RESEARCH ARTICLE

Editorial Process: Submission:05/13/2025 Acceptance:01/26/2026 Published:02/09/2026

Sex Differences in Gastric Cancer Mortality in Ecuador: A Joinpoint Regression Analysis

J Smith Torres-Roman[1]*, Katherine Simbaña-Rivera[2,3], Mabel R Challapa-Mamani[2,4], Jhon Guerrero[5], Joseph Ariel Guerrero González[6], Julio A Poterico[7], Jorge Ybaseta-Medina[8], Gabriel De la Cruz-Ku[9]

Abstract

Background: Gastric cancer (GC) remains a leading cause of cancer-related mortality worldwide. In Ecuador, GC was the primary cause of cancer-related deaths until 2013. Despite a general decline in GC mortality, significant regional and sex-based disparities persist. This study aimes to analyze trends in GC mortality by sex from 2004 to 2021 using Joinpoint regression analysis. **Methods:** We analyzed GC mortality data from the National Institute of Statistics and Censuses (INEC) for the period 2004–2021. Age-standardized mortality rates (ASMR) were calculated using the SEGI world standard population. Joinpoint regression was applied to estimate the annual percentage change (APC) in mortality trends. Additionally, we examined regional differences and identified provinces with the highest mortality rates based on the average from 2017–2021. **Results:** GC mortality rates declined nationally, with an annual decrease of 1.9% in men and 2.2% in women. However, significant regional disparities were observed. In the Coastal region, mortality rates among men showed no significant decline, while the rates for women decreased by 2.4% annually. In the Highlands, GC mortality declined by 1.8% in men and 2.4% in women, while in the Amazon region, the decrease was 2.8% and 3.0% per year for men and women, respectively. The highest GC mortality rates in 2021 were observed in Bolívar, Santo Domingo, and Cotopaxi among men, and in Zamora Chinchipe, Cotopaxi, and Loja among women. Notably, while most provinces experienced a decline, Esmeraldas reported an increasing mortality trend of 2.8% annually from 2004 to 2021. **Conclusions:** Despite an overall decline in GC mortality in Ecuador, disparities persist across regions and between sexes. The faster decline in female mortality suggests potential differences in risk factors, healthcare access, or early detection efforts.

Keywords: Gastric cancer- mortality rates- trends- spatial analysis- Ecuador

Asian Pac J Cancer Prev, **27 (2)**, 749-756

Introduction

Gastric cancer (GC) is a major global health concern, ranking among the top ten causes of cancer-related deaths in both men and women worldwide [1]. According to GLOBOCAN 2022, GC was the third leading cause of cancer-related mortality, accounting for approximately 770,000 deaths, and the fifth most commonly diagnosed malignancy, with nearly 1 million new case [1, 2]. Despite a global decline in GC incidence and mortality, largely attributed to a reduced prevalence of Helicobacter pylori infection the primary risk factor [3-5] substantial geographic and demographic disparities persist.

Men consistently exhibit higher GC incidence and mortality rates than women [6]. In Central and South America, GC remains a significant public health challenge, ranking as the fifth most commonly diagnosed cancer. Notably, incidence rates in this region are significantly higher in men than in women [2].

In Ecuador, GC was the leading cause of cancer-related deaths until 2013, responsible for approximately 19,000 deaths between 2004 and 2015 [7]. The national age-standardized mortality rate (ASMR) during this period was 10.9 deaths per 100,000 population, with higher rates in men (12.0 per 100,000) compared to women (9.4 per 100,000). While crude mortality rates have declined for both sexes, the decrease in incidence has been more pronounced in women. Additionally, there is considerable

*[1]Escuela de Posgrado, Universidad Tecnológica del Perú, Lima, Peru. [2]Latin American Network for Cancer Research (LAN–CANCER), Lima, Peru. [3]Center for Health Research in Latin America (CISeAL), Faculty of Medicine, Pontifical Catholic University of Ecuador (PUCE), Quito, Ecuador. [4]Escuela de Medicina, Universidad Cesar Vallejo, Trujillo, Peru. [5]Scientific Association of Medical Students, Universidad Central del Ecuador, Quito, Ecuador. [6]Faculty of Medical Sciences, Universidad Central del Ecuador, Quito, Ecuador. [7]Universidad de Huánuco, Huánuco, Peru. [8]Universidad Nacional San Luis Gonzaga de Ica, Ica, Peru. [9]Universidad Científica del Sur, Lima, Peru. *For Correspondence: jstorresroman@gmail.com*

variation in GC mortality across Ecuadorian provinces [7, 8].

