

Trends in premature mortality and in years of life lost due to gastric cancer in Brazil's Central-West region

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Abstract *The objective of this study was to analyze the rates and trends of premature mortality (30-69 years) and years of potential life lost (YPLL) due to gastric cancer in the capitals and other cities/towns of the Central-West region, from 1997 to 2021. This is an ecological time series study with data from the Mortality Information System. Premature mortality rates and YPLL were calculated and standardized by age. A joinpoint regression was used for trend. There was a predominance of premature deaths in males. The capitals of all states in the region had lower premature mortality rates compared to other cities/towns. A significant reduction in the trend of these rates was observed in all cities/towns of the region, except for women in the capital of Mato Grosso. The highest YPLL occurred among males, and the Federal District showed an increase of 1.27%. In general, premature mortality from gastric cancer showed significant declines in the Central-West region. Although the results are homogeneous across geographic units, prevention strategies, early diagnosis and increased access to oncological services are essential to reduce inequalities and improve prognoses.*

Key words Gastric neoplasms, Premature mortality, Information systems, Time series studies

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Introduction

One of the factors related to cancer development is increased life expectancy, making it one of the diseases associated with aging¹. A proportional relationship is observed between age and cancer-related mortality rates, with approximately 45% of cancer deaths occurring in individuals aged 70 or older². However, the epidemiological profile of neoplasms has shown an increase in premature mortality, specifically in individuals aged 30-69, for some cancer types³.

In 2022, approximately 9.7 million cancer deaths were recorded worldwide, of which 4.8 million were identified as premature⁴. Gastric cancer (GC), also known as stomach cancer, accounts for 6.4% of the global cancer burden and ranks sixth in incidence and seventh in cancer mortality⁴. Thus, this neoplasm persists as a public health challenge due to its high incidence, poor prognosis, disease heterogeneity, and interrelated risk factors⁵.

Globally, in 2022, the estimated number of GC deaths was 660,175, with 312,443 (47.3%) occurring prematurely⁴. Brazil has the highest number of GC deaths compared to other South American countries⁴. It is estimated that annually, 7.7% of men and 4.8% of women die from this disease in this country⁶. The highest GC mortality rates for both sexes are concentrated in the North and South Regions (7.62 and 5.63/100 thousand inhabitants), followed by the Northeast, Southeast, and Central-West Regions (5.06, 4.92, and 4.57/100 thousand inhabitants)⁶.

Assessing the magnitude of cancer mortality involves quantifying the impact of premature deaths related to the disease using the years of potential life lost (YPLL) indicator⁸. In Brazil, in 2021, 25.6 million potential years of life were lost prematurely due to cancer, of which 1.8 million were specifically attributed to stomach cancer⁷. Thus, exploring this indicator, as well as premature mortality, may reveal social and regional inequities in the distribution of deaths from specific preventable causes⁸.

Decreasing and/or stable trends in GC mortality rates have been observed in the more developed regions of Brazil⁹. The regionalization and centralization of oncological health services in capitals are geographical barriers that result in negative impacts on survival rates for this neoplasm, especially for the population living in remote areas, as it contributes to late diagnoses^{10,11}.

Scientific production on GC in the Central-West region is underexplored, which justifies and motivates the choice of this topic. This gap represents a limitation for understanding the epidemiological scenario of GC and for strengthening preventive measures adapted to the specific needs of the population¹¹. Therefore, the objective of the study was to describe the rates and trends of premature mortality and YPLL due to GC in the states, capitals, and other cities/towns of the Central-West region.

Method design

This is an ecological time-series study of premature mortality and YPLL due to malignant neoplasm of the stomach (C16.0 to C16.9, according to the International Classification of Diseases, 10th version) in Brazil's Central-West region, from 1997 to 2021, with states, capitals, and other cities/towns as units of analysis.

Context

The Central-West region comprises the states of Goiás (GO), Mato Grosso (MT), Mato Grosso do Sul (MS), and the Federal District (DF). The region concentrates 7.9% of the Brazilian population, with approximately 17.1 million inhabitants. Regarding the population profile, there is a predominance of young adults (20-49), self-declared as brown, and a predominance of the female sex¹².

