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Original Article

Temporal analysis of mortality from preventable causes in a municipality in the midwest of Santa Catarina

Análise temporal da mortalidade por causas evitáveis no período de 2013 a 2022, em um município do meio oeste catarinense

Análisis temporal de la mortalidad por causas prevenibles en un municipio del centro oeste de Santa Catarina

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ABSTRACT

Background and Objectives: Preventable deaths are those that could have been avoided by effective health service actions during the period in which they occurred. Describing preventable mortality provides valuable indicators of health services, enabling the assessment of quality and effectiveness based on the data obtained. The objective was to analyze mortality trends from preventable causes and outline the profile of preventable deaths in the municipality of Caçador, Santa Catarina, from 2013 to 2022. **Methods:** An ecological time-series study with secondary data from the DATASUS Mortality Information System. The analysis was bivariate, and Joinpoint regression was used for temporal trend analysis, employing the Empirical Quantile method and the Weighted Bayesian Information Criteria. **Results:** 67.3% of deaths were classified as preventable. Time trend analysis identified two distinct phases: an average annual reduction of 13.09% between 2013 and 2015, followed by an increase of 2.44% per year from 2015 to 2022. Stratification by sex revealed significant trends for males, with a 15.62% annual decrease in the initial period and a subsequent 2.9% annual increase, particularly associated with cardiovascular diseases, which accounted for 10.0% of preventable deaths among men. Among females, an average downward trend of 0.23% per year was observed, without statistical significance. **Conclusion:** A higher rate of preventable mortality was observed in males, and of these, NCDs had a higher rate during the period. Analyzing mortality data is a practice as a tool for managing, planning, and evaluating public policies.

Keywords: *Mortality. Cause of Death. Mortality Rate. Morbidity and Mortality Indicators.*

RESUMO

Justificativa e Objetivos: Óbitos evitáveis são aqueles que poderiam ter sido evitados por ações efetivas dos serviços de saúde no período de ocorrência. Descrever mortalidade evitável fornece valiosos indicadores de serviços de saúde, sendo possível avaliar a qualidade e resolutividade a partir dos dados obtidos. O objetivo foi analisar as tendências de mortalidade por causas evitáveis e delinear o perfil dos óbitos evitáveis no município de Caçador, Santa Catarina no período de 2013 a 2022. **Métodos:** Estudo ecológico de série temporal, com dados secundários do Sistema de Informação sobre Mortalidade DATASUS. A análise foi bivariada e para análise de tendência temporal utilizou a regressão *Joinpoint*, empregando o método *Empirical Quantile* e o critério *Weighted Bayesian Information Criteria*. **Resultados:** Foram classificados como evitáveis 67,3% óbitos. A análise de tendência temporal, identificou duas fases distintas: uma redução anual média de 13,09% entre 2013 e 2015, seguida por um aumento de 2,44% ao ano de 2015 a 2022 A estratificação por sexo demonstrou tendências significativas para o sexo masculino, com queda de 15,62% ao ano no período inicial e subsequente aumento de 2,9% ao ano, especialmente associado a doenças cardiovasculares, que representaram 10,0% dos óbitos evitáveis entre os homens. No sexo feminino, observou-se uma tendência de queda média de 0,23% ao ano, sem significância estatística. **Conclusão:** Observou-se uma maior taxa da mortalidade evitável no sexo masculino, e dessas as DCNT tiveram uma maior taxa no período. Analisar dados de mortalidade é uma prática como instrumento de gestão, planejamento e avaliação de políticas públicas.

Descritores: *Mortalidade. Causa de Óbito. Taxa de Mortalidade. Indicadores de Morbimortalidade.*

