

# Epidemiological study of morbidity and mortality from osteomyelitis in Brazil (2014- 2023)

## Abstract

Osteomyelitis is an infectious inflammatory disease of acute or chronic nature that affects bone tissue, caused by the invasion of microorganisms (through exposure of injured skin tissue), by conventional trauma or post-surgical procedure, spreading through the systems and lodging in the bone, which can lead to necrosis. This is a research of great scientific relevance, as it gathers, associates and presents epidemiological data necessary for understanding the pathological profile of this disease, highlighting its signs and symptoms, diagnostic and treatment methods, to improve academic and professional knowledge about osteomyelitis, which has high morbidity and mortality due to late diagnosis, with complex therapeutic management. Therefore, the objective of this study was to investigate the epidemiological profile of morbidity and mortality due to osteomyelitis in Brazil in the last decade, in order to provide data that support future research and serve as a basis for planning government actions regarding the prevention, diagnosis, and treatment of this pathology. For this, an epidemiological, ecological, cross-sectional, quantitative, and descriptive study was carried out, with secondary data from the SUS Hospital Information System/SIH-SUS (TABNET/DATASUS)-Ministry of Health-Brazil, of a time series (2014 to 2023), on ICD-10-M86: Osteomyelitis, in which variable parameters were measured: region, year, hospitalizations, race, sex, amount spent, average days of stay, deaths, and mortality rate. The data were tabulated in Excel, and the results presented in graphs, absolute numbers, and frequencies. This research does not require submission/approval by a Research Ethics Committee, as it uses secondary data from DATASUS. There were  $n = 149183$  hospitalizations for this pathology during the study period, with oscillating trends until 2019, a decrease in 2020 and a constant increasing trend until 2023. There was a predominance in the Southeast region (39%), followed by the Northeast region (29%) and the North region had fewer hospitalizations (6%). Males represented 71% of the sample. Regarding race in Brazil: more frequent in brown people (43%), followed by white people (31%), with variability in hospitalizations by race, between the regions, with the white race predominating in the Southeast ( $n = 24787$ ) and South ( $n = 16989$ ), and the brown race in the Northeast ( $n=26084$ ), Central-West ( $n = 7282$ ) and North ( $n = 6557$ ). The total amount spent in the period was  $n=R\$ 167977258,48$ . These data demonstrate that there is a high number of hospitalizations due to osteomyelitis in Brazil, with high costs, many days of hospitalization and some deaths. There were more hospitalizations, a higher average number of days and a higher mortality rate in the Southeast. Males were more affected, and brown and white individuals were more affected. It is highly relevant to closely monitor infectious processes in the body in order to prevent the bone progression of this infection in a case of osteomyelitis, through primary diagnosis and effective treatment in less severe phases at an outpatient level, and thus prevent hospitalizations and deaths, through early treatment, with better established care and antibiotic therapy protocols.

**Keywords:** epidemiology, osteomyelitis, hospitalization, public health

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## Introduction

Osteomyelitis is an infectious inflammatory disease of a chronic or acute nature that affects bone tissue, which originates when a pathogenic agent (virus, bacteria or fungi) invades the body through exposure of injured skin tissue, as well as through an episode of trauma or due to complications after surgical procedures, spreading through the systems and lodging in the bone, which can lead to tissue necrosis.<sup>1</sup> It presents high morbidity and mortality, with complex therapeutic management, which often depends on early diagnosis.<sup>2</sup>

In this context, osteomyelitis develops from various pathological conditions, such as cases of Diabetes Mellitus (DB), which is a chronic disease with recurring symptoms of diabetic foot, in which ulcerated lesions due to vascular and nerve damage in the patient

become infectious foci with the potential to affect deeper tissue, such as bone tissue, leading to deterioration and necrosis, which result in limb amputations, systemic risk of infection and, often, death.<sup>3</sup>