Variables

The variables used for deaths by place of residence were: sex, age group (30-69), year of death (1997 to 2021), region of residence (Central-West), state (GO, MT, MS, and DF), their respective capitals (Goiânia, Cuiabá, Campo Grande), and other cities/towns. The data on the latter in each state were subtracted from those of the respective capital.

Data source and collection

Information was accessed through the Department of Informatics of the Unified Health System (DATASUS), of the Ministry of Health (<https://datasus.saude.gov.br/>).

Mortality data were extracted from the Mortality Information System (SIM/DATASUS) (<https://datasus.saude.gov.br/mortalidade-desde->

-1996-pela-cid-10). This database unifies more than 40 instrument models to collect death records in the country, is updated annually, and covers approximately 96.1% of the population¹³.

Population estimates were obtained from the “Study of Population Estimates by Municipality, Sex and Age – 2000-2021”, which are estimates harmonized with the 2018 Population Projection edition of the Brazilian Institute of Geography and Statistics (IBGE) (<http://tabnet.datasus.gov.br/cgi/IBGE/NT-POPULACAO-RESIDENTE-2000-2021.PDF>).

Life expectancy information was collected from different systems due to data unavailability for the complete period. Thus, the demographic indicator of life expectancy at birth was collected from the Interagency Health Information Network (RIPSA/DATASUS: <http://tabnet.datasus.gov.br/cgi/ldb2012/a11.htm>) for 1997-1999, and from the Automatic Retrieval System of the Brazilian Institute of Geography and Statistics (SIDRA/IBGE: <https://sidra.ibge.gov.br/tabela/7362>) for the remainder of the period, through the 2018 population projection.

Statistical analysis

The age-specific premature mortality rate was calculated by dividing the total number of GC deaths occurring in individuals 30-69 in a given year by the total population in the same age group of the region in that same period, multiplied by 100 thousand inhabitants. Although the age-specific rate was calculated, in order to promote comparability, only age-standardized premature mortality rates were presented.

The YPLL calculation was performed using the Romeder and Whinnie method¹⁴, which establishes an age limit for the calculation based on the average life of the population. YPLL was calculated considering the difference between the life expectancy of the population of each state and the midpoint of each age group for the other variables. YPLL rates were calculated by dividing the total years lost by the population of each age group, by sex and disaggregation unit studied.

All study rates were standardized and adjusted. Standardization was performed by the direct method, using the world-standard population as a reference. The calculation was performed by dividing the age-specific mortality rate by the world-standard population by age groups (<https://iris.paho.org/handle/10665.2/49056>). To reduce the impact of occasional variations and ensure stability of the temporal behavior

of the series, the rates were adjusted at 3 points, using the moving average.

A descriptive analysis of the results was performed with presentation of absolute and relative frequencies.

For the temporal analysis, the Joinpoint Regression Program software, version 5.0.2, from the National Cancer Institute of the United States (<https://surveillance.cancer.gov/joinpoint/>) was used. In order to estimate the variations in premature GC death rates and YPLL, the average annual percentage change (AAPC), their 95% confidence intervals, and the respective p-values of statistical significance tests were presented, where $p < 0.05$ indicated an increase or decrease in mortality, and $p > 0.05$ indicated stability of mortality.

The results were visualized graphically using R Project for Statistical Computing software version 4.3.2 (<https://cran.r-project.org/src/base/R-4/>).

Ethical aspects

Data disclosed by SIM/DATASUS and IBGE do not require informed consent or variables that allow the identification of individuals. However, the research respected ethical principles, in accordance with Resolutions 466/12 and 510/2016, and is related to the project, “Study of sociodemographic differences in the epidemiology of neoplasms,” with Ethical Presentation Certificate No. 55847122.1.0000.5078, which obtained approval from the Research Ethics Committee of the Hospital das Clínicas of the Federal University of Goiás (CEP/HC/UFG) on February 15, 2024, under opinion No. 6.651.057.

Results

Of the 10,530 premature GC deaths in the Central-West Region from 1997 to 2021, 7,032 were male, 3,493 were female, and in five records, the sex variable was ignored. Among the states, GO had the highest number of premature deaths (4,476), likewise its capital and other urban centers had the highest figures, respectively 1,030 and 3,446. The lowest records were observed in the DF (2,023 deaths). In MT and MS, premature deaths were 2,169 and 2,223, respectively. There was a predominance of male deaths.

