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Epidemiological profile of patients hospitalized with acute myocardial infarction in the region of Lower Tocantins in Pará between 2015 and 2024

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SUMMARY

Introduction: Acute myocardial infarction (AMI) remains one of the leading causes of mortality in Brazil, representing a significant challenge for the Brazilian Unified Health System (SUS). (SUS) due to high hospitalization rates, mortality, and costs. In the Tocantins Health Region, Located in the Lower Tocantins region of Pará state, factors such as socioeconomic inequalities and limitations of Unequal access to and distribution of emergency services can significantly influence the... epidemiological profile of the disease. Thus, understanding the behavior of hospitalizations due to IAM between 2015 and 2024 is fundamental for guiding public policies and improving workflows. Assistance and strengthen prevention and treatment strategies in the territory. Methodology: The This study is quantitative, descriptive, and retrospective, based on secondary data from the System of Hospital Information from the Brazilian Unified Health System (SIH/SUS). All hospitalizations due to acute myocardial infarction (AMI) were included. (ICD I21) registered between January 2015 and December 2024 in the Tocantins Health Region. The variables analyzed included: number of hospitalizations per year, sex, age group, and municipality. residence, type of hospitalization, mortality rate, average length of hospital stay and Total and average financial values. Data extraction was performed using the platform. TABNET, and the organization and descriptive analysis were performed in Microsoft Excel® 2019. Results: Annual fluctuations were observed in hospitalizations for AMI, with a significant increase. in 2022 and 2023. Mortality has shown a downward trend in recent years, reaching 8.11 per 100 hospitalizations in 2024. The patient profile showed a predominance of males. (70.27%), while females had a higher proportion of deaths. The age group most The most affected group was the elderly over 60 years of age. The average length of stay ranged between 6 and 7 days. with a slight reduction after 2021. The average cost per hospitalization increased. progressively, reaching more than R$ 6,100 in 2024. Among the municipalities, Abaetetuba, Barcarena and Cametá accounted for the majority of hospitalizations, while the municipalities Younger children presented proportionally high mortality rates. Discussion: The results They reflect the national profile of IAM, highlighting greater vulnerability among men, the elderly, and socioeconomically disadvantaged groups. The differences between municipalities indicate inequalities in healthcare and a potential difficulty in accessing specialized care. in due course. The rise in costs accompanies the trend of increasing complexity of Cases and expansion of assistive technologies. The difference in mortality between sexes and age groups. The age range is consistent with Brazilian studies, reinforcing the need for specific strategies. for higher-risk populations. Conclusion: AMI remains a major cause of Hospitalizations and deaths in the Tocantins Health Region, with clinical and financial impact. significant. Although there is a recent trend of decreasing mortality, [the following] persists. inequalities between municipalities and population groups. The findings reinforce the need for

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expand access to specialized care, strengthen the emergency network, and implement
Preventive actions. Future studies should deepen regional analyses and incorporate data.
Clinical and socio-environmental factors for a better understanding of AMI in the territory.

Keywords: Risk Factors; Acute Myocardial Infarction; Hospitalization; Profile
Epidemiological; Hospital Information Systems.

INTRODUCTION

Cardiovascular diseases (CVDs) represent one of the main causes of
global morbidity and mortality, due to a combination of epidemiological factors,
Demographic, environmental, and social factors. It is estimated that CVDs are responsible for approximately one
one third of deaths worldwide (The Global Cardiovascular Risk Consortium, 2023; Roger et al.,
2020). When considering age-standardized rates, the most prevalent region of
Mortality from acute myocardial infarction (AMI) is highest in the Northeast, followed by the North, Central-
West, Southeast and South (Ferreira et al., 2020).

The main modifiable risk factors for acute myocardial infarction include
smoking, dyslipidemia, hypertension, diabetes mellitus, abdominal obesity, diet
Inadequate nutrition, sedentary lifestyle, excessive alcohol consumption, and psychosocial factors. Factors related to...
Non-modifiable risk factors include advanced age, male sex, and family history of disease.
premature coronary artery disease (Yusuf et al., 2004).

Among cardiovascular diseases, myocardial infarction (MI) stands out due to its clinical, social, and...
economically, it is responsible for high rates of hospitalizations, hospital costs, and deaths.
in different regions of Brazil (Oliveira et al., 2022; Brant & Passaglia, 2022).