RESUMEN

Justificación y Objetivos: Las muertes prevenibles son aquellas que podrían haberse evitado mediante acciones efectivas de los servicios de salud durante el período en que ocurrieron. Describir la mortalidad prevenible proporciona indicadores valiosos de los servicios de salud, lo que permite la evaluación de la calidad y la efectividad con base en los datos obtenidos. El objetivo fue analizar las tendencias de mortalidad por causas prevenibles y delinear el perfil de muertes prevenibles en el municipio de Caçador, Santa Catarina, de 2013 a 2022. **Método:** Un estudio ecológico de series de tiempo con datos secundarios del Sistema de Información de Mortalidad DATASUS. El análisis fue bivariado y se utilizó la regresión Joinpoint para el análisis de tendencias temporales, empleando el método de cuantiles empíricos y los criterios de información bayesianos ponderados. **Resultados:** El 67,3% de las muertes se clasificaron como prevenibles. El análisis de tendencias temporales identificó dos fases distintas: una reducción anual promedio del 13,09% entre 2013 y 2015, seguida de un aumento del 2,44% anual entre 2015 y 2022. La estratificación por sexo reveló tendencias significativas para los hombres, con una disminución anual del 15,62% en el período inicial y un aumento anual posterior del 2,9%, particularmente asociado con las enfermedades cardiovasculares, que representaron el 10,0% de las muertes prevenibles en hombres. Entre las mujeres, se observó una tendencia descendente promedio del 0,23% anual, sin significancia estadística. **Conclusión:** Se observó una mayor tasa de mortalidad prevenible en los hombres, y de estos, las ENT tuvieron una tasa más alta durante el período. El análisis de datos de mortalidad es una práctica como herramienta para la gestión, planificación y evaluación de políticas públicas.

Palabras Clave: *Mortalidad. Causa de muerte. Tasa de mortalidade. Indicadores de morbilidad y mortalidade.*

INTRODUCTION

Since the implementation of the Unified Health System (SUS) in 1990, the promotion, prevention, and access to health have been enshrined as fundamental rights guaranteed by the Federal Constitution, establishing shared responsibility between the State and individuals throughout the life cycle, encompassing all instances and levels of care in a universal manner.[1] The evaluation of population health involves, among other approaches, the analysis of the effectiveness of health services offered in different regions, with health indicators playing a central role in converting data into useful information for the formulation and implementation of public health policies. These indicators allow the identification of trends over time, assisting in disease monitoring and the evaluation of existing programs.[2]

Among the main indicators used, mortality stands out, providing geographical, demographic, and etiological information about the determinants of deaths, allowing for more effective health interventions and policies.[3] These indicators are crucial for monitoring and analyzing the performance of the health system, enabling the formulation of evidence-based actions to benefit all users of the SUS.[4]

The mortality indicator reveals a significant evolution in the last thirty years in Brazil, reflecting reductions in death rates in parallel with demographic and epidemiological transformations driven by the consolidation of the SUS.[5] However, this transition is not homogeneous in all regions of the country; areas with less socioeconomic development show a slower reduction in mortality from infectious diseases and external causes.[6] The authors emphasize that, although Brazil is experiencing a transition in mortality and morbidity patterns, significant disparities persist attributed to social inequalities and difficulties in accessing health services.[1]

Avoidable mortality as a concept emerges as an essential tool for monitoring trends and evaluating the quality of health care. This approach allows the identification of discrepancies between observed and expected deaths, reflecting the impact of medical interventions, technological advances, and health practices.[7] The analysis of mortality from preventable causes contributes to understanding death profiles, providing support for the development of public policies that respond to regional demands, and for local planning, allowing primary care to direct its efforts to the most vulnerable groups.[8]

The Brazilian List of Preventable Causes of Death by health system interventions, developed after the implementation of the SUS (Brazilian Unified Health System), defines situations in which deaths could be prevented by appropriate health care actions and preventive measures.[9]

In this context, preventable mortality in Brazil shows significant progress in recent decades, but also reveals persistent inequalities that challenge the health system. Data from the 2019 Global Burden of Disease (GBD) study show that, although mortality rates from preventable causes decreased significantly between 1990 and 2019, with a reduction from 343.9 to 155.8 deaths per 100,000 inhabitants, the decline was more pronounced for infectious causes, maternal and neonatal conditions, while non-communicable chronic diseases (NCDs) and external causes remained as structural challenges to public health.[8] The proportional decrease in mortality from NCDs contrasts with their continued status as the main cause of death, highlighting the limitations of strategies for controlling and preventing these diseases amidst population aging and the Brazilian epidemiological transition.[1,8]

Furthermore, the weight of external causes among young adults, especially men, as pointed out by Malta et al, reaffirms the complexity of preventable mortality, influenced by social determinants, violence, and weaknesses in the healthcare network.[8] The negative correlation between preventable mortality and the Sociodemographic Index (SDI) ($R = –0.74$; $p < 0.000001$) reinforces the role of territorial and socioeconomic inequalities in determining health.[1]

In this scenario, it becomes urgent to rethink intersectoral public policies and health surveillance strategies that not only expand access but also promote social justice and equity in the distribution of resources and healthcare. To this end, the continuous promotion of scientific production and rigorous epidemiological analysis is fundamental, as it provides essential technical and ethical support for the formulation of effective, sustainable public policies centered on health equity.