The standardized premature GC mortality rates showed homogeneity in results among the geographical units of analysis, except for the states, in both sexes, for the 1997. In the same period, the highest mortality rate was observed

in the capital of MS (18.5) and the lowest in the DF (12.4) for males (Table 1, Graph 1). For females, these rates were 7.8 in the capital of MS and 5.8 in the capital of GO, respectively (Table 1, Graph 2). In 2021, all premature mortality rates were lower than at the beginning of the time series. Among men, in the last year of the series, the capital of MT showed the highest rate (11.2), while other cities/towns of this state and those others in the region showed similar rates. In females, similarity in mortality patterns was observed among states, capitals, and other cities/towns. It is noteworthy that premature mortality in the capital of MS was 4.7, representing the highest rate, while the others ranged between 3.7 and 4.5 (Table 1).

The annual percentage change was significant for the period in all the states and cities/towns in the region analyzed, except for women in the capital of MT. The regions that showed the largest reductions in the trend of premature mortality among males were MS capital (AAPC: -3.55), other MT urban centers (AAPC: -3.41), and MT (AAPC: -3.32). The smallest trend reduction was observed in the DF (AAPC: -1.59). Females showed a similar decline pattern, highlighting MS capital (AAPC: -2.93), DF (AAPC: -2.81), and the state capital and other urban centers of MT (AAPC: -2.76 and -2.75, respectively). In contrast, the lowest decreasing trend was observed in GO capital (AAPC: -1.08) (Table 1).

Premature GC mortality, from 1997 to 2021, totaled 182,897.4 YPLL in the Central-West Region. GO led these losses, recording 34,226.0 years lost for males and 30,066.2 for females. The highest losses occurred among males in all states, whether in the capitals or other cities/towns. The declining trend of rates occurred in MT urban centers except for the capital (-1.40), GO capital (-0.58), and MS (-0.58); in DF, an increasing trend was observed (AAPC: 1.27). Although decreases in YPLL rates were observed in the other geographical units analyzed, MT capital and DF showed an increase in the initial and final year among men (Graph 3). In females, YPLL rates increased in MS capital and other cities/towns (Graph 4). In other GO urban centers (AAPC: -1.32) and MT (AAPC: -0.72), this rate showed a significant reduction.

Discussion

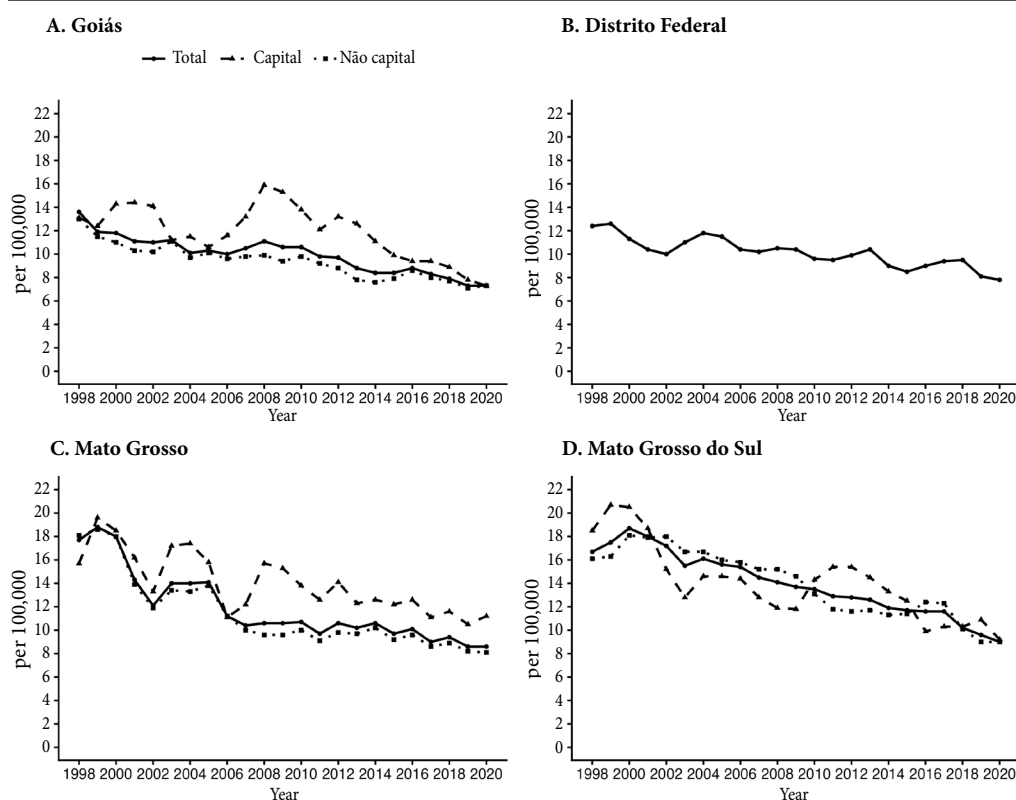
The premature GC mortality profile in Brazil's Central-West region, characterized by decreasing rates, resembles that observed in studies conducted in various parts of the world^{15,16}. Despite declining trends, GC continues to be an important cause of mortality, contributing 6% of all cancer-related premature deaths in Brazil in 2021⁶. The Brazilian Central-West accounts for 5.7% of premature cancer deaths, and Goiás state is responsible for 41% of deaths in the region⁶.

