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RESEARCH

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Evolution of mortality rates due to gastrointestinal bleeding in Peru and its geographic areas, 2003–2022

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Abstract

Background Gastrointestinal bleeding (GIB) is a common cause of emergency medical admissions and represents a significant public health issue due to its high morbidity and mortality. In Peru, information on mortality rates from GIB disaggregated by region and sex is limited. Therefore, this study aimed to analyze GIB mortality in the country between 2003 and 2022 using official data from the Peruvian Ministry of Health (MINSA).

Methods An observational, ecological, and descriptive time-series study was conducted using MINSA mortality records for gastrointestinal bleeding from 2003 to 2022. Mortality rates were analyzed by sex and geographical region. Trends were assessed using Poisson regression models in Joinpoint software, identifying significant changes over time.

Results Comparing the first (2003–2007) and last (2018–2022) five-year periods, a shift in the geographic burden was observed in coastal departments such as Ica and La Libertad to highland regions like Huancavelica, Puno, and Huánuco, which reported the highest mortality rates in the most recent period for both sexes. Between 2003 and 2022, GIB mortality rates declined significantly among men in Peru, with an annual percent change (APC) of – 2.2%. In contrast, no significant national trend was observed among women. Regional analysis showed a significant decline in the coastal region for both sexes, while no significant trends were detected in the highland or jungle regions. At the departmental level, three departments (Ica, La Libertad, and Piura) showed significant decreases among men, whereas two departments (Arequipa and La Libertad) showed reductions among women. Notably, Madre de Dios experienced a significant increase in GIB mortality among men.

Conclusion Comparing the first (2003–2007) and last (2018–2022) five-year periods, a shift in the geographic burden was observed in coastal departments such as Ica and La Libertad to highland regions like Huancavelica, Puno, and Huánuco, which reported the highest mortality rates in the most recent period for both sexes.

Keywords Gastrointestinal bleeding, Mortality, Peru

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Introduction

Gastrointestinal bleeding (GIB) is a clinical condition that is anatomically classified as upper or lower, depending on the origin of the bleeding relative to the ligament of Treitz. Upper gastrointestinal bleeding (UGIB) refers to bleeding proximal to the ligament of Treitz. It is further categorized as variceal or non-variceal, with the latter being the most common cause [1, 2]. Clinically, UGIB typically presents with hematemesis and, in some cases, melena, depending on the volume and rate of bleeding, which may compromise hemodynamic stability [3]. In contrast, lower gastrointestinal bleeding (LGIB) originates distal to the ligament of Treitz, with diverticular disease being its most frequent cause [4].

UGIB is one of the leading causes of emergency admissions in gastroenterology services worldwide. It generates high hospital demand, prolonged stays, and a significant increase in healthcare costs, making it a major public health concern [5]. Globally, the incidence of UGIB ranges from 15 to 172 cases per 100,000 population, with an estimated mortality with rates ranging from 0.9 to 9.8 per 100,000. LGIB has an approximate incidence of 20.5 to 87 cases per 100,000 population, and a mortality rate ranging between 0.8 and 3.5 per 100,000 population [6]. In Peru, approximately 1,030 deaths from GIB were reported in 2021, equivalent to a mortality rate of 3.3 deaths per 100,000 inhabitants. Although a decline in GIB-related mortality has been observed in recent decades, there is still no comprehensive study assessing GIB mortality across Peru's different geographic regions.

Several risk factors have been identified that increase the prevalence of GIB, including the use of anticoagulants, advanced age, a history of UGIB, and the use of high doses of nonsteroidal anti-inflammatory drugs (NSAIDs) [7]. In addition, certain factors are associated with higher mortality, such as in-hospital rebleeding, congestive heart failure, liver disease, renal disease, older age, comorbidities, lower BMI, a nonacademic hospital, nonsteroidal anti-inflammatory drug use, the cause of bleeding, requirements for blood transfusion [8].

Despite advances in pharmacological and endoscopic therapy, UGIB continues to pose a clinical challenge due to its considerable morbidity and mortality rates [9]. Nevertheless, recent studies suggest a reduction in in-hospital mortality, likely attributable to improvements in medical and endoscopic management [10].