Considering these premises, this study aimed to analyze mortality trends from preventable causes and to outline the profile of preventable deaths in Caçador city, in Santa Catarina, from 2013 to 2022.

METHODS

This study is characterized as descriptive, ecological and time-series, encompassing the analysis of a ten-year historical series, between 2013 and 2022. The research was conducted in Caçador, located in the mid-west of the state of Santa Catarina, in the Alto Vale do Rio do Peixe region, with a total population of 73,720 inhabitants, according to the 2022 Census. Its economy is diversified, with emphasis on the timber, metallurgical, agricultural, and service sectors. Caçador has a healthcare network composed of basic health units, specialized outpatient and hospital services, being

a regional reference in some specialties, considering access and coverage of services as determining aspects of the preventability of deaths. The city presents a demographic and epidemiological profile compatible with regions in transition, with a significant presence of preventable causes of mortality between 5 and 74 years old.[10]

The data used were obtained from the Mortality Information System (SIM), made available by the Department of Informatics of the Unified Health System (DATASUS) platform. Inclusion criteria considered deaths referring to the resident population, occurring in the analyzed period and classified according to the Brazilian List of Avoidable Causes of Death by interventions in the SUS from 5 to 74 years old. The use of this age group is justified by allowing the comparability of data, temporal monitoring, and analysis of the effectiveness of public health policies, based on causes of death that can be prevented by already consolidated interventions, such as immunization, screening, adequate treatment, and health promotion. Additionally, the age range between 5 and 74 years excludes causes mostly attributed to perinatal conditions and extreme senility, focusing on potentially preventable deaths in groups with greater exposure to effective SUS interventions.[9]

The variables analyzed included sex, age group from 5 to 74 years, color/race, place of occurrence, educational level, year of occurrence, and cause of death, according to the chapters of preventable causes defined by the International Statistical Classification of Diseases and Related Health Problems (ICD-10), highlighting the three main subgroups. Deaths of children under 1 year to 4 years were excluded. Annual crude mortality rates were calculated for Brazil and for Caçador, as well as the total rate for the analyzed period.

Initially, bivariate analyses were performed to describe the prevalence of deaths from preventable causes among men and women, according to demographic characteristics such as age, color/race, marital status, and education level. Pearson's chi-square test was applied to verify associations, considering those with a p-value < 0.05 as significant.

For the analysis of the association between sex and sociodemographic characteristics in relation to mortality from preventable causes, descriptive statistics with absolute and relative frequencies were used. The comparison between proportions was performed using Pearson's chi-square test, considering a significance level of 5% ($p < 0.05$).

In situations where the assumptions of the chi-square test were not met, specifically when at least one cell in the table contained an expected frequency less than 5, Fisher's Exact Test was applied. This procedure was necessary for categories with a smaller number of observations, such as the "Yellow" and "Indigenous" categories of the race variable, in order to ensure the statistical validity of the results.

For the temporal analysis of preventable deaths, a descriptive approach was used, based on historical series, with the aim of identifying trends, patterns, and variations throughout the studied period. The temporal analysis was performed using annual rates or moving averages, allowing for the assessment of trends of increase, decrease, or stability over time. The mortality rate from preventable causes was obtained by dividing the number of deaths by the total estimated population for the year of occurrence, and multiplying the result by 100,000 inhabitants. Age standardization was performed using the direct method, using the Brazilian population from the 2022 Census as the standard and stratifying the results by sex.

The temporal trend analysis used Joinpoint regression, employing the Empirical Quantile method and the Weighted Bayesian Information Criteria (BIC). This method, developed by the American Cancer Research Center, allows the identification of changes in mortality trends by detecting inflection points, dividing the data into distinct segments. The Annual Percent Change (APC) was calculated with 95% confidence intervals (95% CI), with APCs with $p<0.05$ considered significant. The analyses were conducted in Joinpoint software version 5.2.0, with a maximum of one inflection point.

The study followed the ethical principles established by Resolutions No. 466/2012 - 510/2016 - 580/2018 of the Ministry of Health, and was approved by the Research Ethics Committee of the University of Alto Vale do Rio do Peixe, under CAAE 83317624.3.0000.0259 and opinion No. 7.111.996 in September 2024.

