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Observational Study

Epidemiological Profile of Acute Myocardial Infarction Mortality from 2013 to 2023 in Brazil

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Abstract

Introduction: Cardiovascular diseases are the leading cause of death worldwide, accounting for more than 30% of deaths in Brazil, especially due to Acute Myocardial Infarction (AMI). This study aims to outline the epidemiological profile of AMI deaths in Brazil between 2013 and 2023, analyzing the main variables.

Methodology: This is an ecological study on AMI mortality in Brazil from 2013 to 2023, focusing on identifying epidemiological and regional patterns. The research covered the entire national territory, divided into five regions (North, Northeast, Central-West, Southeast, and South), considering distinct sociodemographic characteristics. Data on AMI deaths were collected from the Mortality Information System (SIM) of DATASUS, classified according to ICD-10. The variables analyzed included sex, geographic region, age group, education level, and race/color.

Results: Between 2013 and 2023, Brazil recorded 1,017,263 deaths from AMI, with a predominance of male deaths (59.1%). The year 2022 had the highest number of deaths (98,019), while 2013 had the lowest (85,939). Statistical analysis indicated an increasing trend in deaths over the decade. Regarding race/color, the white population was the most affected, accounting for 52.06% of deaths, followed by the brown population (36.70%) and the black population (7.91%).

Discussion: The highest mortality rates occurred in the Southeast and South regions, reflecting population density and aging. The white population accounted for 52.1% of deaths, while individuals with lower education levels showed higher mortality. Although some studies indicate a reduction in cardiac mortality rates, the data from this study suggest an increase.

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Introduction

Cardiovascular Diseases (CVDs) are the leading cause of global mortality, surpassing any other health condition and solidifying their position as the primary cause of death worldwide. Despite significant advancements in medical technology, CVDs remain a substantial challenge for healthcare professionals, particularly in developing countries [1].

In Brazil, CVDs are also among the main causes of morbidity and mortality, accounting for just over 30% of all deaths, 31% of which are attributed to Coronary Artery Disease (CAD) [2]. CAD is characterized by insufficient blood and oxygen supply to the heart, with Acute Myocardial Infarction (AMI) being its most significant manifestation. AMI results from partial or complete occlusion of a coronary vessel and has a high mortality rate [3].

Globally, the risk factors for CAD—such as smoking, diabetes, hypertension, abdominal obesity, dyslipidemia, and sedentary lifestyle—are similar to those observed in Brazil. However, epidemiological and socioeconomic factors also play a critical role, directly influencing the prevalence, severity, and treatment of CAD in Brazilian patients [1]. The burden of heart disease is notably higher in the Southeast and South regions of Brazil, leading to elevated mortality rates among low- and middle-income populations.

Given the aging population and the increasing prevalence of associated comorbidities, it is crucial to understand the epidemiology of this condition. Therefore, this study aims to profile the epidemiology of deaths from acute myocardial infarction in Brazil between 2013 and 2023, examining mortality trends based on sex, geographic region, age group, education level, and race/color [4].

While previous studies have extensively explored risk factors and outcomes of AMI on a global scale, there remains a scarcity of research focusing on the detailed epidemiological patterns specific to Brazil. This manuscript seeks to address this gap by providing a comprehensive analysis of mortality trends over the last decade. By incorporating sociodemographic variables and regional disparities, this study aims to offer valuable insights that could inform public health strategies, improve healthcare resource allocation, and contribute to the existing body of knowledge on cardiovascular disease epidemiology in developing countries.

Methodology

Study design

This is an ecological study aimed at analyzing mortality related to acute myocardial infarction in Brazil from 2013 to 2023. Ecological studies are used to evaluate associations at population levels, making them an appropriate approach for investigating the geographic and temporal distribution of health events, such as AMI mortality, over time.

In terms of geographic space, Brazil is the largest country in South America and the fifth largest in the world, with a total area of 8,515,767 km^2 and a population of approximately 213 million inhabitants in 2021, according to the Brazilian Institute of Geography and Statistics (IBGE). The country is divided into five major regions (North, Northeast, Center-West, Southeast, and South), each with distinct sociodemographic and epidemiological characteristics, enabling detailed analysis of health conditions in different geographic contexts [5].

Context

This study analyzes deaths from acute myocardial infarction in Brazil between 2013 and 2023 to understand the epidemiological profile of mortality in the Brazilian population. Monitoring over ten years allows for identifying trends in the cardiovascular landscape, influenced by population aging, lifestyle factors, and medical advancements. These insights are essential for guiding public health policies, optimizing resource allocation, and developing preventive strategies that consider the country's regional and social particularities.

Participants

The study population included all records of deaths and hospitalizations due to AMI that occurred in Brazil between 2013 and 2023, covering all regions of the country. The inclusion criteria considered deaths whose underlying cause was identified as AMI, according to the International Classification of Diseases (ICD-10).