Understanding sex-based disparities in GC mortality trends is essential for developing targeted public health strategies. This study aimed to analyze GC mortality trends by sex in Ecuador from 2004 to 2021 using Joinpoint regression analysis. Additionally, we examined regional variations and spatial distribution patterns at different altitudes from 2016 to 2021 to provide insights into potential environmental or healthcare access influences.

Materials and Methods

Source of information

This is an ecological observational time series study. This study analyzed gastric cancer (GC) mortality trends in Ecuador from 2004 to 2021. Mortality data were obtained from the National Institute of Statistics and Censuses (INEC), which records deaths based on official death certificates issued by physicians following World Health Organization (WHO) standards. GC-related deaths were identified using the International Classification of Diseases, 10th Revision (ICD-10, code C16) [9].

Population denominators were extracted from INEC demographic projections published by the National Secretariat of Planning. Ecuador consists of 24 provinces across four geographical regions: Coastal, Highlands, Amazon, and Insular. As of the most recent projections, the country's population exceeded 17.7 million, with over 8.7 million men.

Statistical analysis

[10] We performed an analysis with the average of the last 5 years (2017-2021) for GC mortality rates in Ecuador and its provinces. The analysis was conducted using the Joinpoint Regression Program (version 4.7.0, National Cancer Institute). Mortality counts, population estimates, and the Segi world standard population were used to compute age-standardized mortality rates (ASMRs) per 100,000 inhabitants [11, 12]. The Joinpoint model was fitted under the assumption of uncorrelated errors and applied a log transformation [ln(y) = xb], allowing for the interpretation of the slope as the annual percent change (APC). The Monte Carlo permutation method was used to determine the optimal number and location of joinpoints. The model assumed uncorrelated errors, and standard errors were calculated internally by the software based on input data. APC estimates with p-values <0.05 were considered statistically significant.

Results

Figure 1 presents the mortality rates for gastric cancer in Ecuadorian provinces, comparing the first year (2004)