RESULTS

Between 2013 and 2022, a total of 3,137 deaths were recorded in the city of Caçador (SC). Of these, 67.3% (n = 2,112) were classified as preventable, 29.0% (n = 909) as resulting from causes not clearly preventable (garbage category), and 3.7% (n = 116) had poorly defined causes. Bivariate analysis of deaths from preventable causes showed a higher prevalence in males compared to females. In the age group analysis, the 15-19 year old group stood out among males, with 86.7% of deaths classified as preventable. Among women, the highest prevalence was observed in the 5-9 year old age group (60.0%). The variable color/race did not show a statistically significant association with the preventability of deaths. For categories with a small number of observations, such as 'Yellow' and 'Indigenous', Fisher's Exact Test was applied. In both cases, the p-values (0.304 and 1.000, respectively) indicated the absence of a statistically significant

association between sex and mortality from preventable causes, considering these racial categories.

Regarding marital status, a higher frequency of preventable deaths was observed among single men (73.6%) and widowed women (65.0%). In relation to education level, the prevalence was higher among men with 8 to 11 years of schooling (65.6%) and women without formal education (56,3%) (Table 1).

Table 1. Proportion of avoidable mortality from preventable causes standardized by sex according to sociodemographic characteristics in Caçador between 2013 and 2022.

	Female N (%)	Male N (%)	p-value*
Age range			<0,001
5 a 9	6 (60,0)	4 (40,0)	
10 a 14	8 (42, 1)	11 (57,9)	
15 a 19	6 (13,3)	39 (86,7)	
20 a 24	15 (24,2)	47(75,8)	
25 a 29	19 (27,5)	50 (72,5)	
30 a 34	21 (30,0)	49 (70,0)	
35 a 39	32 (43,8)	41 (56,2)	
40 a 44	47 (41,6)	66 (58,4)	
45 a 49	42 (30,7)	95 (69,3)	
50 a 54	74 (33,6)	146 (66,4)	
55 a 59	102 (40,2)	152 (59,8)	
60 a 64	144 (44,0)	183 (56,0)	
65 a 69	150 (45,3)	181 (54,7)	
70 a 74	157(41,1)	225 (58,9)	
Race			0,173
White	701 (39,7)	1064 (60,3)	
Black	16 (51,6)	15 (48,4)	
Yellow	0 (0,0)	4 (100,0)	
Brown	98 (34,3)	188 (65,7)	
Indigenous	1 (100,0)	1 (50,0)	
Marital Status			<0,001
Single	130 (26,4)	363 (73,6)	
Married	298 (38,9)	468 (61,1)	
Widowed	147 (65,0)	79 (35,0)	
Separated	72 (42,6)	97 (57,4)	
Other	77 (37,0)	131 (63,0)	
Unknown	99 (39,6)	151(60,4)	
Education			<0,001
None	80 (56,3)	62(43,6)	
1 to 3	216 (40,3)	320 (59,7)	
4 to 7	232 (36,7)	401 (63,3)	
8 to 11	111 (34,4)	212 (65,6)	
12 or more	38 (40,0)	57 (60,0)	
Unknown	146 (38,1)	237 (61,9)	

Legend: * Pearson's chi-squared test; * Fisher's exact test.

External causes accounted for 21.0% of preventable deaths, with a predominance of transport accidents (35.7%) and assaults (19.0%). A peak in mortality from external causes was observed in 2021, with 69 deaths (15.6% of the total preventable deaths in the period) (Figure 1).