Table 1. Standardized rates and trends of premature mortality due to CG, in the Central-West Region of Brazil, by sex, from 1997-2021.

States		Male			Female		
		Standardized Rate		AAPC (IC95%)	Standardized Rate		AAPC (IC95%)
		1997	2021		1997	2021	
GO	Capital	13.1	7.3	-2.32* (-2.78; -1.67)	5.8	3.7	-1.08* (-2.04; -0.12)
	Cities/towns	13.0	9.3	-2.17* (-2.57; -1.77)	6.6	3.8	-2.59* (-2.94; -2.30)
	Total	13.6	7.3	-2.55* (-2.96; -2.19)	6.5	3.8	-2.25* (-2.68; -1.93)
MT	Capital	15.7	11.2	-2.11* (-2.89; -1.31)	7.5	4.0	-1.34 (-4.63; 2.03)
	Cities/towns	16.1	8.1	-3.41* (-4.15; -2.67)	6.2	3.8	-2.75* (-4.29; -1.28)
	Total	16.7	9.0	-3.32* (-3.93; -2.47)	6.7	4.5	-2.76* (-3.41; -2.16)
MS	Capital	18.5	9.2	-3.55* (-4.33; -2.98)	7.8	4.1	-2.93* (-3.82; -1.99)
	Cities/towns	16.1	9.0	-2.83* (-3.28; -2.35)	6.2	4.7	-1.35* (-2.39; -0.29)
	Total	16.7	7.3	-2.78* (-3.01; -2.54)	6.7	3.9	-2.08* (-2.82; -1.20)
DF	Total	12.4	7.8	-1.59* (-2.08; -1.11)	7.7	4.1	-2.81* (-3.67; -1.83)

Legend: GO: Goiás; MT: Mato Grosso; MS: Mato Grosso do Sul; DF: Federal District. * p-value with significance level < 0.05.

Source: Authors.



Graph 1. Standardized premature mortality rates for CG, in the Central-West Region of Brazil, males, from 1997-2021.

Source: Authors.

In this study, a greater magnitude was observed in the analyzed rates for males, twice as high as those recorded for females. This disparity can be attributed to a complex interaction of biological and behavioral factors, patterns of seeking medical assistance, and potential prolonged exposure to GC-associated risk factors¹⁷.

