine improvements in health infrastructure with interventions targeting the social determinants of health.

Peru reported a fluctuation in national breast cancer mortality rates between 2021 and 2022, which could be attributed to multiple factors related to the COVID-19 pandemic. In 2021, the impact of the pandemic was still significant, with two major waves of contagion that severely affected the Peruvian health system [33]. These waves not only reduced the capacity to make early diagnoses and provide adequate treatment for breast cancer [34], but also limited death certification services [35, 36], which may have led to over- or under-registration of cancer deaths. In contrast, relative improvement in health system management was observed in 2022, thanks to progress in the implementation of COVID-19 vaccination programs and the responsiveness of medical services [37]. This probably contributed to better care of breast cancer patients and more accurate certification of deaths. However, this decline should be interpreted with caution, as it may reflect not only improvements in health management, but also a possible cumulative delay in diagnosis and treatment that could manifest itself in higher mortality rates in future years.

The National Plan for the Prevention and Control of Breast Cancer in Peru (2017–2021) establishes key strategies to address this disease. Among its priorities are improving the quality and coverage of mammographic screening, developing standards and technical guidelines, optimizing pathology network management, and implementing a monitoring system [38]. Evidence supports initiating mammographic screening at age 40 for women at average risk of developing breast cancer, as an increase in breast cancer mortality rates has been observed in women over 50 years of age in Peru, with the most affected regions being Huancavelica, Loreto, and Ayacucho.

Breast cancer mortality rates decreased during the initial years of the study, possibly due to the implementation of the Plan Esperanza, which contributed to improvements in early diagnosis and the certification of deaths