Furthermore, other more common diseases also have the risk of worsening into osteomyelitis, due to the poor sanitary conditions of individuals associated with the delay of therapeutic interventions in those with lower socioeconomic levels and precarious access to health services. As proof of this, a rare case of osteomyelitis in the cranial region caused by furuncular myiasis is reported, in which boils in the epithelial tissue of patients due to local contamination by fly larvae deposited on the skin of individuals, become a serious bacterial infection in the case of osteomyelitis. In this sense, cutaneous myiasis has a high incidence in countries in the Central and South American regions, as well as in Africa, due to poor hygiene habits and limited

health resources for adequate diagnosis and treatment, making it essential to monitor population pathologies and direct state resources to avoid the increase in the complexity of cases like this.<sup>4</sup>

Its symptoms include pain, edema, fever, chills, abscesses, and local erythema. Early diagnosis and therapeutic management by a multidisciplinary team are essential to reduce morbidity rates and improve the patient's prognosis.<sup>5</sup> It can affect any bone in the body, with the face being a site of occurrence of the rarest, most complex, aggressive, and fatal pathological form, due to the fact that the anatomical area of the region is extremely complex and has extensive vascularization, making it a region that is difficult to manage the infectious process. Furthermore, systemic factors that reduce the vascularization of bone tissue and immunosuppression worsen the patient's clinical condition and prognosis.<sup>6</sup>

In the face, the main cause of osteomyelitis is infectious, mainly due to dental procedures and lack of postoperative care, with infectious spread to the bony region of the face.<sup>7</sup> Among the bones of the skull, osteomyelitis mainly affects the mandible because its cortical bone is thicker with denser trabeculae, in addition to having low vascularization, making it more susceptible to infections than the maxilla.<sup>8</sup>

In this context, to diagnose this disease, laboratory tests are performed, analyzing microbiological culture, erythrocyte sedimentation rate and C-reactive protein, which are part of the analysis of the infectious and inflammatory process of osteomyelitis. In addition, both radiography associated with clinical bone percussion and magnetic resonance imaging are used to aid diagnosis, with biopsy being the gold standard for verifying the presence of pathology.<sup>9</sup>

In cases where there is the presence of necrotic tissue, antibiotic therapy, which is essential in the treatment of osteomyelitis, is not as effective, requiring precise surgical treatment due to the local complexity, with removal of the necrotic bone area of the affected soft tissues, eradicating the infection, in order to avoid further systemic involvement in bones in other areas of the human body.<sup>6,8</sup>

Therefore, surgical treatment of osteomyelitis in the face is essential for resolving the condition, resolving cases with a late diagnosis, in situations of complications and persistence of the disease after conservative therapy with drainage of collection, culture, antibiotic therapy, antibiogram and culture, in addition to supportive therapy. The surgical options for treating osteomyelitis are: sequestrum, cauterization and debridement.<sup>7,10</sup>

Therefore, in order to minimize the damage caused by extensive and invasive surgical procedures, which result in anatomical impairment of the face, loss of masticatory function and emotional imbalances due to a decrease in the patient's quality of life, early diagnosis is essential in order to improve the prognosis of the disease, preventing an increase in the mortality rate due to osteomyelitis.<sup>10</sup>

In view of this, this study aims to study the epidemiological profile of hospital morbidity and mortality from osteomyelitis in Brazil, to better understand the most affected groups and thus provide more knowledge about the epidemiology of this disease in our country, so that these data can support public health policies that allow the development of prevention actions, better diagnosis, greater effectiveness in treatment and minimize deaths.

## Methodology

An ecological, quantitative, descriptive and cross-sectional epidemiological study was carried out using secondary data from

the Brazilian Ministry of Health's Unified Health System (TABNET/DATASUS) Information System, covering a decade, from 2014 to 2023, on the topic of osteomyelitis, according to the 10th International Classification of Diseases (ICD-10): M86-Osteomyelitis.

TABNET-DATASUS is a SUS tabulator that allows access to data from the entire Brazilian population, whose health data are collected during health care in the public and private networks and recorded in a broad health information system of the Brazilian Unified Health System, thus being an excellent database on health in our country, providing relevant epidemiological data. Access to this information system is public, free and open to anyone who accesses it, whether or not they are a researcher.