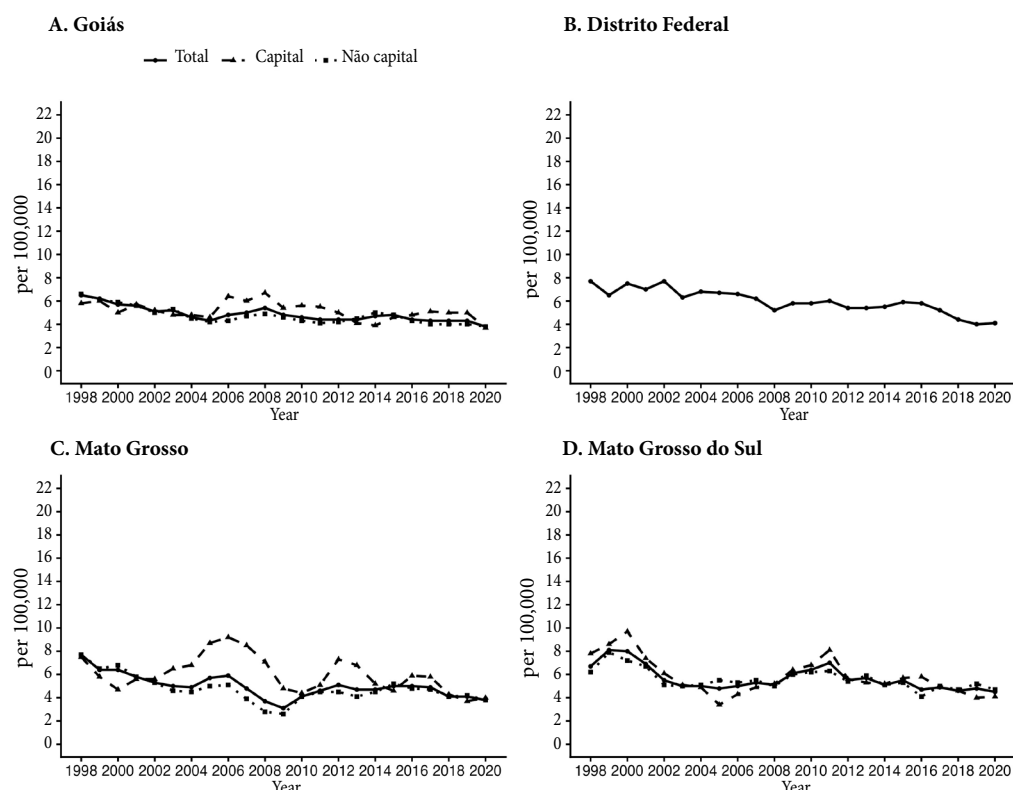
Abusive consumption of alcohol and tobacco, combined with diets characterized by a high intake of meat and ultra-processed foods, are important risk factors linked to male habits and lifestyle¹⁸. Furthermore, infection by the bacterium *Helicobacter pylori* (*H. pylori*), which is a class I carcinogen and the main risk factor for GC development, has a higher prevalence among men^{20,21}. The difference in risk distribution between sexes justifies higher premature GC mortality rates in the male population.

In GO, the early mortality rates of cities/towns for both sexes surpassed those of the capitals. This fact was also observed in MS for females. The centralization of health services in

large capitals frequently imposes geographical barriers for inhabitants of remote regions, as it promotes migration to capitals in search of better oncological care provision^{22,23}. This reality highlights the inequity in access to specialized services, while causing delays in screening, diagnosis, and early treatment of GC, consequently contributing to unfavorable outcomes²⁴, such as early deaths.

The trends of premature GC mortality in the states, capitals, and other cities/towns of the Central-West region showed a decline for the period. The results of this research corroborate other studies that investigated the behavior of GC deaths in the five Brazilian regions across all age groups. These analyses revealed a reduction trend for the Central-West, South, and Southeast regions^{9,25}, stability for the North region, and an increase for the Northeast region⁹.

The observed reductions in mortality rates can be attributed to improved basic sanitation conditions, enhanced food quality, including



Graph 2. Standardized premature mortality rates for CG, in the Central-West Region of Brazil, females, from 1997-2021.

Source: Authors.