In this context, understanding the burden and trends of GIB mortality is essential for informing public health strategies, particularly in developing countries such as Peru. Therefore, the objective of this study was to calculate the mortality rates from gastrointestinal bleeding in Peru and its geographic areas from 2003 to 2022.

Materials and methods

Data source

An observational, descriptive ecological time-series study was conducted. All death records due to GIB in Peru reported by the Ministry of Health (MINSA) between 2003 and 2022 were analyzed. As a national and secondary database was used, the study population consisted of all deaths attributed to GIB across the country's 25 geographic regions. The MINSA mortality database is publicly accessible at the following link:

https://www.minsa.gob.pe/reunis/data/tasas_mortalidad.asp.

GIB-related mortality data were extracted for the period 2003–2022. Deaths were coded using the International Classification of Diseases, 10th Revision (ICD-10), as follows: K920 for upper gastrointestinal bleeding, K921 for lower gastrointestinal bleeding, and K922 for unspecified gastrointestinal bleeding [11].

Age adjusted mortality rates

GIB mortality data were downloaded from the official MINSA platform and organized into an Excel file, where records were grouped by sex and across the 25 geographic regions available in the database. The dataset was then imported into the Joinpoint Regression Program version 4.9.0 [12]. This model was used to identify statistically significant changes (joinpoints) in mortality trends over time, dividing the series into linear segments with varying slopes.

Age-standardized mortality rates per 100,000 population were calculated by sex and geographic region using the direct method, with the SEGI world standard population as reference [13]. Mortality trends were then analyzed using the Joinpoint Regression Program version 4.9.0, estimating the annual percent change (APC) and the average annual percent change (AAPC), along with the corresponding 95% confidence intervals (95% CI) for each region. Changes were considered statistically significant when APC or AAPC values had a p-value < 0.05, based on the Monte Carlo permutation test, using the log-transformed mortality rates [14].

Results

Figure 1 shows the average mortality rates for the first five-year period (2003–2007) compared to the last five-year period (2018–2022). During the first five-year period (2003–2007), the departments with the highest age-standardized mortality rates due to gastrointestinal bleeding were Ica (4.4 per 100,000), Huánuco (4.2), and La Libertad (4.0) for men, and Madre de Dios (3.1), La Libertad (2.6), and Ucayali (2.1) for women. In contrast, during the most recent five-year period (2018–2022), the highest rates were observed in Huancavelica (5.0 in men and 3.3 in women), Puno (4.1 in men and 2.6 in women),