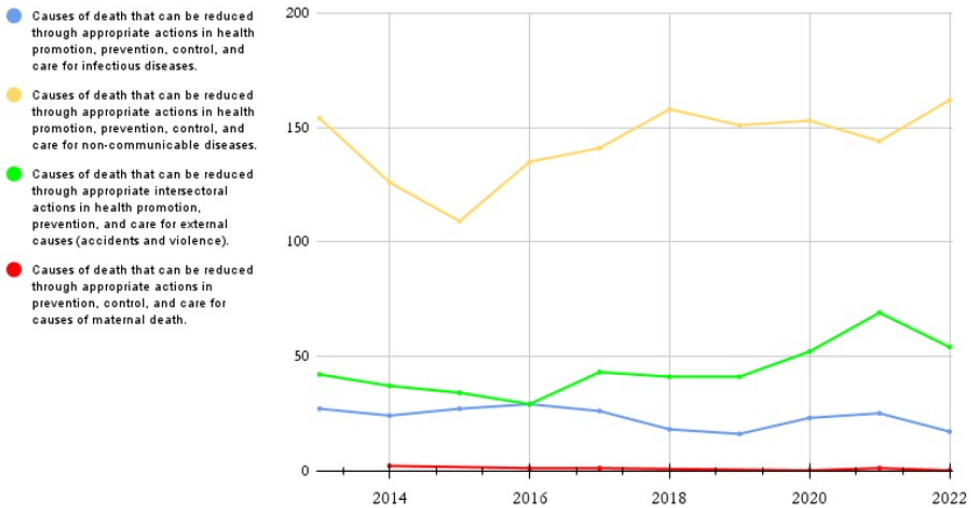

Figure 1. Temporal trends by groups of preventable causes between 2013 and 2022 in the city of Caçador.

Infectious diseases maintained a linear trend (11.0% of the total), with a cumulative reduction of 4.3% during the studied period. Among these, respiratory infections – especially pneumonia and influenza – accounted for 52.0% of cases. Maternal deaths corresponded to 0.24% of the total number of deaths, all attributed to obstetric complications. The estimated Maternal Mortality Ratio (MMR) was 43 per 100,000 live births. No deaths from vaccine-preventable diseases were recorded during the analyzed period.

The temporal trend analysis, performed using the Joinpoint model, identified two distinct phases: an average annual reduction of 13.09% (not statistically significant) between 2013 and 2015, followed by an increase of 2.44% per year from 2015 to 2022 (Table 2; Figure 2). Stratification by sex showed significant trends for males, with a decrease of 15.62% per year in the initial period and a subsequent increase of 2.9% per year, especially associated with cardiovascular diseases (CVD), which represented 10.0% of preventable deaths among men. In females, an average decreasing trend of 0.23% per year was observed, without statistical significance (Table 2; Figure 2).

Table 2. Annual Percentage Change (APC) and 95% Confidence Intervals (95% CI) of age-standardized mortality rates from preventable causes, stratified by sex, in Caçador between 2013 and 2022.

Sex	Period	APC (CI95%)
Both	2013-2015	-13,09 (-20,5; 0,30)
Both	2015-2022	2,44 (-0,67; 13,52)
Male	2013-2015	-15,62 (-23,40; -1,81)*
Male	2015-2022	2,90 (0,06; 13,13)*
Female	2013-2022	-0,23 (-3,09; 2,82)