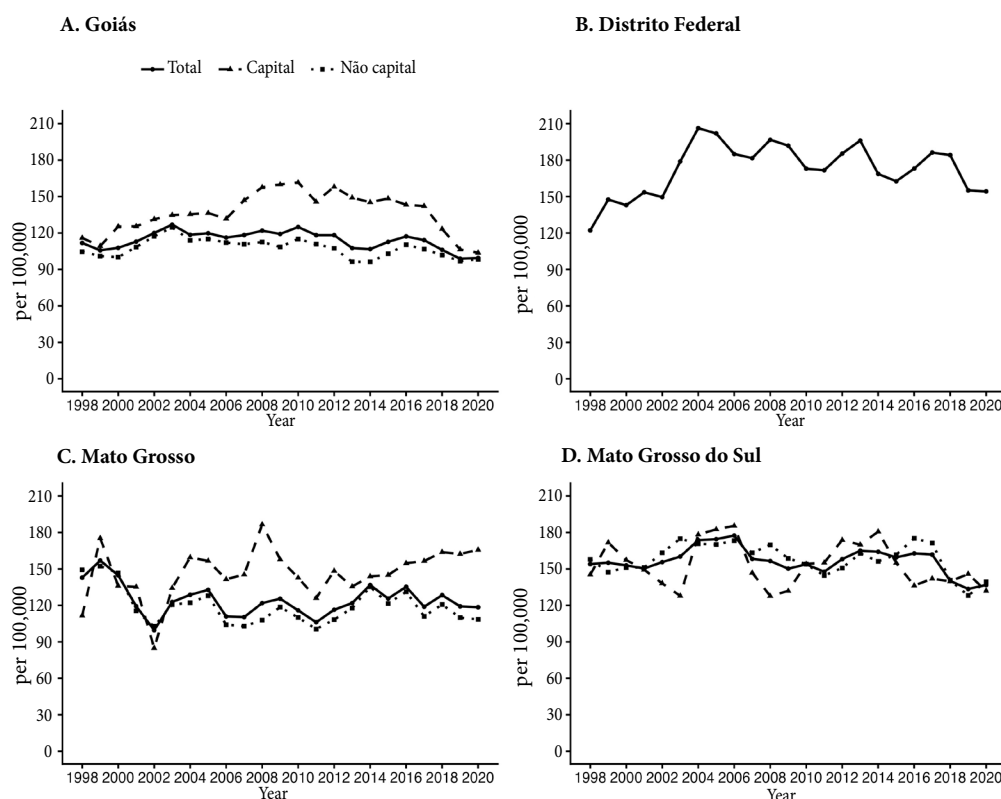
improved storage, hygiene in processing stages, increased consumption of fruits and vegetables, modification of lifestyle habits such as reduced or abandoned smoking²⁶, and, finally, *H. pylori* eradication²⁷. Interestingly, even though the capital of MS registered the largest reductions in premature mortality, self-reported national surveys indicated that the adult population of MS perceives themselves as more exposed to GC risks associated with diet and lifestyle²⁸.

The decline in cancer mortality is associated with preventive interventions, the implementation of screening programs, and advances in diagnostic and therapeutic methods²⁹. Outstanding among the main strategies for GC prevention is upper digestive endoscopy for early detection of pre-neoplastic lesions^{17,23}. Studies conducted in developed countries showed that the implementation of these actions yielded promising results, where screening led to a significant reduction in GC deaths^{30,31}. However, the adoption of this strategy is not universally

accessible, especially in regions characterized by socioeconomic disparities.

In Brazil, although public policies for oncological screening for some more prevalent cancers, such as breast, cervical, and prostate, have been consistently implemented and shown remarkable progress, there is still a gap in specific approaches for GC control and prevention. This is reflected in the 5-year survival rate for individuals with this neoplasm, which does not exceed 35%³. Thus, specific guidelines should focus on early diagnosis actions, treatment accessibility, improving the quality of life of GC patients, and raising public awareness⁹.

Preventable diseases, such as GC, are intrinsically linked to lifestyle habits, environmental exposures, behavioral factors, and socioeconomic status, which alter the patterns of GC morbidity and mortality in the population¹⁷. This association not only results in losses of potential years of life, but also incurs economic implications due to the early interruption of



Graph 3. Standardized rates of potential years of life lost due to gastric cancer, in the Central-West Region of Brazil, males, from 1997-2021.

Source: Authors.

these individuals' productivity^{6,15}. Regarding YPLL for GC, in the DF there was an increase of almost 1.3% in the male population during the study period. Different from this study, other authors found a significant increase in YPLL in MT³² in both sexes.

Study limitations include the use of secondary data, which depends on the quality of records. However, its strengths focus on the comprehensive temporal and regional analysis of premature deaths and YPLL in the Central-West region.

The Central-West region recorded a significant decline in premature GC mortality rates. It was observed that the patterns of variation in these rates were similar across all states, in both capitals and their other urban centers. However, disparities persist between sexes, the impact on males being considerably greater.