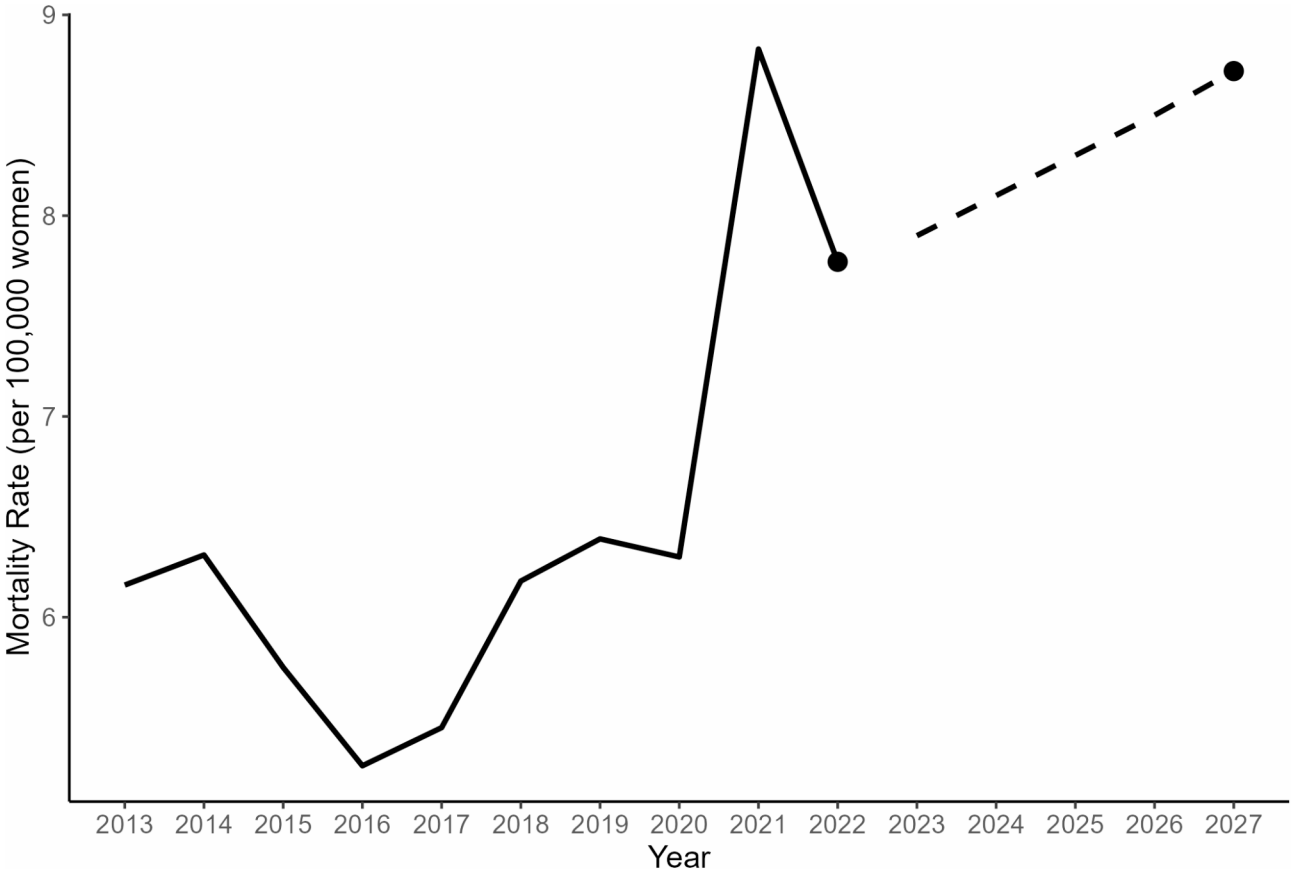

Fig. 3 Breast cancer mortality rate predictions for the year 2027 for Peru

in several provinces of Peru. However, health policies, such as those implemented through Plan Esperanza [12], require considerable time to significantly impact mortality trends. Access to effective treatments, such as chemotherapy, radiotherapy and immunotherapy, plays a crucial role in reducing mortality rates. In Peru, the availability and distribution of these treatments varies widely between regions. For example, Lima have relatively better access to advanced therapies, while in the highland and rainforest regions, access is limited [39] due to insufficient healthcare infrastructure and economic constraints.

A study reported significant reductions in the number of screenings and breast cancer diagnoses during the pandemic year, which led to an increase in global mortality rates [40]. In Peru, two major COVID-19 waves were recorded during this period, which were associated with higher breast cancer mortality rates. Additionally, the pandemic severely impacted early breast cancer detection. In 2020, only 4.3% of breast cancer cases in Peru were diagnosed at an in situ stage, while 48.6% were diagnosed at advanced stages (III and IV) [34]. This delay in diagnosis underscores the importance of strengthening screening programs and ensuring their continuity, even in emergency health situations.

The present study projects a significant increase in breast cancer mortality rates in Peru by 2027. This finding highlights persistent inequalities in access to screening and treatment services in the country, especially in the most disadvantaged regions. Despite efforts made through national programs such as Plan Esperanza, the results suggest that these initiatives have failed to reverse the upward trend in mortality rates, particularly in areas where access to comprehensive care remains limited. This increase could be due to late diagnosis, as a significant percentage of cases in Peru continue to be detected in advanced stages, as shown by previous studies [34].

This study presents several limitations, many of which are common in research based on the analysis of secondary data. First, the quality and integrity of death records can vary significantly between regions, potentially introducing biases in mortality estimates. Missing data and the lack of specific information about tumor characteristics, such as histopathology and anatomical subsites, limit our ability to conduct more detailed analyses that could enhance the interpretation of the results. Additionally, the capacity to evaluate individual factors that may influence mortality rates is restricted.

Another significant limitation is the absence of national-level incidence data, which prevents a more comprehensive analysis of the disease burden and the relationship between incidence and mortality in the country. This gap limits the ability to assess the effectiveness of detection and treatment programs implemented in different regions.

Finally, the impact of the COVID-19 pandemic on data collection and healthcare services must be considered as a factor that could have affected both mortality records and the capacity for early diagnosis and timely treatment. This may have caused fluctuations in mortality rates and complicated the precise interpretation of observed trends.

Conclusion

The study concludes that although breast cancer mortality among Peruvian women is increasing, it remains lower than in other Latin American countries. However, regional disparities persist. The highest rates are recorded in the coastal region, where they declined after 2013 but increased again following 2020, while rates in the Rainforest region have shown a steady rise. These differences may be attributed to underreporting due to the pandemic and unequal access to diagnosis and treatment, highlighting the need for targeted public health interventions in Peru.

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Author contributions
Conceived and designed the idea: MKTP, GSR. Had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis: MKTP, GSR, CQV. Contributed to the writing of the manuscript: All authors.Contributed to the statistical analysis: JSTR. Critical revision of the manuscript: JYM, JSTR. Approval of the submitted and final version: All authors.

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Data availability
The datasets generated and/or analysed during the current study are available in the following link: https://www.minsa.gob.pe/portada/transparencia/solicitud/.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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