Data sources and variables

The data used in this study were extracted from the Mortality Information System (SIM) and the Hospital Morbidity System (SIH/SUS), available on DATASUS, which is the main source of mortality data in Brazil. The analyzed variables included deaths and the total number of hospitalizations due to acute myocardial infarction categorized by sex, geographic region, age group, education level, and race/color. This approach enabled a detailed analysis of the distribution of AMI deaths across the country, considering demographic, social, and regional differences over the period 2013–2023 [6].

The Mortality Information System (SIM) operates as a national platform that compiles mortality data based on death certificates (Declaração de Óbito - DO) issued by healthcare professionals. The data collection process begins at the local level, where deaths are registered in civil registry offices and municipal health departments, which subsequently transmit the information to state health departments. These data are then centralized and validated at the federal level by DATASUS. SIM covers both Brazilian residents and foreigners whose deaths are formally registered within Brazil. The data undergo regular audits to ensure accuracy, and causes of death are categorized using the International Classification of Diseases, 10th Revision (ICD-10). This systematic approach allows for comprehensive temporal and spatial analyses of mortality, supporting the identification of patterns and trends in AMI-related deaths.

Analysis of AMI subtypes and recurrence

The primary objective of this study is to evaluate overall AMI-related mortality; however, the International Classification

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of Diseases, 10th Revision (ICD-10), utilized for data analysis, permits some degree of specificity by including detailed subcategories within codes I21 and I22. Code I21, which pertains to Acute Myocardial Infarction (AMI), is further stratified into subtypes. Similarly, recurrent myocardial infarctions are classified under code I22, with additional subcategories. Nevertheless, the ICD-10 framework does not distinguish between ST-Elevation Myocardial Infarction (STEMI) and non-ST-elevation myocardial infarction (NSTEMI), representing a significant limitation in the granularity of the data analyzed in this study.

For the purposes of this research, AMI was defined in accordance with international guidelines as myocardial necrosis resulting from prolonged ischemia, identified by elevations in cardiac biomarkers such as troponin, alongside characteristic clinical presentations or electrocardiographic abnormalities. Recurrent AMI events occurring within 28 days were categorized as distinct incidents only if explicitly recorded under ICD-10 code I22. While this methodological approach provides a standardized framework for assessing population-level trends, it does not account for the full spectrum of clinical subtleties associated with recurrent AMI events. These constraints notwithstanding, the use of ICD-10 facilitates a structured and reproducible analysis of AMI-related mortality trends and epidemiological patterns within the Brazilian population.

Ethical aspects

Since the study utilized publicly accessible secondary data, ethical approval was waived as per Resolution 510/2016 of the Brazilian National Health Council. The analysis adhered to ethical norms for research involving secondary data in Brazil.

Statistical methods

Data on AMI-related deaths in Brazil from 2013 to 2023 were analyzed using various statistical methods to identify trends and patterns, employing Excel and GraphPad Prism 8.02.

Initially, the Shapiro-Wilk test [7] was used to assess the normality of annual death data distribution. To explore the temporal relationship of AMI deaths, Pearson's correlation test was applied [8]. Additionally, linear regression was performed on mortality data over the period to provide a clear graphical and statistical representation of temporal trends. A p-value < 0.05 was considered statistically significant.

The geographic distribution of deaths was analyzed using descriptive statistics, assessing disparities in AMI mortality across Brazil's five regions (North, Northeast, Center-West, Southeast, and South). Sociodemographic characteristics of deceased individuals, including sex, race/color, and education level, were also analyzed to outline the epidemiological profile of mortality.

Statistical results were presented through graphs and tables highlighting the distribution of deaths by sex, year, region, race/color, and education level, enabling visual and quantitative comparisons of data over the analyzed decade.

Results

Between 2013 and 2023, Brazil registered a total of 1,017,263 deaths from Acute Myocardial Infarction (AMI), representing a mortality rate of 44.85/100,000 (CI 95% 44.56-45.13). Of these, 59.1% (601,717) of the deaths occurred in men, with a mortality rate of 54.32/100,000 (CI 95% 53.86-54.77), and 40.9% (415,438) in women, with a mortality rate of 35.80/100,000 (CI 95% 35.43-36.16), highlighting a male predominance in deaths from this condition. The year with the highest number of recorded deaths was 2022, with 98,019 deaths from AMI, while the year with the lowest number of deaths was 2013, with 85,939 deaths.

The Shapiro-Wilk normality test applied to the data from 2013 to 2023 indicated that the data were normally distributed (p - value = 0.7792). Additionally, the Pearson correlation test revealed a significant positive correlation, suggesting a rising trend in the number of AMI deaths over the analyzed period (p - value = 0.0077). A linear regression analysis of the data was performed to better visualize the temporal relationship. The equation of the line was Y = 824.8*X – 1571950, representing an increase of 824.8 cases or 0.9% per year, as illustrated in Figure 1.