Access is via the digital platform, via the link: <https://datasus.saude.gov.br/>. For information on osteomyelitis morbidity and mortality, the SUS hospital morbidity and mortality tab was accessed through the link: <https://datasus.saude.gov.br/>, the SUS hospital information system, selecting the following variables: SUS Hospital Morbidity - by place of residence - Brazil, osteomyelitis, region, year of processing (2014-2023), hospitalizations, race, sex, amount spent, average amount, average number of days of hospital stay, deaths. The explored data were imported into Excel, where they were tabulated and graphed and the results expressed in absolute numbers and frequencies. These data were later exported to the Bioestat 5.3 Program (a free statistical program, made available online by the Mamirauá Institute), in which exclusively descriptive statistics were performed and the means, standard deviations and coefficients of variation were presented.

Our sample consisted of n=149183 hospitalizations for osteomyelitis. The data criteria refer to the variables mentioned above and directly related to the objectives of this study, excluding data on residents abroad, type of care, care regime, ICD-10 chapter, age group 2, cost of hospital services and cost of professional services, which were not directly linked to our general and specific objectives.

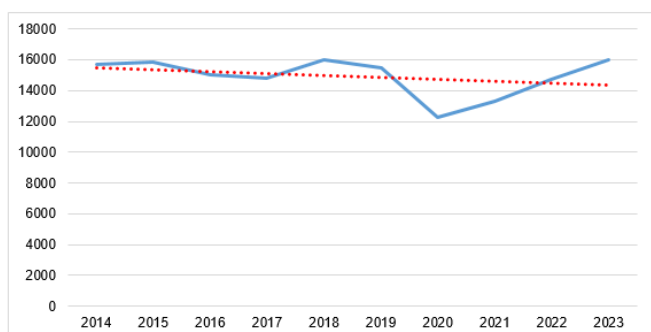
Because it uses secondary data, available in an official and public database of the Brazilian Ministry of Health, which meets the requirements of public administration advertising, and also meets individual rights, with presentation of population data, without presentation of individual information that allows any individual identification, this research does not require submission and approval by a Research Ethics Committee. Thus, this research respects the ethical and legal principles of scientific research in health, respecting the Declaration of Helsinki, as well as respects Brazilian legislation and is in accordance with Resolution 196/96 of the National Health Council (CNS)-Brazil.

## Results

Osteomyelitis in Brazil (Graph 1) has been shown to be quite prevalent. During the study period, there were n=149183 hospitalizations due to osteomyelitis in Brazil. Such hospitalizations showed an oscillating trend until 2019, with a significant decrease in 2020 and a constant increasing trend from 2020 to 2023, remaining below the trend line from 2019 to 2021 and exceeding the initial trend from 2018 to 2019, and from 2022 to 2023. During the period, the mean was found to be 14918, 30 ( $\pm$  1238, 70) and the Coefficient of Variation (CV) was 8,3%.

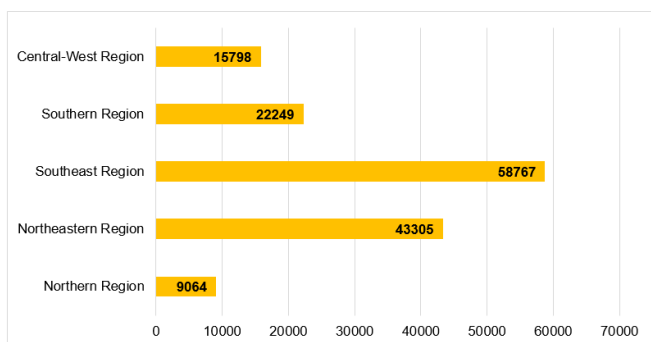
Regarding the regions (Graph 2), in the decade under study, it was observed that the Southeast Region had the highest number of hospitalizations due to osteomyelitis with n=58767 hospitalizations, which represented 39% of the sample; followed by the Northeast

with n=43305 hospitalizations, representing 29%; South with n=22249 hospitalizations, representing 15%; Central-West with n=15798, representing 11% and North with n=9064 hospitalizations, representing 6% of hospitalizations.



**Graph 1** Distribution of hospitalizations due to osteomyelitis in Brazil from 2014 to 2023.

Source: Prepared by the authors, with data from the Ministry of Health - SUS Hospital Information System (SIH/SUS), 2024.