Legend: *p<0,05

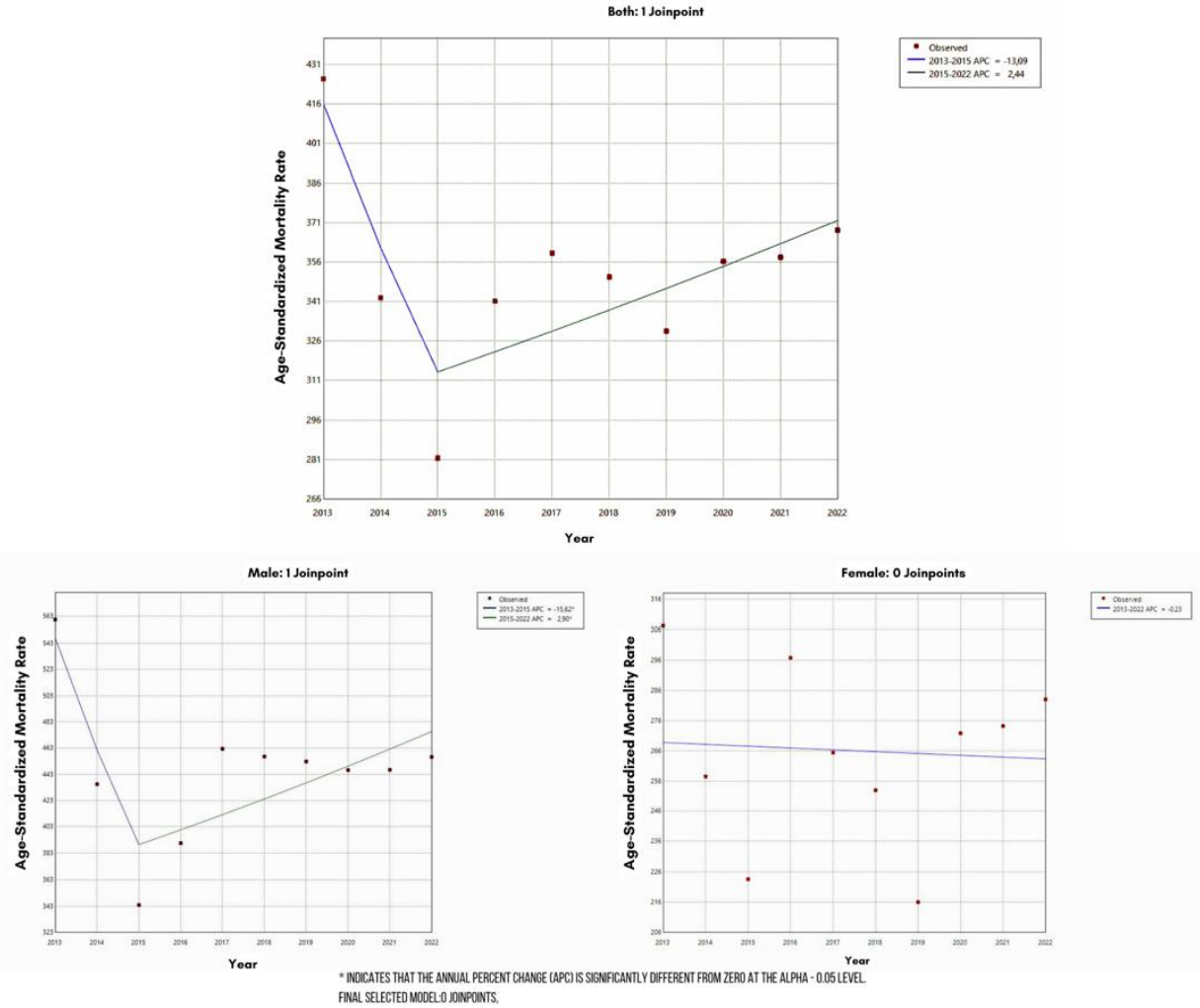

Figura 2. Joinpoint regression model of the standardized mortality rate for all preventable causes (A), for males (B) and for females (C) in Caçador between 2013 and 2022.

DISCUSSION

The results of this study reinforce previous findings on disparities in mortality by sex, with a higher proportion of preventable deaths among men. This difference is often attributed to lower male adherence to health services and factors related to male lifestyle and social contexts in which they are embedded.[11,12] In addition, men tend to seek medical attention only in situations of clinical worsening, which compromises the effectiveness of preventive actions and can contribute to more serious outcomes.[13] Another relevant issue concerns the organization of operating hours of health services, especially those linked to the Unified Health System (SUS). The predominantly daytime hours of

operation can constitute a significant barrier to access for men who are working during this period, hindering the provision of preventive care and continuous health monitoring.

The predominance of deaths among white individuals in Caçador reflects the demographic profile of the state of Santa Catarina, which, according to the 2022 Demographic Census, has the second highest percentage of white population in the country (76.3%).[10] This data, therefore, does not reveal a specific racial inequality, but follows the local population composition. Regarding marital status, the literature suggests that marital union is associated with healthier lifestyles and greater social support, which may explain the higher mortality observed among single men.[14] In the case of women, the higher mortality rate among widows may be related to female longevity and greater exposure to chronic conditions at advanced ages.[15] In this regard, the authors highlight the greater propensity of women to practice self-care and adhere to health prevention actions.[13]

Throughout the analyzed period, it was observed that non-communicable chronic diseases (NCDs) represented the main cause of preventable deaths, accounting for 68.0% of these deaths. Among them, cerebrovascular diseases (15.0%), ischemic heart diseases (14.0%), and diabetes mellitus (13.0%) stand out. The temporal analysis revealed a slight decrease between 2013 and 2015, followed by stabilization until 2020 and a gradual increase in 2021 and 2022. These findings align with authors who attribute the growth of NCDs to population aging, but also reveal structural weaknesses in the health system's capacity to carry out effective actions for the prevention, control, and continuous care of NCDs, especially in territories marked by social vulnerabilities.[1,8,16] The Global Burden of Disease (GBD) study indicates that, although standardized mortality rates for NCDs have decreased in recent decades, the absolute number of deaths remains high, especially in the North and Northeast regions, where primary care coverage is often insufficient and social determinants of health, such as low income, limited education, and food insecurity, strongly influence illness.[8] The World Health Organization (WHO) recognizes that genetic, behavioral, and environmental factors contribute to the development of these diseases.[17] NCDs are aggravating factors for mortality rates; therefore, primary care plays a fundamental role in the diagnosis and management of these diseases, thus preventing future complications, with expanded diagnostic capacity, provision of longitudinal and multidisciplinary care, health education programs focused on self-care and behavioral changes, in addition to integration with intersectoral actions that promote healthy environments and equitable access to social determinants of health.[18]