The distribution of deaths by region was also analyzed. The Southeast region had the highest number of AMI deaths, followed by the Northeast, South, Central-West, and North regions. Detailed figures are provided in Table 1.

These data reflect Brazil's population distribution, with higher death rates in more populous regions. The highest number of regional deaths occurred in 2022 in the Southeast region, with 45,187 records, while the lowest was recorded in 2013 in the North region.

Regarding race/ethnicity, the white population had the highest incidence of deaths, totaling 529,586 (52.06%), followed by the mixed-race population with 373,315 deaths (36.70%). Death distribution among other racial categories included 80,505 deaths in the Black population (7.91%), 5,963 in the Asian population (0.59%), and 2,101 among Indigenous

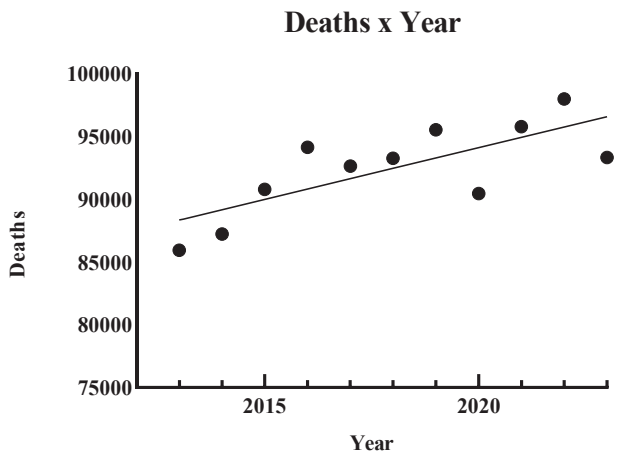

Figure 1: Deaths from acute myocardial infarction, Brazil 2013-2023.

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people (0.21%). Additionally, there were 25,793 deaths (2.54%) where race/ethnicity was not specified. This analysis suggests a mortality distribution relatively consistent with Brazil's self-reported racial demographics.

The analysis also included the educational level of the deceased, as detailed in Table 2.

Finally, the age group distribution of AMI deaths over the period is shown in Table 3.

Discussion

The results of this study indicate 1,017,263 deaths from Acute Myocardial Infarction (AMI) in Brazil between 2013 and 2023. The male predominance in AMI mortality, accounting for 59.1% of deaths, aligns with international literature that identifies a higher cardiovascular risk among men. This finding may be attributed to known risk factors, such as a higher prevalence of risky behaviors, hormonal differences, and lipid profiles, making the male population more vulnerable to cardiovascular events [9].

The regional analysis revealed a higher incidence of AMI deaths in more populous regions, particularly in the Southeast, which had the highest absolute number of deaths. These data reflect population density and demographic profiles, as the Southeast and South regions have relatively older populations, a significant risk factor for AMI [10]. Previous studies also highlight how population aging and unequal access to healthcare contribute to cardiovascular mortality distribution. Regions with more robust healthcare infrastructure might offer better prevention and treatment, although significant disparities in care persist [11].

Table 1: Deaths from acute myocardial infarction by region, Brazil 2013–2023.

Region	Deaths
North	57.022
North East	280.937
Southeast	470.078
Sul	140.496
Midwest	68.730
Total	1.017.263

Table 2: Deaths from acute myocardial infarction by education level, Brazil 2013–2023.

Education	Deaths
No education	179.585
1 to 3 years	239.971
4 to 7 years	224.132
8 to 11 years old	158.321
12 years and over	55.035
Ignored	160.219
Total	1.017.263

Table 3: Deaths from acute myocardial infarction by age group, Brazil 2013–2023.

Age Range	Deaths
Up to 19 years old	1.367
20 to 49 years old	93.837
50 to 59 years old	153.302
60 to 69 years old	240.792
70 to 79 years old	255.855
80 years and over	271.270
Total	1.017.263

In terms of race/ethnicity, the white population had the highest proportion of AMI deaths (52.1%), followed by the mixed-race population (36.7%). While the white population constitutes approximately 42.7% of Brazil's population, their higher proportion of deaths may reflect factors such as healthcare access, socioeconomic disparities, and risk factor prevalence. Similarly, the Black population, representing 9.1% of the Brazilian population, accounted for 7.9% of AMI deaths, suggesting potential inequalities in disease management and prevention. These findings highlight the need for a deeper investigation into the impact of socioeconomic conditions and healthcare access on AMI mortality, considering that the mixed-race population, Brazil's largest demographic group (47.0%), accounted for a smaller proportion of deaths [12].