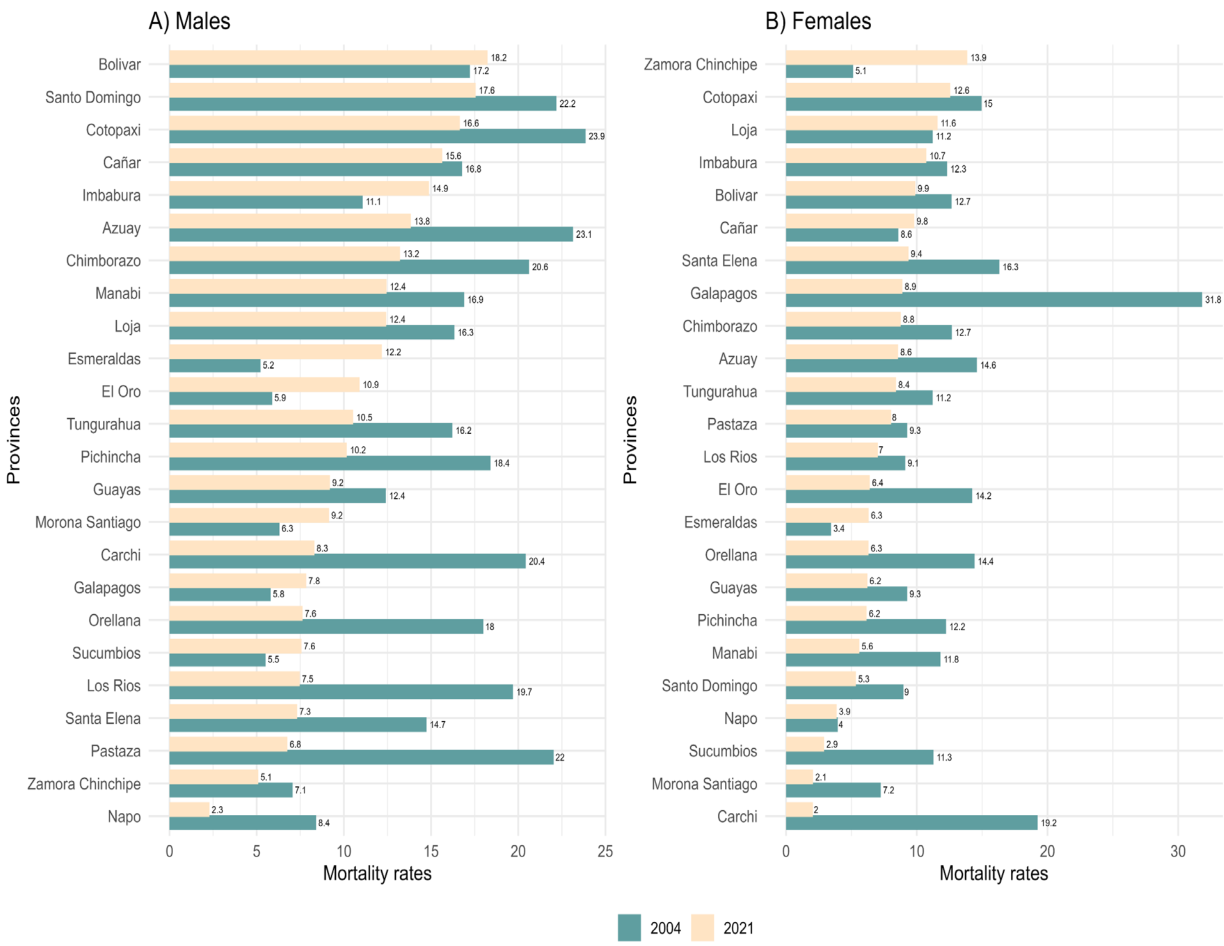

Figure 1. Age-Standardized (SEGI's World Standard Population) Gastric Cancer Mortality Rates per 100,000 in 2004 and Predicted for 2021 in Ecuador and Its Provinces

and the last year (2021) of the study period. Among males, seventeen provinces reported lower mortality rates in 2021 compared to 2004. In 2004, the highest mortality rates were observed in Cotopaxi (23.9 per 100,000), Azuay (23.1), and Santo Domingo (22.2); whereas in 2021 were observed in the provinces of Bolívar (18.2), Santo Domingo (17.6), and Cotopaxi (16.6). Among females, twenty provinces reported lower mortality rates in 2021 compared to 2004. In 2004, the highest mortality rates were observed in Galapagos (31.8 per 100,000), Carchi (19.2), and Santa Elena (16.3); whereas in 2021, the provinces with the highest mortality rates were Zamora Chinchipe (13.9), Cotopaxi (12.6), and Loja (11.6).

Among men, the national mortality rate declined from 14.62 to 11.10 per 100,000, with an Average Annual Percent Change (AAPC) of −1.9% (95% CI: −2.3 to −1.4; $p < 0.05$). In the Highlands, the decline was even more pronounced (AAPC = −2.4%; 95% CI: −3.1 to −1.7), while the Amazon region (Orient) also experienced a significant decrease (AAPC = −2.8%; 95% CI: −5.2 to −0.4). In contrast, the Coastal region presented a more complex trend: an initial non-significant increase between 2004 and 2006 (+11.2%; 95% CI: −3.3 to 28.0), followed by two significant decreasing segments from 2006 to 2013 (APC = −3.7%; 95% CI: −5.8 to −1.6) and from 2013 to 2021 (APC = −1.2%; 95% CI: −2.6 to −0.2). However, the overall AAPC for the Coastal region in men was not statistically significant (−0.9%; 95% CI: −2.6 to 0.9). Among women, the national mortality rate declined from 10.72 to 7.19 per 100,000. The trend was characterized by a significant decline from 2004 to 2016 (APC = −3.2%; 95% CI: −3.9 to −2.4), followed by a plateau from 2016 to 2021 (APC = +0.1%; 95% CI: −2.7 to 2.9), resulting in an overall AAPC of −2.2% (95% CI: −3.1 to −1.3; $p < 0.05$). All three geographic regions showed statistically significant decreases in female mortality: Coastal (AAPC = −2.6%; 95% CI: −3.4 to −1.7), Highlands (AAPC = −2.8%; 95% CI: −3.4 to −2.1), and Orient (AAPC = −4.0%; 95% CI: −7.0 to −0.9) (Table 1 and Figure 2).

Table 2 presents the annual percentage change in mortality rates by province. At the provincial level, the most significant declines in gastric cancer mortality among men were observed in Azuay (APC: −3.0%; 95% CI: −4.5 to −1.4), Carchi (−3.2%; 95% CI: −5.6 to −0.7), Chimborazo (−1.9%; 95% CI: −3.5 to −0.3), Guayas (−3.2%; 95% CI: −4.2 to −2.2), Los Ríos (−3.2%; 95% CI: −4.7 to −1.6), and Santa Elena (−5.5%; 95% CI: −8.7 to −2.3). In contrast, Esmeraldas experienced a significant increase in mortality from 2015 to 2021 (APC: +19.9%; 95% CI: 9.5 to 31.3), while Sucumbíos showed a marked decline from 2006 to 2019 (−11.8%; 95% CI: −14.0 to −8.5). Among women, the provinces with the steepest and statistically significant reductions were Carchi (−5.5%; 95% CI: −7.7 to −3.2), Chimborazo (−3.1%; 95% CI: −5.0 to −1.1), Cotopaxi (−3.3%; 95% CI: −5.3 to −1.3), El Oro (−3.5%; 95% CI: −5.0 to −2.0), Guayas (−3.3%; 95% CI: −4.3 to −2.2), Pichincha (−2.8%; 95% CI: −4.7 to −0.8), and Tungurahua (−3.3%; 95% CI: −5.1 to −1.6). Esmeraldas was the only province with a significant increase in female mortality (APC: +2.8%; 95% CI: 0.2 to 5.5).