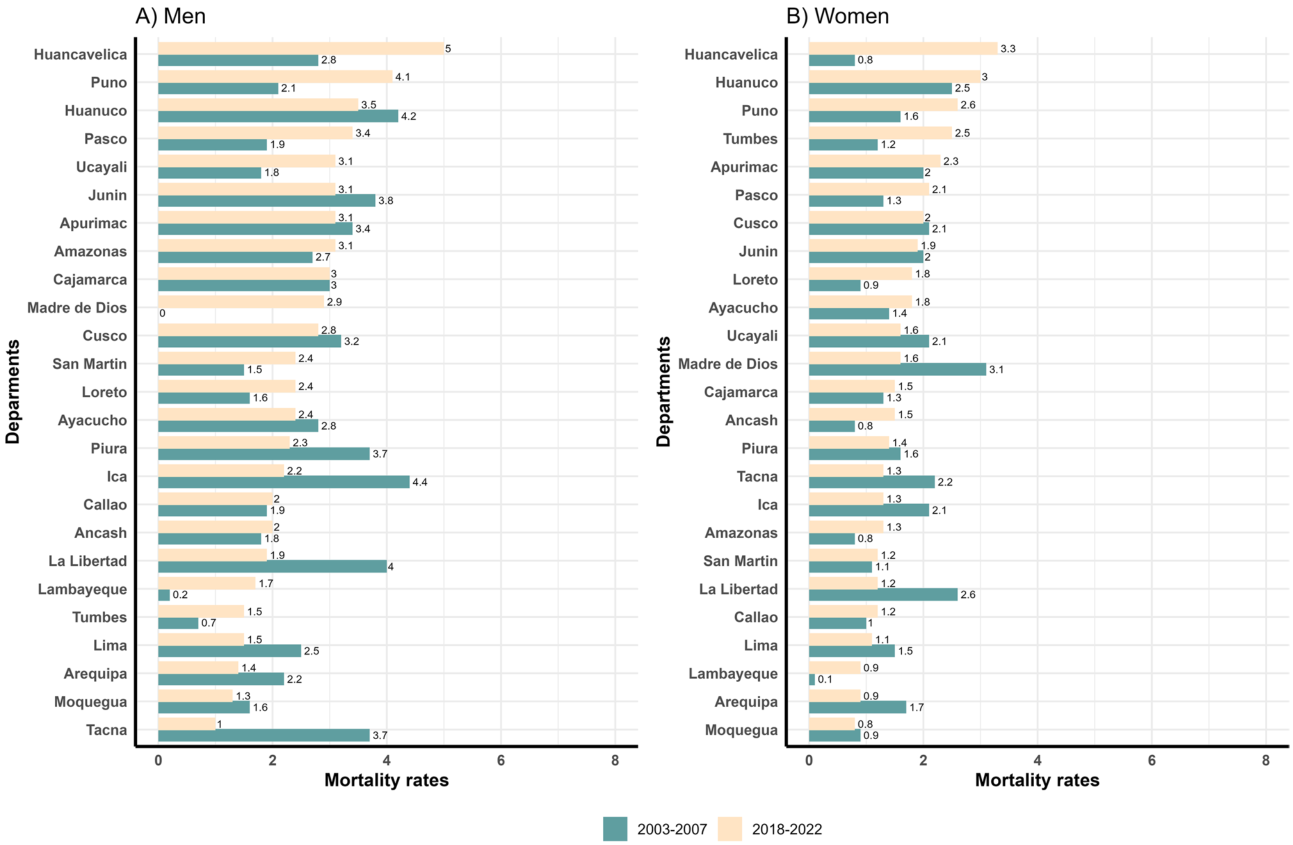

Fig. 1 Average age-standardized mortality rates due to gastrointestinal bleeding in Peru by department, comparing the periods 2003–2007 and 2018–2022, stratified by sex

Table 1 Annual percentage change in mortality rates due to gastrointestinal bleeding for Peru and its regions, 2002–2022

Men	Years	APC1	Years	APC2	Years	APC3	AAPC
Peru	**2003–2022**	**−2.2*(− 3.2, − 1.1)**					**−2.2*(− 3.2, − 1.1)**
Coast	2003–2007	−15.5*(− 25.1, − 4.7)	2007–2010	12.3(− 23.4, 64.7)	2010–2022	−4.0*(− 5.8, − 2.2)	−4.2(− 9.8, 1.7)
Highlands	2003–2022	−0.3(− 2.1, 1.5)					−0.3(− 2.1, 1.5)
Rainforest	2003–2022	1.5(− 1.7, 4.7)					1.5(− 1.7, 4.7)
Women							
Peru	**2003–2022**	**−1.1 (− 2.3, 0.2)**					**−1.1 (− 2.3, 0.2)**
Coast	2003–2022	−1.7*(− 3.1, − 0.2)					−1.7*(− 3.1, − 0.2)
Highlands	2003–2022	0.2(− 1.8, 2.4)					0.2(− 1.8, 2.4)
Rainforest	2003–2022	0.5(− 2.2, 3.3)					0.5(− 2.2, 3.3)

and Huánuco (3.5 in men and 3.0 in women), reflecting a shift toward the central and southern highlands.

Among men, Peru experienced a significant decrease in gastrointestinal bleeding (GIB) mortality, with an annual percent change (APC) of − 2.2%. In the coastal region, trends were variable: there was a significant decrease of 15.5% from 2003 to 2007, followed by an increase of 12.3% from 2007 to 2010, and then another significant decline of 4.0% from 2010 to 2022. In contrast, no statistically significant changes were observed in the highland or jungle regions during the study period. Among women, the coastal region showed a significant annual reduction of 1.7% throughout the study period. However, at the national level and in the other regions, no significant trends were detected (Table 1).