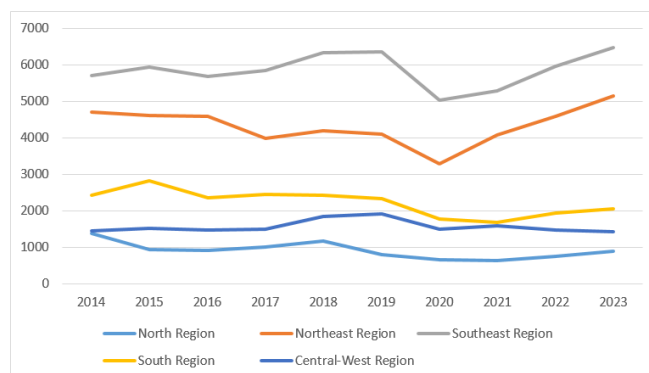


**Graph 2** Distribution of hospitalizations for osteomyelitis in Brazil, by Region, from 2014 to 2023.

Source: Prepared by the authors, with data from the Ministry of Health - SUS Hospital Information System (SIH/SUS), 2024.

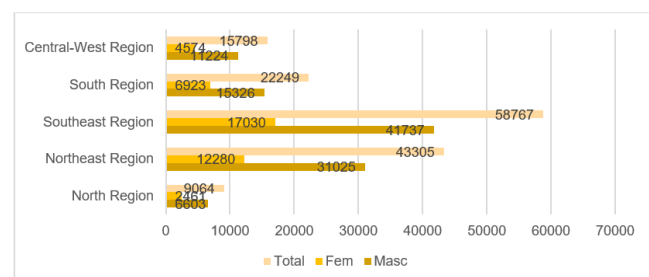
Regarding the distribution of hospitalizations by Brazilian region over the years (Graph 3), it can be noted that in all regions there was an oscillating trend in hospitalizations for this disease. In all regions, there was a decrease in hospitalizations for osteomyelitis from 2019 to 2020, with this decrease beginning in 2018 and continuing until 2021 in the North region, and in the South region, the decrease continued from 2019 to 2021. In the Central-West region, the trend has been decreasing again since 2021. The Northeast and Southeast regions showed a similar pattern of hospitalizations, with an increasing trend from 2020 to 2023. In the Southeast region, the following average was observed =  $5863,90 \pm 459,37$  and  $CV = 7,83\%$ ; the Northeast had an average =  $4332,00 \pm 514,88$  and  $CV = 11,89\%$ ; South had an average =  $2228,6 \pm 350,34$  and  $CV = 15,72\%$ ; Center-West with an average =  $1575,10 \pm 169,68$  and  $CV = 10,77\%$  and the North region with an average =  $918,70 \pm 229,11$  and  $CV = 24,94\%$ .

Regarding sex (Graph 4), osteomyelitis was more prevalent in males with n=105915,00 hospitalizations/osteomyelitis, equivalent to 71% of the sample, while in females n=43268,00 hospitalizations/osteomyelitis, equivalent to 29% of the sample. In all Brazilian regions, the same profile was observed, with more cases for males, following very similar percentages.



**Graph 3** Distribution of hospitalizations due to osteomyelitis in Brazil, by Region/year, from 2014 to 2023.

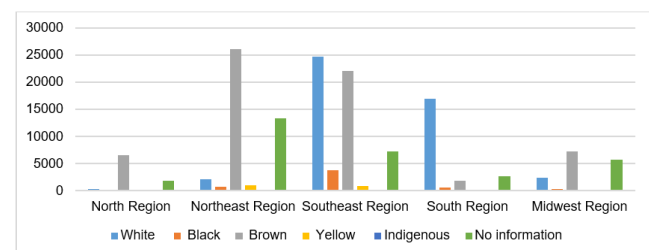
Source: Prepared by the authors, with data from the Ministry of Health - SUS Hospital Information System (SIH/SUS), 2024.



**Graph 4** Distribution of hospitalizations due to osteomyelitis in Brazil, by sex, from 2014 to 2023.

Source: Prepared by the authors, with data from the Ministry of Health - SUS Hospital Information System (SIH/SUS), 2024.