In the Legal Amazon, it is observed that metropolitan areas, such as Manaus and Belém, concentrate
greater technical, scientific and population density, which favors diversification and the supply of
specialized health services. These cities become centers of reference both in training
professional in providing care of medium and high complexity cases. Conversely, the scarcity
And the precariousness of these services in other areas of the region intensifies the demand from patients.
coming from the interior and neighboring states. This scenario results in overload and in
tendency towards the strangulation of available health services (Viana et al., 2007).

The Tocantins Health Region, which encompasses municipalities in the Lower Tocantins region, includes:
Abaetetuba, Acará, Baião, Barcarena, Cametá, Igarapé-Miri, Limoeiro do Ajuru, Mocajuba,
Moju, Oeiras do Pará, and Tailândia are characterized by presenting a demographic reality and
geographical area marked by heterogeneity (Almeida, 2010).

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This diversity can influence the epidemiological profile of non-chronic diseases.
transmissible diseases, including AMI, and reflect inequalities in both hospital care and
in clinical outcomes. In this scenario, it becomes crucial to understand how
Demographic and institutional variables are associated with hospitalizations for acute myocardial infarction (AMI) and their outcomes.
outcomes, allowing the identification of patterns and possible disparities between different groups.
population-related.

Therefore, analyzing the behavior of IAM over time and in different
Contexts within the region allow us to gather evidence about factors that may interfere not only
in the occurrence of hospitalizations, but also in the length of hospital stay, in the costs to
public health system and, above all, in associated mortality.

From this perspective, the present study seeks to investigate how different variables
Demographic and contextual factors have been intertwined in the Tocantins Health Region over the course of 10 years.

The main focus is to understand how characteristics such as the year of processing, the
The municipality of residence and the health facility influence the epidemiological scenario.
local.

Furthermore, the research analyzes the impact of individual factors, such as age range and
sex, regarding clinical and operational outcomes.

These elements are directly related to the number of hospitalizations, the average of
length of stay, average cost of hospitalizations, and finally, mortality rate.
resulting from AMI.

1. METHODOLOGY

This study is an epidemiological, observational, quantitative, descriptive, and...
retrospective study, with the objective of analyzing data related to hospitalizations due to AMI in
Tocantins Health Region, in the state of Pará, over the last decade.

A survey was conducted of secondary data made available online by
Department of Informatics of the Unified Health System (DataSUS), in the Hospitalizations system.
Hospitals (SIH), from January 2015 to December 2024 (Figure 1).

Data from outside the specified period (before 2015 or after 2024) were not included in the research.
secondary data from other information systems or other epidemiological studies
available in the literature.

The variables used in the research were: year of processing, municipality of
residence, establishment, age group, and sex. These variables, in turn, were related
Regarding the content: hospitalizations, average length of stay, average cost of hospitalization, and rate of
mortality.

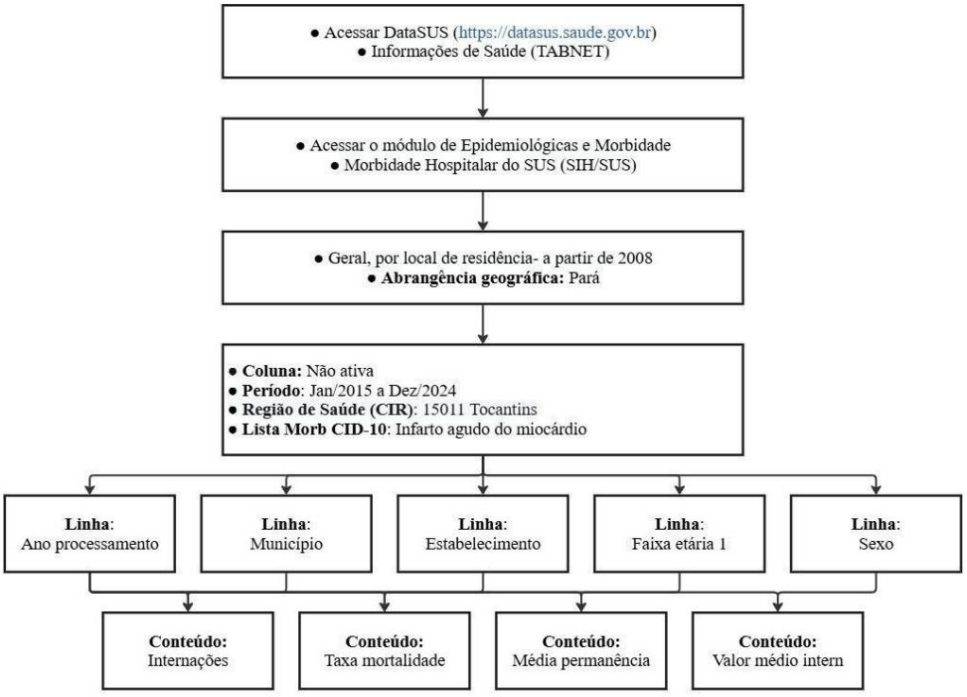
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The study is limited to the analysis of AMI (ICD I21), and it is worth noting that the SIH does not It distinguishes between hospitalizations and individuals, as the system does not allow for the identification of unique patients. It does not delve into other variations, such as, for example, recurrent myocardial infarction (ICD I22).