The relationship between education and AMI mortality is also significant. The highest proportion of deaths occurred among individuals with lower education levels, indicating a social gradient directly influencing cardiovascular outcomes. Lower educational levels are often associated with limited access to health information, fewer prevention and early diagnosis opportunities, and greater exposure to risk factors such as smoking, obesity, and sedentary lifestyles [13]. The high proportion of deaths in the "unspecified education level" category underscores the need to improve the quality of mortality records in Brazil to obtain a more accurate understanding of the role of education in health outcomes [12].

Regarding age, the data align with established literature, showing that the risk of AMI mortality increases significantly with age. The age groups of 60–69, 70–79, and 80 years or older accounted for the highest proportions of deaths [14]. This pattern is consistent with research linking aging to an increased prevalence of chronic diseases and cardiovascular system deterioration. Although higher death rates among older age groups are expected, the data emphasize the importance of preventive interventions and early management of risk factors in younger populations [10-15].

Another relevant study analyzing heart disease mortality trends in Brazil suggests decreasing rates, particularly in more developed regions, mirroring trends observed in countries like the United States and Australia [2]. However, the data from this study suggest an increasing trend in AMI mortality in Brazil over the past decade. The Pearson correlation test identified a significant positive correlation, and the linear regression analysis confirmed this upward trend. This may indicate a rise in risk factors such as obesity, hypertension, and diabetes, or improvements in death registration and AMI diagnosis.

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The comparison of mortality due to Acute Myocardial Infarction (AMI) between Brazil and other South American countries reveals both similarities and significant differences. In Argentina, the ARGEN-IAM-ST registry indicates that in-hospital mortality from AMI remains high despite elevated reperfusion rates, such as angioplasty. Mortality has not shown a significant reduction over the past eight years, underscoring the need for more effective public health interventions, particularly considering the prevalence of risk factors such as hypertension, diabetes, and dyslipidemia [16]. Additionally, a comparative study among Latin American countries, including Argentina, Cuba, and Mexico, observed that dyslipidemia accounted for 36% of AMI cases in Argentina, highlighting the importance of prevention strategies targeting elevated cholesterol levels. In contrast, diabetes had a more significant impact on AMI mortality in Mexico [17].

The situation in Brazil, similar to that of other South American countries, reflects a growing prevalence of cardiovascular risk factors such as hypertension and obesity, which contribute to the increase in AMI-related deaths. Differences among countries, including genetic and environmental factors, as well as disparities in healthcare access, also influence mortality rates. Finally, the comparison among these nations reinforces the need for a multifactorial approach and more effective public policies for AMI prevention and treatment, taking into account individual risk factors and the cultural and social specificities of each region.

Future studies should consider socioeconomic variables, healthcare access, and the impact of AMI prevention and management strategies across regions and population groups. Additionally, improving record quality and standardizing diagnostic criteria are essential for a better understanding of AMI's impact and for proposing more effective public health strategies in Brazil [18].

Conclusion

The data highlight that AMI mortality is more prevalent among men, older adults, and individuals with lower education levels, emphasizing the need for targeted strategies for these high-risk groups and further studies with in-depth methodologies to establish stronger causal relationships between factors and the disease.

Author 's Contributions

- **Pedro Henrique Amorim Moura dos Santos (Corresponding Author)**
- Study conception and design
- Data collection, analysis, and interpretation
- Manuscript drafting and critical review
- Final approval of the manuscript version
- o **Position:** First Author (due to the central role in study development and communication with the journal)
- **Nelson Agapito Brandão Rios (Supervisor)**
- Overall project supervision
- Guidance in study conception and design
- Critical review of the manuscript for intellectual content
- Final approval of the manuscript version

Position: Last Author (Indicating the role as supervisor and advisor)

- **Mário Leite de Sousa Neto**
- Data collection and analysis
- Partial drafting and contribution to the manuscript's critical review
- Final approval of the manuscript version
- **Luiz Amadeu de Sousa Nogueira Matias**
- Data collection
- Participation in the manuscript's critical review
- Final approval of the manuscript version
- **Carlos Eduardo Alencar**
- Data analysis
- Partial drafting and manuscript review
- Final approval of the manuscript version
- **Kahuã Andrade Silva**
- Data collection and analysis
- Critical review of the manuscript
- Final approval of the manuscript version
- **Roberto César de Arêa Leão Nascimento**
- Partial drafting and result interpretation
- Critical review of the manuscript
- Final approval of the manuscript version

Ethical approval

Since this study utilized publicly accessible secondary data, it was exempt from ethical approval by the Research Ethics Committee involving Human Subjects, as outlined in Resolution 510/2016 of the Brazilian National Health Council. Thus, the analysis adhered to the current ethical norms for research using secondary data in Brazil.

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