At the departmental level among men, 3 out of 25 departments (3/25) showed significant decreases in GIB mortality. Ica showed a decline of 5.4% per year, La Libertad 5.3% per year, and Piura 3.4% per year. In contrast, Madre de Dios reported a significant increase of 3.9% annually over the study period (Table 2 and Fig. 2). Among women, 2 out of 25 departments (2/25) showed significant decreases: Arequipa with a 3.9% annual reduction and La Libertad with a 4.5% annual reduction. Piura exhibited a mixed trend, with a 5.4% annual increase

Table 2 Annual percentage change among men mortality rates in peru's departments, 2003–2022

Departments	Years	APC	AAPC
Amazonas	2003–2022	−0.4 (− 5.4,4.9)	−0.4 (− 5.4,4.9)
Ancash	2003–2022	−0.5 (− 4.5,3.8)	−0.5 (− 4.5,3.8)
Ayacucho	2003–2022	−0.9 (− 4.8,3.3)	−0.9 (− 4.8,3.3)
Cajamarca	2003–2022	−1.1 (− 4.0,1.8)	−1.1 (− 4.0,1.8)
Callao	2003–2022	−0.7 (− 3.5,2.3)	−0.7 (− 3.5,2.3)
Cusco	2003–2022	−1.2 (− 3.7,1.3)	−1.2 (− 3.7,1.3)
Huancavelica	2003–2022	3.0 (− 1.6,7.8)	3.0 (− 1.6,7.8)
Huanuco	2003–2022	−1.9 (− 5.1,1.4)	−1.9 (− 5.1,1.4)
Ica	2003–2022	−5.4* (− 8.1,−2.5)	−5.4* (− 8.1,−2.5)
Junin	2003–2022	−2.2 (− 4.7,0.3)	−2.2 (− 4.7,0.3)
La Libertad	2003–2022	−5.3* (− 7.3,−3.4)	−5.3* (− 7.3,−3.4)
Lima	2003–2022	−3.4* (− 5.0,−1.7)	−3.4* (− 5.0,−1.7)
Madre de Dios	2003–2022	3.9* (0.4,7.5)	3.9* (0.4,7.5)
Piura	2003–2022	−3.4* (− 5.8,−0.9)	−3.4* (− 5.8,−0.9)
Puno	2003–2022	1.6 (− 1.7,5.1)	1.6 (− 1.7,5.1)

between 2003 and 2014, followed by a significant annual decrease of 9.4% through 2022 (Table 3 and Fig. 2).

Discussion

This study reported a declining trend in GIB mortality rates in Peru, particularly among men, who experienced a significant annual reduction of 2.2%, largely driven by decreases in the coastal region. At the departmental level, the most marked reductions among men occurred in Ica, La Libertad, and Piura, while Madre de Dios showed a significant increase. When comparing the average mortality rates between the first (2003–2007) and the most recent (2018–2022) five-year periods, a shift in the geographic burden was observed: initially highest in Ica, Huánuco, and La Libertad for men and in Madre de Dios, La Libertad, and Ucayali for women, the burden more recently concentrated in highland departments such as Huancavelica, Puno, and Huánuco for both sexes. These findings highlight persistent geographic disparities in GIB mortality across the country.

These findings are consistent with international studies that have reported a progressive decrease in the incidence and mortality of gastrointestinal bleeding, mainly attributed to improvements in early diagnosis and endoscopic treatment [6]. In countries like Chile, similar reductions have been observed following the implementation of clinical protocols and increased access to