Discussion

Our study found a significant decline in gastric cancer mortality in Ecuador between 2004 and 2021, with an annual decrease of 1.9% in men and 2.2% in women. This downward trend, more pronounced among women, aligns with global patterns but also reveals persistent regional disparities. The Coastal region showed limited reductions, particularly in men, while the Highlands and Orient regions experienced more notable declines. These differences may reflect variations in healthcare access, early detection practices, and exposure to key risk factors such as Helicobacter pylori (H. pylori). In Ecuador, the prevalence among asymptomatic individuals varies between 47.7% and 62.7%, and it increases substantially with age, exceeding 90% in older adult [13, 14]. These findings emphasize the critical role of H. pylori control in addressing GC. Efforts to reduce its prevalence, coupled with early detection and targeted interventions, could significantly impact the burden of GC in Ecuador. The persistent regional disparities in H. pylori prevalence and its direct correlation with GC incidence underscore the need for comprehensive public health strategies tailored to high-risk populations.

And at the national level, in the context of the downward trend in gastric cancer rates, it is relevant to consider the specific data from Quito between 1985 and 2013. Age- and sex-standardized incidence rates have been

Table 1. Mortality Trends for Gastric Cancer in Ecuador and Its Regions: Average Annual Percentage Change (AAPC) and 95% confidence interval (95% CI) for the period 2004–2021

Men	2004	2021	Year	APC	Year	APC	Year	APC	Average APC (CI 95%)
Ecuador	14.62	11.1	2004−2021	−1.9*(−2.3,−1.4)					−1.9*(−2.3,−1.4)
Coastal	12.06	9.94	2004−2006	11.2(−3.3, 28.0)	2006−2013	−3.7*(−5.8,−1.6)	2013−2021	−1.2*(−2.6,−0.2)	−0.9(−2.6, 0.9)
Highlands	18.25	12.77	2004−2021	−2.4*(−3.1,−1.7)					−2.4*(−3.1,−1.7)
Orient	7.45	6.73	2004−2021	−2.8*(−5.2,−0.4)					−2.8*(−5.2,−0.4)
Women									
Ecuador	10.72	7.19	2004−2016	−3.2*(−3.9,−2.4)	2016−2021	0.1 (−2.7, 2.9)			−2.2*(−3.1,−1.3)
Coastal	9.3	6.31	2004−2021	−2.6*(−3.4,−1.7)					−2.6*(−3.4,−1.7)
Highlands	12.12	8.18	2004−2021	−2.8*(−3.4,−2.1)					−2.8*(−3.4,−2.1)
Orient	6.17	5.44	2004−2021	−4.0*(−7.0,−0.9)					−4.0*(−7.0,−0.9)

APC, Annual Percent change; CI95%: Confidence interval 95% ;* p value <0.05

Table 2. Joinpoint Analysis for Mortality Rates for Ecuador Provinces from 2004 to 2021