The YPLL also showed an overall reduction, with the exception of the Federal District, which

evidenced a worrying increase among men. The findings reinforce the need for public health strategies that prioritize combating regional and gender inequalities.

GC mitigation demands a multifaceted approach centered on primary and secondary prevention. In this context, addressing modifiable risk factors, such as excessive alcohol consumption, smoking, and the adoption of inadequate dietary habits, constitutes a primary strategy. Furthermore, expanding coverage and optimizing access to early diagnosis services, with an emphasis on upper digestive endoscopy, are fundamental. Such a measure assumes particular importance in the region's cities/towns other than the capitals, where geographic and socioeconomic barriers impose additional challenges to healthcare system accessibility.

The integration of these actions with specific public policies for GC can contribute to advancements in reducing health inequities and

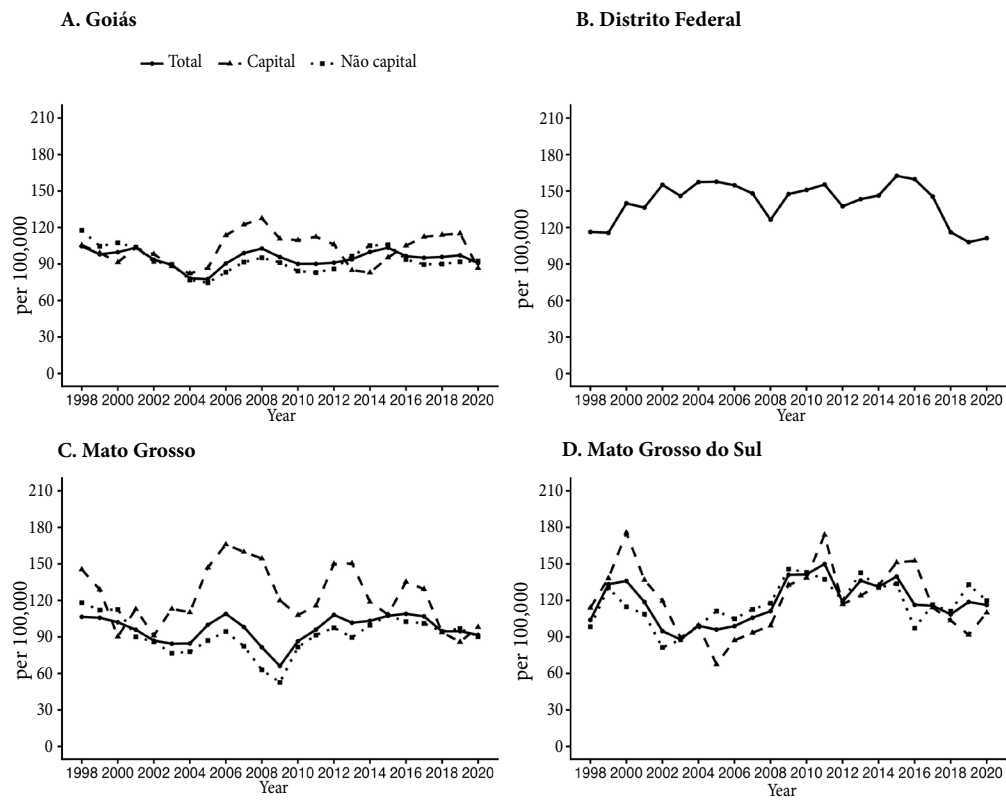


Figura 4. Graph 3. Standardized rates of potential years of life lost due to gastric cancer, in the Central-West Region of Brazil, males, from 1997-2021.

Source: Authors.

improving prognoses for the population of the Central-West region. Finally, the need for future studies that explore specific risk factors and gender differences in exposure is highlighted in detail, with the aim of deepening the understanding of GC mortality dynamics and supporting more effective policies for controlling this condition.

Collaborations

ALS Bizinoto contributed to the study design, data collection, analysis, interpretation of results and writing of the manuscript. Ferreira PMN contributed to writing and data collection. MM Oliveira contributed to the analysis, interpretation of data and execution of figures. MS Barbosa and MP Curado contributed to the study design, coordination, writing and critical review of the manuscript content.

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Data availability statement

The data sources adopted in the research are indicated in the article's body.

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