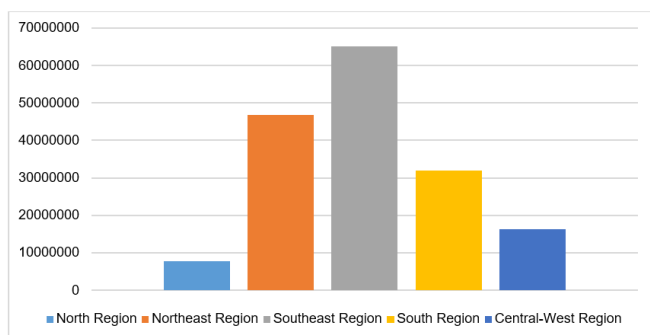
Regarding race/region (Graph 5), most hospitalizations for osteomyelitis occurred in mixed race: n=63916 (43%); white: n=46416(31%); no information: n=30780(21%); black: n=5458(4%); yellow: n=2367(1%); indigenous: n=246(0%). There is variability in the distribution of hospitalizations for osteomyelitis, by race/region, the Southeast region had more cases among whites: n=24787 and mixed race: n=22146; the Northeast region had more cases among mixed race: n=26084 and no information: n=13342; the South had more cases in whites: n=16989 and no information: n=2631; The Center-West had more cases among mixed race people: n=7282 and without information: n=5661 and the North, had more mixed race people: n=6557 and without information: n=1877 hospitalizations due to osteomyelitis.



**Graph 5** Distribution of hospitalizations for osteomyelitis in Brazil, by race/region, from 2014 to 2023.

Source: Prepared by the authors, with data from the Ministry of Health - SUS Hospital Information System (SIH/SUS), 2024.

The total amount spent on hospitalizations for osteomyelitis during the study period was R\$1679772585,00. This value fluctuated over the period, remaining above the trend line from 2014 to 2016, falling in 2017 and showing new growth from 2018 to 2019, remaining below the trend from 2019 to 2021 and showing new growth from 2021 to 2023, therefore with a current trend of increased spending. The region with the highest spending (Graph 6) was the Southeast region with n=r\$65075310,09; followed by the Northeast n=r\$4683682,04; the South n=r\$3204487,90; Central-West n= r\$16281107,50 and North n= r\$7741530,95.



**Graph 6** Distribution of hospitalizations due to osteomyelitis in Brazil, by amount spent/region, from 2014 to 2023.

Source: Prepared by the authors, with data from the Ministry of Health - SUS Hospital Information System (SIH/SUS), 2024.

Regarding the average amount spent in Brazil, it was n=R\$1125,98. The South was the region with the highest average amount spent (n=R\$1437,79), above the national average; followed by the Southeast (n=R\$1109,76); the Northeast (n=R\$1081,18); the Central-West (R\$1033,66); and the lowest average amount spent in the North (n=R\$842,66).

Regarding the average number of days spent, the average in Brazil was n=8, 50 days. This average was highest in the Southeast (n=9, 60) days; followed by the Northeast (n=8,50) days; the Central-West (n=7,70) days; the North (n=7,60) days; and the South (n=6,60) days.

As for deaths, there were n=1970 deaths from osteomyelitis in the decade studied; these deaths were highest in the Southeast, n=982 deaths, corresponding to 50%; followed by the Northeast n=513 with 26%; South n=283 with 14%; Central-West n=141 with 7% and finally the North n=51 with 3% of deaths.

The mortality rate for this pathology in Brazil was n=1,32. The region with the highest mortality rate was the Southeast region with n=1,67; the only region that exceeded the mortality rate for osteomyelitis in Brazil. Followed by the South region n=1,27; Northeast n=1,18; Central-West n=0,90 and North n=0,56.