Geographical area	2004	2021	Years	APC	Years	APC	Years	APC	Average APC(CI 95%)
					Men				
Azuay	23.14	13.84	2004-2021	−3.0*(−4.5,−1.4)					−3.0*(−4.5,−1.4)
Bolivar	17.23	18.24	2004-2021	0.1 (−2.3, 2.7)					0.1 (−2.3, 2.7)
Cañar	16.78	15.64	2004-2021	-0,6 (-3,7 - 2,6)					-0,6 (-3,7 - 2,6)
Carchi	20.43	8.31	2004-2021	−3.2*(−5.6, −0.7)					−3.2*(−5.6, −0.7)
Chimborazo	20.62	13.22	2004-2021	−1.9*(−3.5, −0.3)					−1.9*(−3.5, −0.3)
Cotopaxi	23.86	16.65	2004-2021	−1.4 (−3.5, 0.7)					−1.4 (−3.5, 0.7)
El Oro	5.89	10.9	2004-2021	−1.7 (−4.2, 0.8)					−1.7 (−4.2, 0.8)
Esmeraldas	5.22	12.18	2004-2012	8.2*(1.1, 15.9)	2012-2015	−27.7 (−59.1, 27.9)	2015-2021	19.9*(9.5, 31.3)	
Guayas	12.41	9.2	2004-2021	−3.2*−-4.2, −2.2)					−3.2*−-4.2, −2.2)
Imbabura	11.08	14.88	2004-2021	1.1 (−1.2, 3.5)					1.1 (−1.2, 3.5)
Loja	16.34	12.43	2004-2021	−1.0 (−2.6, 0.6)					−1.0 (−2.6, 0.6)
Los Rios	19.7	7.47	2004-2021	−3.2*(−4.7,−1.6)					−3.2*(−4.7,−1.6)
Manabi	16.9	12.45	2004-2013	−5.9*(−8.3,−3,5)	2013-2016	21.8 (−6.7, 59.0)	2016-2021	−4.7 (−9.3, 0.1)	
Morona Santiago	6.31	9.15	2004-2021	−1.6 (−5.7, 2.7)					−1.6 (−5.7, 2.7)
Napo	8.41	2.29	2004-2021	NA					NA
Orellana	18	7.63	2004-2021	NA					NA
Pastaza	22.03	6.76	2005-2021	−4.2 (−10.1, 2.1)					−4.2 (−10.1, 2.1)
Pichincha	18.41	10.17	2004-2011	−6.9*(−9.2,−4.6)	2011-2021	−0.6 (−1.9, 0.8)			
Santa Elena	14.74	7.32	2008-2021	−5.5*(−8.7, −2.3)					−5.5*(−8.7, −2.3)
Santo Domingo	22.19	17.56	2008-2021	−1.2 (−3.1, 0.7)					−1.2 (−3.1, 0.7)
Sucumbios	5.51	7.57	2004-2006	72.1 (−14.3, 245.6)	2006-2019	−11.8*(−14.0,−8,5)	2019-2021	51.3 (−20.9, 189.4)	
Tungurahua	16.22	10.53	2004-2006	13.4 (−19.0, 58.8)	2006-2009	−17.7 (−41.4, 15.6)	2009-2021	−0.1 (−2.2, 2.0)	
Zamora Chinchipe	7.06	5.09	2004-2021	NA					NA
					Women				
Azuay	14.6	8.57	2004-2021	−2.1*(−3.8,−0.5)					−2.1*(−3.8,−0.5)
Bolivar	12.66	9.89	2004-2021	−2.1(−5.7, 1.6)					−2.1(−5.7, 1.6)
Cañar	8.59	9.81	2004-2021	−1.4 (−3.9, 1.1)					−1.4 (−3.9, 1.1)
Carchi	19.24	2.05	2004-2021	−5.5*(−7.7, −3.2)					−5.5*(−7.7, −3.2)
Chimborazo	12.68	8.77	2004-2021	−3.1*(−5.0,−1.1)					−3.1*(−5.0,−1.1)

APC, Annual percentage change; CI 95%: Confidence interval 95%; * p value <0.05; NA, Not applicable

Table 2. Continued

Geographical area	2004	2021	Years	APC	Years	APC	Years	APC	Average APC(CI 95%)
					Women				
Cotopaxi	14.96	12.56	2004-2021	−3.3*(−5.3,−1.3)					−3.3*(−5.3,−1.3)
El Oro	14.24	6.4	2004-2021	−3.5*(−5.0, −2.0)					−3.5*(−5.0, −2.0)
Esmeraldas	3.44	6.32	2004-2021	2.8*(0.2, 5.5)					2.8*(0.2, 5.5)
Guayas	9.27	6.22	2004-2021	−3.3*(−4.3,−2.2)					−3.3*(−4.3,−2.2)
Imbabura	12.32	10.73	2004-2021	−0.9 (−2.7, 1.0)					−0.9 (−2.7, 1.0)
Loja	11.22	11.59	2004-2021	−1.7(−3.7, 0.3)					−1.7(−3.7, 0.3)
Los Rios	9.12	7.02	2004-2009	7.6 (−3.3, 19.8)	2009-2021	−5.8*(−8.2, −3.3)			−2.0 (−5.2, 1.3)
Manabi	11.81	5.61	2004-2021	−1.3 (−3.1, 0.6)					−1.3 (−3.1, 0.6)
Morona Santiago	7.24	2.06	2004-2021	NA					NA
Napo	3.95	3.87	2004-2021	NA					NA
Orellana	14.42	6.31	2004-2021	NA					NA
Pastaza	9.27	8.04	2004-2021	NA					NA
Pichincha	12.24	6.16	2004-2013	−6.4*(−9.1,−3.7)	2013-2021	1.6 (−1.8, 5.0)			−2.8*(−4.7,−0.8)
Santa Elena	16.32	9.37	2008-2021	−2.1(−7.8, 3.8)					−2.1(−7.8, 3.8)
Santo Domingo	8.98	5.34	2008-2021	−0.8 (−4.7, 3.2)					−0.8 (−4.7, 3.2)
Sucumbios	11.28	2.91	2005-2021	NA					NA
Tungurahua	11.21	8.41	2004-2021	−3.3*(−5.1,−1.6)					−3.3*(−5.1,−1.6)
Zamora Chinchipe	5.13	13.86	2004-2021	NA					NA