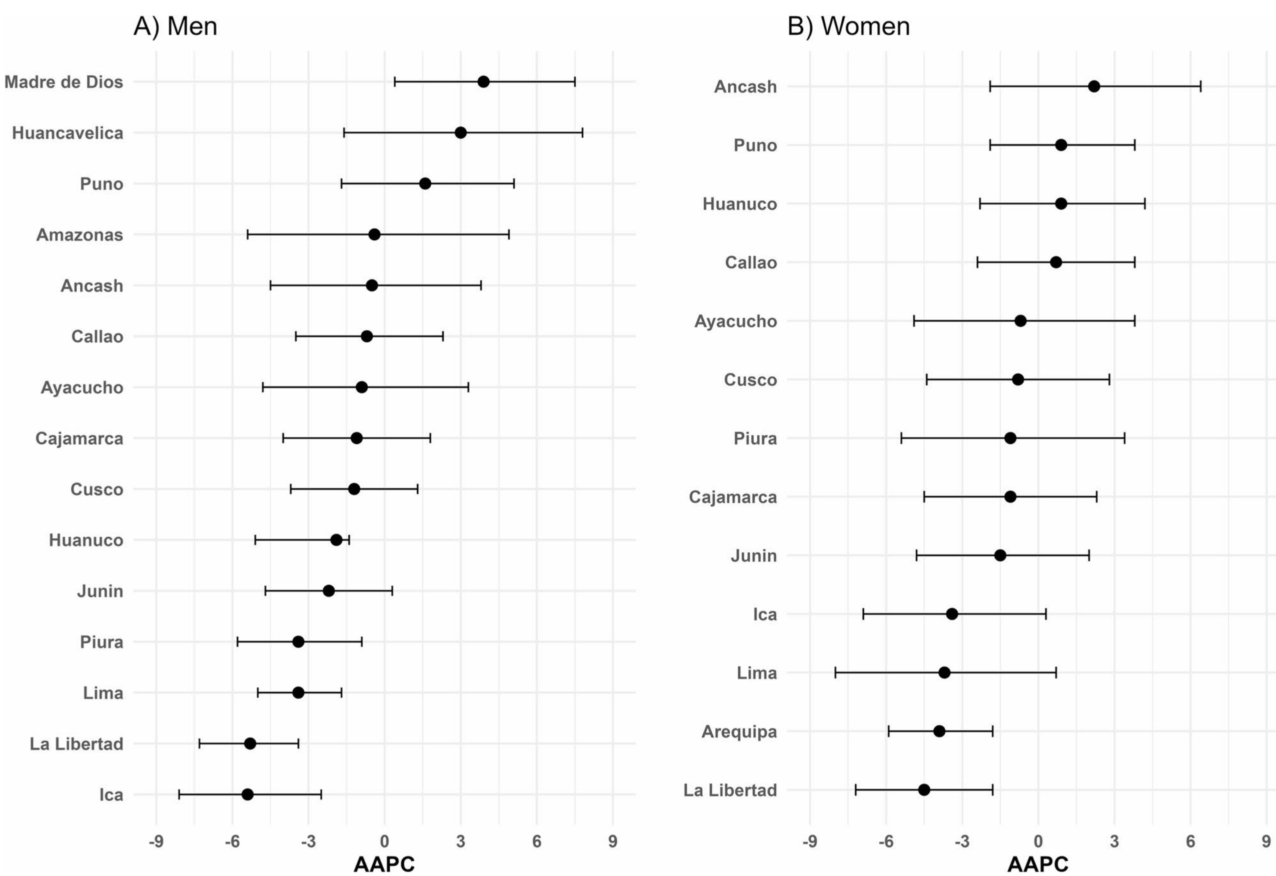

Fig. 2 Annual percent change from trends in gastrointestinal bleeding mortality by department in men and women, Peru, 2003–2022

Table 3 Annual percentage change among women mortality rates in peru's departments, 2003–2022

Departments	Years	APC1	Years	APC2	AAPC
Ancash	2003–2022	2.2 (− 1.9,6.4)			2.2 (− 1.9,6.4)
Arequipa	2003–2022	−3.9* (− 5.9,−1.8)			−3.9* (− 5.9,−1.8)
Ayacucho	2003–2022	−0.7 (− 4.9,3.8)			−0.7 (− 4.9,3.8)
Cajamarca	2003–2022	−1.1 (− 4.5,2.3)			−1.1 (− 4.5,2.3)
Callao	2003–2022	0.7 (− 2.4,3.8)			0.7 (− 2.4,3.8)
Cusco	2003–2022	−0.8 (− 4.4,2.8)			−0.8 (− 4.4,2.8)
Huanuco	2003–2022	0.9 (− 2.3,4.2)			0.9 (− 2.3,4.2)
Ica	2003–2022	−3.4 (− 6.9,0.3)			−3.4 (− 6.9,0.3)
Junin	2003–2022	−1.5 (− 4.8,2.0)			−1.5 (− 4.8,2.0)
La Libertad	2003–2022	−4.5* (− 7.2,−1.8)			−4.5* (− 7.2,−1.8)
Lima	2003–2006	−22.3 (− 41.8,3.7)	2006–2022	0.2 (− 2.0,2.5)	−3.7 (− 8.0,0.7)
Piura	2003–2014	5.4 (− 0.6,11.7)	2014–2022	−9.4* (− 16.6,−1.5)	−1.1 (− 5.4,3.4
Puno	2003–2022	0.9 (− 1.9,3.8)			0.9 (− 1.9,3.8)