## Discussion

Through the study of hospitalizations due to osteomyelitis in Brazil between 2014 and 2023, a high number of hospitalizations due to osteomyelitis in Brazil (n=149183) was observed over the period between 2014 and 2023, with a downward trend in the period, with considerable growth in 2018, 2021, 2022 and 2023, revealing that osteomyelitis is still a major public health problem in Brazil, with high average hospitalizations per year. Furthermore, this disease has a complex diagnosis and prolonged treatment, which may require hospitalization in most cases.<sup>11</sup>

As for the regions of Brazil, the Southeast (n=58639) and Northeast (n=43320) regions had the most hospitalizations in the country, following the trends of the studies by Santos et al.,<sup>12</sup> and Muner,<sup>5</sup> who state that these regions are those with the highest number of hospitalizations due to osteomyelitis and those with the longest hospital stays. Furthermore, this factor can be justified due to the high population density and higher HDI of the Southeast region, higher compared to other regions of the country according to the IBGE, having greater access to health, especially for the richest, who have easier access to highly complex services, while the poor have more access to primary care services, which in some cases take time to access the necessary health service.<sup>13</sup>

Regarding the distribution of hospitalizations by Brazilian region over this period, there was a significant fluctuation, with a combined decrease in all regions when comparing the years 2019 and 2020, followed by an increase in hospitalizations in subsequent years. This fact may be influenced by the suspension of hospitalizations during the COVID-19 pandemic and the reduction in the search for medical care, which had a longer impact on hospitalizations for osteomyelitis in the North and South regions, extending until 2021.<sup>14,15</sup>

In addition, it is possible to note that males are predominant in hospitalizations (n=105915), according to the literature and the study by Pires et al.<sup>16</sup> This is because men are the majority in cases of post-traumatic osteomyelitis due to greater exposure to risky activities, such as sports, traffic accidents and work, which cause injuries that, if not treated properly, can develop into osteomyelitis.<sup>17,18</sup> Added to this is the greater reluctance of men to seek medical services and preventive health care, which occurs only in critical situations, thus contributing to the late diagnosis of the disease and the possibility of more serious conditions.<sup>19</sup>

Regarding the racial aspect, it is observed that the majority of hospitalizations for osteomyelitis in Brazil occur among people of mixed race/color (43%), followed by white race (31%), however, there are significant regional variations. In the Southeast and South regions, hospitalizations are predominantly among white people, reflecting the demographic composition and historical process of these areas, marked by a greater presence of European immigrants. In contrast, in the Northeast, North and Central-West regions, the majority of hospitalizations occur among brown people, in line with the more diverse and historically vulnerable population composition of these regions.<sup>13</sup> This scenario highlights racial inequalities that go beyond demographic differences, and are also influenced by structural factors, such as unequal access to health services, socioeconomic conditions and greater exposure to risk factors that complicate osteomyelitis. The Northeast, for example, has a population composed predominantly of black and brown people, and historical and social vulnerability is aggravated by socioeconomic challenges that hinder access to health and education, in addition to precarious living conditions, such as housing in marginalized and unhealthy areas, which favor more severe cases of the disease.<sup>20</sup>

Furthermore, studies such as that of Guimarães,<sup>21</sup> demonstrate that access to health services in Brazil varies widely according to socioeconomic status. Wealthier individuals are able to use these services more frequently and with higher quality, facing fewer restrictions related to costs and time, while vulnerable populations face greater barriers, contributing to the perpetuation of these inequalities.

In relation to the amounts spent, the total amount spent on hospitalizations for osteomyelitis, in the period under study, showed fluctuations. Years with higher numbers of hospitalizations, such

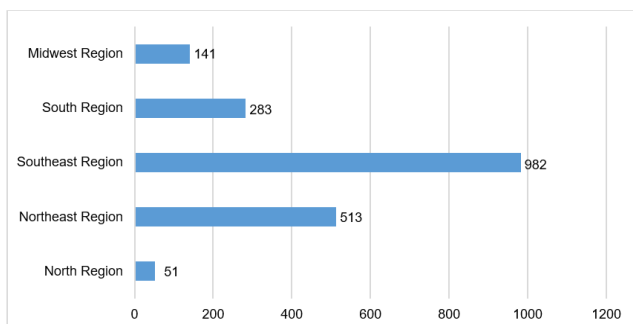


as 2018 and 2019, had proportional expenses, remaining above the trend line. Furthermore, the years 2020 and 2021 were below the trend, so this decline is consistent with the period in which measures were adopted to address the public health emergency of international importance resulting from the COVID-19 pandemic, a fact that may have interfered in the reduction of hospitalizations for osteomyelitis.<sup>22</sup>