APC, Annual percentage change; CI 95%: Confidence interval 95%; * p value <0.05; NA, Not applicable

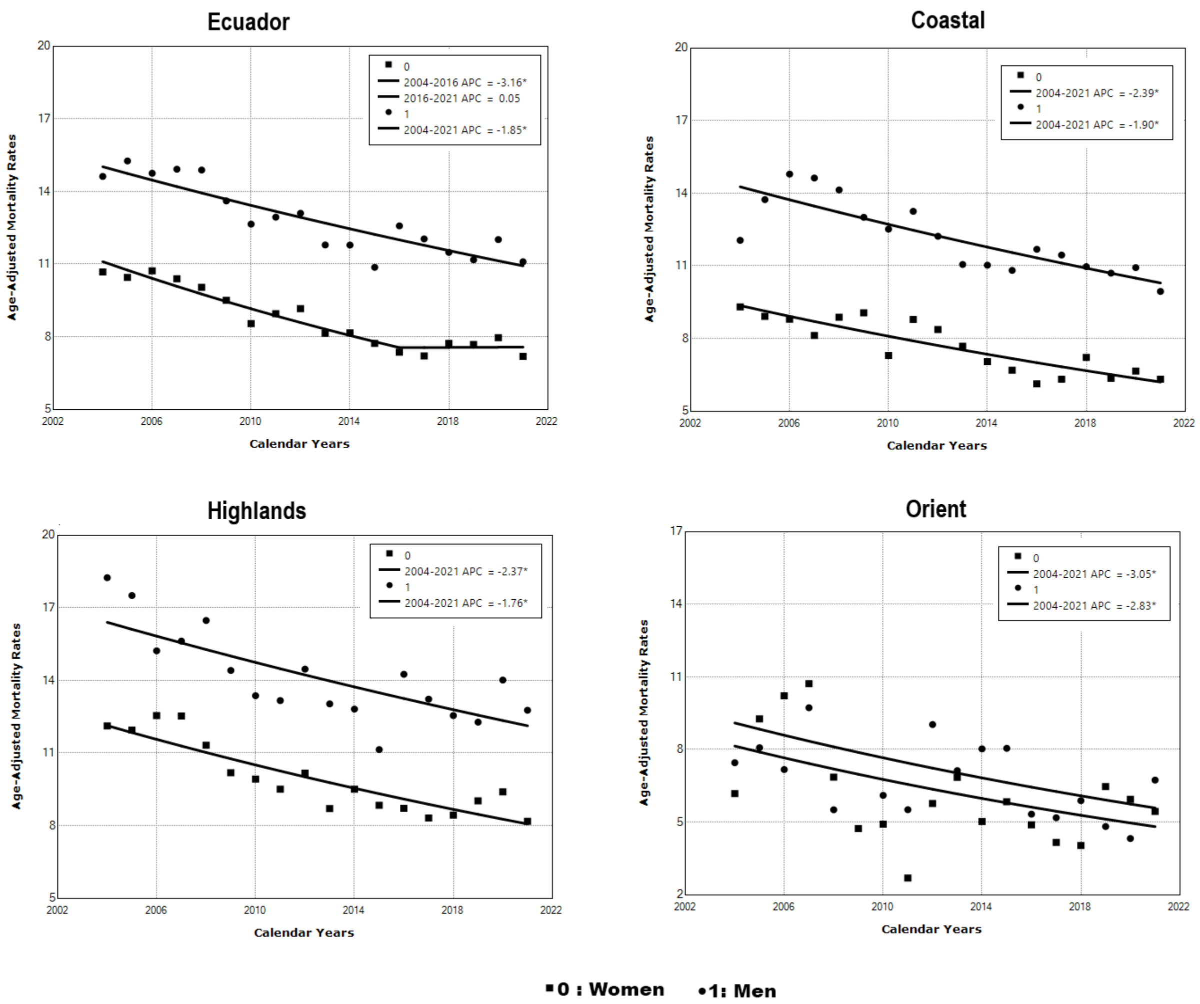

Figure 2. Joinpoint for Gastric Cancer Mortality Trends in Ecuador and Its Regions, 2004-2021.

observed to show a significant decrease among females, while no significant difference was observed for males [8]. These findings are linked to a previous publication in the National Tumor Registry, which explored differences in gastric cancer incidence among several cities, including Quito, Guayaquil, Manabí, Loja and Cuenca. This publication highlighted that the incidence rate in Loja was approximately double that of the other cities. Despite the methodological divergences between this study and the previous publication, Loja was also identified as one of the secondary groups with a high incidence of gastric cancer mortality [7].