specialized services [15]. In Peru, however, available studies have focused primarily on hospital-based populations, rather than national-level data [16]. As such, this work represents one of the first efforts to characterize the temporal evolution of GIB mortality with a geographic and sex-based perspective. Furthermore, the regional differences identified may reflect inequalities in the distribution of medical resources, endoscopic infrastructure, and specialized gastroenterological care—elements that are critical for managing this emergency [17]. A study conducted at the National Hospital Cayetano Heredia also highlights the importance of timely and specialized care [18].

The coastal region showed a significant reduction in GIB mortality among both men and women. This finding may be explained by the higher concentration of referral hospitals and the availability of endoscopic services in this area [19]. Additionally, the coast has a greater number of training and research centers for health professionals, as well as more accredited universities, contributing to a workforce that is more aligned with clinical guidelines [20]. Another important factor is the higher proportion of insured individuals in the region, which facilitates access to specialized care when needed [21]. Moreover, greater access to health information in urban areas, particularly regarding disease prevention and the dangers of self-medication, may play a role. One study found that 54% of patients with non-variceal UGIB in five hospitals in Metropolitan Lima used NSAIDs, and of these, 55.4% did so without medical prescription [22].

By contrast, the highland and jungle regions did not exhibit significant changes, possibly due to limited access to timely health services and lower diagnostic capacity [23]. This challenge not only affects access to medium- and high-complexity services but also impacts primary care, which is essential for disease prevention and early intervention in cases of GIB. A study emphasized the need to strengthen early management and response capacity in patients with LGIB, showing that indicators such as age, hemodynamic instability and Charlson-comorbidity-index were significantly risk factor with higher mortality [24]. Risk behaviors such as NSAID use and self-medication may also be more prevalent in areas lacking adequate healthcare systems [25]. Another probable factor is the limited availability of gastroenterologists or other trained personnel to provide timely treatment for GIB, particularly in the highland and jungle regions.

Madre de Dios reported a significant increase in mortality, which may reflect deficiencies in referral systems or inaccuracies in death cause reporting. It is also possible that there has been an increase in diseases that predispose individuals to GIB, such as liver disorders. For instance, a study conducted in Brazil by Zaltman et al. at the Federal University of Rio de Janeiro Hospital reported a high UGIB mortality rate (15.3%), which was mainly associated with underlying liver disease, including portal hypertension and cirrhosis [26]. Additionally, research has demonstrated a strong link between educational level and poverty quintile with infant mortality rates, patterns that could plausibly extend to other clinical contexts like UGIB [27]. In any case, further studies are needed to explore and clarify the potential contributing factors in greater depth.

Regarding sex-based differences, the smaller reduction among women is due to the fact that they already had a lower incidence compared to men. This may be due to lower exposure to certain medications (e.g., NSAIDs), or differential underreporting in rural areas or to biological factors [28]. Structural barriers may also limit women's access to invasive procedures, such as therapeutic endoscopy, compared to men. In some areas of the country, economic, social, familial, or cultural factors may restrict women's access to timely specialized care. This could be associated with a smaller decrease in the mortality rate, considering a study conducted in China that highlights the importance of identifying high-risk patients upon hospital admission in order to provide them with more intensive and specialized management to reduce adverse outcomes [29].

The use of Joinpoint regression provides great flexibility for modeling changing trends over time, detecting statistically significant "joinpoints" where the slope of a trend shifts [30]. Unlike linear regression, which assumes a single direction of change, this method captures nuanced inflection points that may correspond to public health interventions or environmental events [31]. Compared with time series models like ARIMA, Joinpoint does not require assumptions of seasonality, autocorrelation, or strict stationarity, making it more robust and interpretable [32]. Model selection is guided by permutation tests or Bayesian Information Criterion (BIC), ensuring accuracy without overfitting [33]. Widely applied in cancer epidemiology, it has revealed shifts in mortality and incidence rates, providing evidence for evaluating screening or treatment programs [34]. Beyond oncology, it has been used to track stroke mortality in Brazil and to study incidence and mortality of tuberculosis in India, underscoring its value across diverse health datasets [34].