The Southeast region had the highest total expenditure on hospitalizations due to osteomyelitis, in addition to recording the highest average number of days of hospital stay (9,6 days), a value higher than the national average of 8,5 days. This high number can be partially explained by the performance of therapeutic procedures, such as lavages and debridements, necessary for the management of the disease, as described by Murta et al.<sup>15</sup>

The relationship between high expenditure and a greater number of hospitalizations and days of hospitalization is consistent with the trends observed in the studies by Santos et al,<sup>12</sup> and Muner,<sup>5</sup> which indicate that regions with a greater demand for hospitalizations tend to accumulate higher costs. Additionally, when analyzing the average amount spent per hospitalization, the South region stood out, with costs higher than the national average, reinforcing the findings of Murta et al.<sup>15</sup>

Deaths from osteomyelitis are a challenge in the country, especially in the Southeast, which has the highest number of deaths (n=982) (Graph 7) and the highest mortality rate (n=1,67), with a value above the Brazilian average (n=1,32). It is known that osteomyelitis represents a significant challenge in orthopedics, especially in the context of surgical procedures, due to the risk of serious complications that can include sepsis and, consequently, an increase in the mortality rate in vulnerable patients.<sup>23</sup>



**Graph 7** Distribution of deaths from osteomyelitis in Brazil, by region, from 2014 to 2023.

Source: Prepared by the authors, with data from the Ministry of Health - SUS Hospital Information System (SIH/SUS), 2024.

Among vulnerable patients, those with chronic diseases, such as diabetes, which increase susceptibility to infections, stand out.<sup>24</sup> Antimicrobial resistance is also a significant concern, making treatment with antibiotics difficult and contributing to persistent and difficult-to-control conditions.<sup>25</sup> Infections associated with joint prostheses also represent an additional risk factor, worsening the clinical condition and increasing mortality in these patients.<sup>26</sup>

Although osteomyelitis is a pathology with high morbidity and mortality, there are clear opportunities to reduce its impact through strategies that combine early diagnosis, training community health workers to identify initial signs of infections that may progress to osteomyelitis, and educational campaigns for at-risk populations,

especially patients with diabetes, highlighting the importance of early diagnosis, hygiene and preventive care to avoid infection, in addition to the rational use of antibiotics.

The regional and racial inequalities observed in the data, together with the vulnerability of specific groups, such as low-income individuals and those in regions with limited health infrastructure, indicate the need for more equitable public policies, adapted to local realities. Investments in prevention, such as health education actions and improvement of sanitary conditions, can minimize the incidence of severe cases.

Furthermore, continuous epidemiological monitoring and the development of research in this area are essential to guide interventions that not only reduce hospitalizations and deaths, but also promote a more efficient allocation of resources and improvements in clinical outcomes.

It is worth noting that our study has limitations inherent mainly to the type of data, as it uses secondary data and whose variables are limited to those available in the DATASUS-SIH-SUS system, allowing us to generate hypotheses, however, without allowing us to infer causality. In order to better search for correlations and associations, field studies are recommended to search for primary data that allow better exploration of the causal relationships that are related to hospital morbidity and mortality due to this disease.

## Final considerations

The findings of this study show that, although osteomyelitis is an often preventable condition, the number of cases and hospitalizations in Brazil has been increasing in recent years, with high costs, long hospitalization periods, and high mortality, especially in the Southeast region. This disease constitutes a serious public health problem. It affects more men, whites, and browns, with regional differences that demonstrate the need to adapt public health policies for the treatment of infectious diseases such as osteomyelitis more appropriately to the realities of each region.

Therefore, it is essential to implement protocols for early screening of the disease, especially for patients with diabetes and other comorbidities, identifying and treating initial infections effectively, reducing cases of osteomyelitis. In addition, other measures such as health education, strengthening sanitary measures, and expanding access to diagnostic tests and outpatient treatment need to be prioritized to ensure quality in access to health, especially for the most affected patient profile. Furthermore, it is urgent to reallocate financial resources equitably, directing funds to the most affected areas, increasing public policies that act mainly on early diagnosis, generating lower spending on hospitalizations in the future, in addition to better established care and antibiotic therapy protocols.

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## Conflicts of interest

The authors declare there is no conflict of interest.

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