The cost-effectiveness analysis of screening tests such as serum pepsinogen shows a favorable relationship in countries such as Mexico, especially when combined with upper gastrointestinal endoscopies performed every three years [15]. However, in Eastern countries such as Japan and South Korea, where the incidence of gastric cancer is higher, five-year survival rates of about 70%, and nearly 95% in early stages, have been achieved through more frequent screening, such as upper gastrointestinal endoscopy performed every two years [16]. In Asian countries, gastric cancer screening strategies and programs have shown good results in terms of early detection and REF survival [17, 18]. The effective implementation of these strategies in developing countries such as Ecuador requires budgeting and addressing determinants of health, which include behavioral, environmental, biological and social factors, which could represent a challenge to achieve the objectives established in the short and long term in terms of early detection of gastric cancer, while the results in terms of mortality are not clear [19].

In 2017, the Ministry of Public Health (MSP) of Ecuador launched the National Strategy for Comprehensive Cancer Care, which included gastric cancer screening for individuals over 50 years of age using serological tests for H. pylori, pepsinogen assays, and upper gastrointestinal endoscopy, aiming to detect the disease at early stages. The strategy also incorporated behavioral counseling as a key component of prevention and health promotion for this age group, implemented across primary care centers (first level) and general hospitals (second level), with diagnosis and treatment centralized in specialized tertiary centers. Strengthening cancer registries and expanding access to population-based screening—following models from countries with successful outcomes—could offer valuable guidance for Ecuador. By adopting a comprehensive, multi-level approach, the country could make significant progress in reducing the burden of gastric cancer.

Future recommendations

Given these gaps, expanding population-based screening particularly in high-mortality provinces and incorporating cost-effective tools such as pepsinogen testing and H. pylori eradication strategies could improve early diagnosis. Strengthening the cancer registry system and addressing behavioral, environmental, and socioeconomic determinants are also critical for long-term control. Ecuador's public health system must prioritize integrated, region-specific interventions to reduce disparities and improve gastric cancer outcomes.

Limitations

This study has several limitations inherent to its ecological design. Although it focused on detailing mortality trends, it did not include individual-level variables such as socioeconomic status, dietary habits, smoking, or exposure to Helicobacter pylori, which are key factors in the development of gastric cancer. Additionally, the data analyzed may be subject to underreporting or misclassification of causes of death, potentially affecting the accuracy of the calculated mortality rates. Finally, the study did not account for the impact of changes in screening programs, early detection efforts, or therapeutic advancements that may have influenced mortality rates during the study period. On the other hand, this study provides a comprehensive analysis of gastric cancer mortality trends in Ecuador, covering an extended period (2004–2021) with nationwide data from the National Institute of Statistics and Censuses (INEC). By disaggregating mortality rates by sex and geographic region, the study highlights critical disparities and population-specific patterns. The use of standardized methodologies and robust statistical tools, such as Joinpoint regression, ensures the reliability and global comparability of the findings. Additionally, the focus on a high-burden disease contributes valuable insights for public health planning and targeted interventions.

In conclusion, this study reported an overall decrease in gastric cancer mortality rates in Ecuador between 2004 and 2021, mainly in women. Heterogeneity in the evolution of mortality rates was reported in the different regions of the country. On the other hand, the highest mortality rates were reported in Bolívar, Santo Domingo, and Cotopaxi for males, and in Zamora Chinchipe, Cotopaxi, and Loja for females.

Author Contribution Statement

JSTR and KSR planned and designed the conduct of the study. KSR, JG, JAGG, were responsible for data collection. JSTR, MRCM, JG, and JAGG conducted and are responsible for the data analysis. GDK critically reviewed the study. All authors wrote and built the final manuscript. All authors approved the decision to submit the manuscript.

Acknowledgements

We thank the editing services of the Universidad Cientifica del Sur for reviewing our paper.

Data Availability

The datasets generated and/or analysed during the current study are available in the following links: https://www.ecuadorencifras.gob.ec/defunciones-generales/

Conflict of interest

The authors have no conflicts of interest to declare. All co-authors have seen and agree with the contents of the manuscript and there is no financial interest to report.