Although hematemesis and melena are the classic signs of UGIB, in massive or rapid hemorrhage cases, hematochezia may also occur, leading to potential confusion with LGIB [35]. This overlap becomes particularly problematic in the absence of confirmatory endoscopy, such as in emergency situations or death certification, where clinical misclassification may compromise coding accuracy [36]. Studies validating ICD-9 and ICD-10 codes for UGIB show positive predictive values above 91% and 77% respectively, but also highlight variability when free-text records or non-specific codes are used, increasing the risk of error [37]. Such inaccuracies in cause-of-death coding can bias epidemiological trends and hinder public health planning. To address this, experts recommend standardized diagnostic protocols, more training for certifiers, and the potential integration of artificial intelligence tools to improve precision in classification and mortality statistics [38].

Future research should explore individual-level determinants of gastrointestinal bleeding mortality, including medication use, underlying liver disease, and delays in diagnosis or treatment. Strengthening endoscopic capacity in underserved regions, improving medical death certification practices, and expanding public health education on gastrointestinal symptoms and risk factors may help reduce the burden of gastrointestinal bleeding in Peru. Additionally, regional investments in health information systems are essential for generating more timely and complete mortality data.

Limitations

This study has several limitations inherent to its ecological design, as the analysis was conducted at the population level rather than the individual level. Consequently, it was not possible to control for potential confounding factors such as comorbidities, medication use, socioeconomic status, and access to healthcare services. This design also carries the risk of ecological fallacy, whereby associations observed at the group level may not accurately reflect individual-level relationships. Additionally, the mortality data were obtained from secondary sources provided by the MINSA, whose data quality may vary across departments and regions. Although the MINSA mortality database is widely used and curated by national health authorities, it does not publish formal annual validation reports. As such, there is a risk of underreporting or misclassification of causes of death, particularly in areas with limited health information infrastructure.

While we included the primary ICD-10 codes for gastrointestinal bleeding (K92.0–K92.2), it is possible that some deaths were recorded under alternative etiological codes related to hemorrhagic complications (e.g., peptic ulcers or variceal bleeding), potentially leading to an underestimation of the true mortality burden. Furthermore, unmeasured factors such as regional disparities in healthcare coverage, prevalence of comorbid conditions (e.g., cirrhosis, peptic ulcer disease), and variability in death certification practices may contribute to the observed differences between regions and sexes. The accuracy of mortality reporting may also be influenced by access to diagnostic services, the training of certifying physicians, and the completeness of medical documentation—factors that vary across Peru and are likely more limited in resource-constrained areas. Future research using individual-level data and incorporating additional determinants is warranted to better understand the underlying causes of these geographic and sex-based disparities in gastrointestinal bleeding mortality.

Among the main strengths of this study are the use of an official, publicly available national database, which ensures the representativeness of the results, and the analysis of multiple time series over two decades, allowing for the assessment of robust mortality trends. Additionally, the use of the Joinpoint Regression model, internationally validated for trend analysis in public health, enabled the identification of statistically significant changes in mortality trends, providing a rigorous and reproducible analytical approach.

Conclusions

In conclusion, GIB mortality in Peru has shown a declining trend over the past two decades, particularly among men and in coastal regions. However, significant geographic disparities persist. A comparison between the earliest (2003–2007) and most recent (2018–2022) five-year periods revealed a shift in the burden of mortality toward highland regions, with departments such as Huancavelica, Puno, and Huánuco now showing the highest rates for both sexes. These findings underscore the need for targeted public health interventions aimed at improving access to timely diagnosis and specialized care, particularly endoscopic services in underserved regions. Strengthening regional health infrastructure and addressing inequities in healthcare delivery are essential to reducing preventable deaths from gastrointestinal bleeding across the country.

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Authors' contributions
Authors' contributionsConceived and designed the idea: MAOA, JCVD, JSTRHad 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: MAOA, JCVD, BRS, IAC, LMTMContributed to the writing of the manuscript: All authors. Contributed to the statistical analysis: MAOA, JCVD, JSTR, LMTMCritical revision of the manuscript: JAP, JYM, LMTMApproval 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/reunis/data/tasas_mortalidad.asp.

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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