Regarding external causes, which accounted for 21.0% of preventable deaths, their prevalence among young people stands out, representing a significant impact on premature mortality. Similarly, studies corroborate the data and show an increase in mortality from external causes in recent years, mainly mortality related to traffic accidents.[19] The recommendations of the Ministry of Health for the consolidation of intersectoral actions in education, prevention, and strengthening of the emergency network to reduce morbidity and mortality from external causes are highlighted.[20]

Among deaths from infectious causes, respiratory infections – mainly pneumonia and influenza – were responsible for more than half of the cases (52.0%). The global reduction in infant mortality from pneumonia is directly associated with the introduction of the pneumococcal vaccine. However, this progress is still uneven, especially in regions with less access to vaccination.[21]

Maternal deaths, which represented 0.24% of the total deaths, showed a Maternal Mortality Ratio (MMR) of 43 per 100,000 live births, a value close to the state average (41/100,000) and lower than the national average (77/100,000).[22] Despite advances since the 1990s, maternal mortality still requires continuous efforts, especially through the strengthening of Maternal Death Investigation Committees and the qualification of obstetric care.[23]

The fact that no deaths from vaccine-preventable diseases were registered during the analyzed period is an indication of the effectiveness of immunization policies, especially the National Immunization Program (NIP), whose coverage has historically been high in the city.[24]

This result highlights the importance of maintaining high vaccination rates and epidemiological surveillance as essential strategies for the prevention of vaccine-preventable diseases. This study has important limitations, among which the use of secondary data from death records stands out. These records are subject to underreporting, inconsistencies in filling out death certificates, and inaccurate classification of causes of death – especially in cases categorized as garbage codes (poorly defined). Such limitations may compromise the accuracy of the estimates, especially in specific cause analyses. To mitigate these effects, rigorous classification criteria were adopted according to the Brazilian list of preventable causes, and a stratified analysis was performed by demographic variables, in addition to the use of statistical trend techniques that increase the robustness of the findings. For future studies, the incorporation of qualitative methods and triangulation of sources is suggested for a deeper understanding of the determinants of preventable mortality in the local context.

The findings of this study reiterate the urgency of an integrated, intersectoral, and territorialized approach to health, centered on equity, the prevention of diseases, and the reduction of structural inequalities that permeate the Brazilian health system. The persistent and high proportion of preventable deaths, particularly among men of working age and due to NCDs, reflects failures in guaranteeing timely access, continuity of care, and the effectiveness of Primary Health Care (PHC) actions.[1,8] Furthermore, social vulnerability determined by factors such as low education, food insecurity, precarious housing, and unemployment exacerbates the risk of illness and premature death, disproportionately impacting peripheral, Black, Indigenous populations, and those residing in regions with a low Sociodemographic Index (SDI).[8]

Considering this perspective, strengthening PHC with well-distributed multidisciplinary teams, updated care protocols for chronic diseases and external causes, expanding health promotion actions in school, community, and work contexts, as well as investing in epidemiological surveillance sensitive to the local reality and improving the quality of death records, becomes strategic. The continuous and qualified analysis of mortality data should be valued as a management and monitoring tool, capable of supporting evidence-based public policies aimed at overcoming health inequities, especially through actions focused on the most underserved territories. In this way, the promotion of life and the prevention of avoidable deaths become central ethical and operational commitments in the consolidation of a truly universal and equitable health system.

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AUTHORS' CONTRIBUTIONS

Valéria Delazzari Valer contributed to the bibliographic research, writing of the abstract, introduction, methodology, discussion, interpretation and description of the results, table preparation, conclusions, review, and statistics. **Paula Brustolin Xavier** contributed to project administration, bibliographic research, writing of the abstract, introduction, methodology, discussion, interpretation and description of the results, conclusions, review, and statistics. **Maiton Bernardelli** contributed to the writing of the abstract, methodology, interpretation of the results, conclusions, review, and statistics. **Heloisa Marquardt Leite** contributed to the review and statistics. **Bruno Vitiritti** contributed to the review and final adjustments.

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