References

1. Ferlay J, Ervik M, Lam F, Colombet M, Mery L, Piñeros M, et al. Global Cancer Observatory: Cancer Today. Lyon, France: International Agency for Research on Cancer. 2022. [Cited 11 March, 2023]. Available from: https://gco.iarc.fr/today.
2. Bray F, Laversanne M, Sung H, Ferlay J, Siegel RL, Soerjomataram I, et al. Global cancer statistics 2022: Globocan estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin. 2024;74(3):229-63. https://doi.org/10.3322/caac.21834.
3. Park Y, Ki M. Population attributable fraction of helicobacter pylori infection-related gastric cancer in korea: A meta-analysis. Cancer Res Treat. 2021;53(3):744-53. https://doi.org/10.4143/crt.2020.610.
4. Huang JQ, Sridhar S, Chen Y, Hunt RH. Meta-analysis of the relationship between helicobacter pylori seropositivity and gastric cancer. Gastroenterology. 1998;114(6):1169-79. https://doi.org/10.1016/s0016-5085(98)70422-6.
5. Wang C, Yuan Y, Hunt RH. The association between helicobacter pylori infection and early gastric cancer: A meta-analysis. Am J Gastroenterol. 2007;102(8):1789-98. https://doi.org/10.1111/j.1572-0241.2007.01335.x.
6. Lou L, Wang L, Zhang Y, Chen G, Lin L, Jin X, et al. Sex difference in incidence of gastric cancer: An international comparative study based on the global burden of disease study 2017. BMJ Open. 2020;10(1):e033323. https://doi.org/10.1136/bmjopen-2019-033323.
7. Montero-Oleas N, Núñez-González S, Simancas-Racines D. The remarkable geographical pattern of gastric cancer mortality in ecuador. Cancer Epidemiol. 2017;51:92-7. https://doi.org/10.1016/j.canep.2017.10.014.
8. Corral Cordero F, Cueva Ayala P, Yépez Maldonado J, Tarupi Montenegro W. Trends in cancer incidence and mortality over three decades in quito - ecuador. Colomb Med (Cali). 2018;49(1):35-41. https://doi.org/10.25100/cm.v49i1.3785.
9. World Health Organization. International Classification of Disease and Related Health Problems: 10th Revision. Geneva; 1992. Available from:https://www.who.int/standards/classifications/classification-of-diseases/list-of-official-icd-10-updates. 1.
10. Ahmad OB, Boschi-Pinto C, Lopez AD, Murray CJ, Lozano R, Inoue M. Age standardization of rates: a new WHO standard. Geneva: World Health Organization. 2001 Jan 1;9(10):1-4.
11. National Cancer Institute. Joinpoint regression program. [Accesed 30 January, 2025] .Available from: https://surveillance.cancer.gov/help/joinpoint.
12. Kim HJ, Fay MP, Feuer EJ, Midthune DN. Permutation tests for joinpoint regression with applications to cancer rates. Stat Med. 2000;19(3):335-51. https://doi.org/10.1002/(sici)1097-0258(20000215)19:3<335::aid-sim336>3.0.co;2-z.
13. Bustos-Fraga S, Salinas-Pinta M, Vicuña-Almeida Y, de Oliveira RB, Baldeón-Rojas L. Prevalence of helicobacter pylori genotypes: Caga, vaca (m1), vaca (s1), baba2, dupa, icea1, oipa and their association with gastrointestinal

diseases. A cross-sectional study in quito-ecuador. BMC Gastroenterol. 2023;23(1):197. https://doi.org/10.1186/s12876-023-02838-9.
14. Albiño J, Vélez Zamora L. Prevalencia de helicobacter pylori en pacientes asintomáticos en ecuador. Revista Vive. 2021;4:193-202. https://doi.org/10.33996/revistavive.v4i11.87.
15. Enríquez-Sánchez LB, Gallegos-Portillo LG, Camarillo-Cisneros J, Cisneros-Castolo M, Montelongo-Santiesteban JJ, Aguirre-Baca DA, et al. Cost-benefit of serum pepsinogen screening for gastric adenocarcinoma in the mexican population. Rev Gastroenterol Mex (Engl Ed). 2022;87(3):285-91. https://doi.org/10.1016/j.rgmxen.2021.11.002.
16. Leung WK, Wu MS, Kakugawa Y, Kim JJ, Yeoh KG, Goh KL, et al. Screening for gastric cancer in asia: Current evidence and practice. Lancet Oncol. 2008;9(3):279-87. https://doi.org/10.1016/s1470-2045(08)70072-x.
17. Choi KS, Jun JK, Suh M, Park B, Noh DK, Song SH, et al. Effect of endoscopy screening on stage at gastric cancer diagnosis: Results of the national cancer screening programme in korea. Br J Cancer. 2015;112(3):608-12. https://doi.org/10.1038/bjc.2014.608.
18. Mabe K, Inoue K, Kamada T, Kato K, Kato M, Haruma K. Endoscopic screening for gastric cancer in japan: Current status and future perspectives. Dig Endosc. 2022;34(3):412-9. https://doi.org/10.1111/den.14063.
19. Yopa DS, Massom DM, Kiki GM, Sophie RW, Fasine S, Thiam O, et al. Barriers and enablers to the implementation of one health strategies in developing countries: A systematic review. Front Public Health. 2023;11:1252428. https://doi.org/10.3389/fpubh.2023.1252428.