For data verification, descriptive statistics were used, with absolute numbers and percentages, calculated using spreadsheets and formulas in Microsoft® Excel® 2019.

Figure 1. Flowchart of the process for accessing data in the DATASUS system – Department of Informatics of the Unified Health System.



Source: prepared by the author.

The presentation of the data from this study is structured in two complementary ways: While Appendix 1 presents the raw data in detail, using tables, the topic of Results prioritizes visual analysis, using graphs to highlight trends and correlations in a more intuitive way.

2. RESULTS

2.1. Years of processing

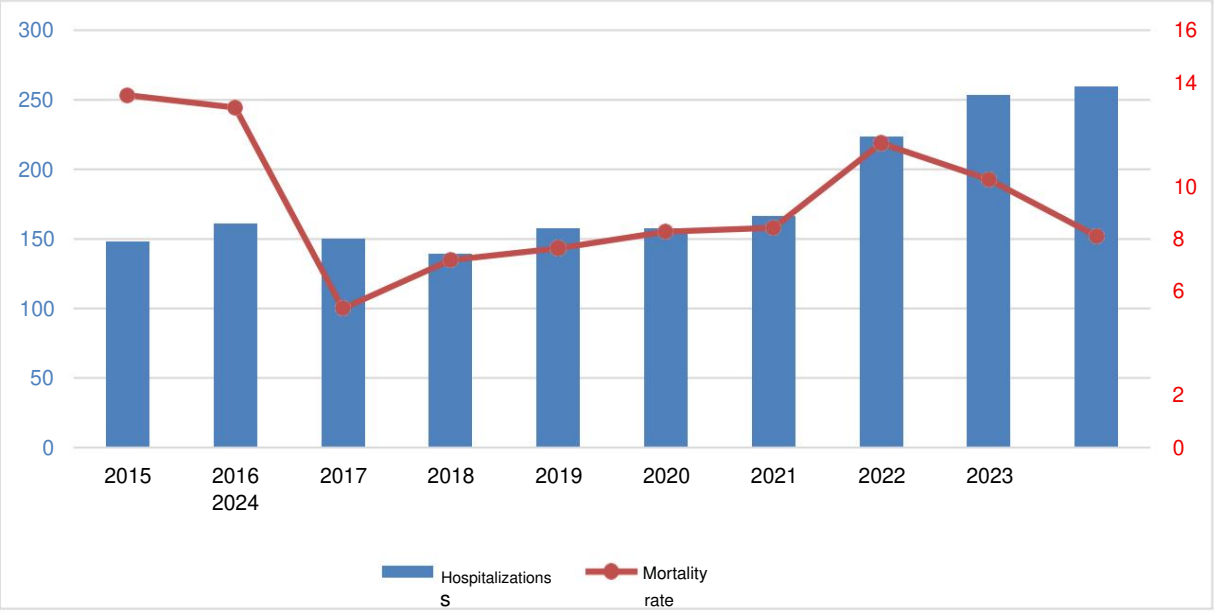
During the period analyzed, moderate fluctuations were observed in hospitalizations due to IAM, totaling just over 1,800 records. Overall, there was a trend of

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growth, with successive, more significant increases starting in 2021 — especially in 2022, when hospitalizations rose by about 34%, followed by further increases in 2023. (13%) and 2024 (2%). Before this period, the annual variations were more discreet, alternating small increases and decreases.

The hospital mortality rate for AMI showed variable behavior, but not linear. Over the period, it maintained an average of approximately 9%, with declines. accentuated in some years — such as in 2017, when there was a reduction of about 59% — and Significant increases in other areas, such as in 2022, which recorded an increase of approximately 38%. In In the final years, a progressive reduction is observed, with a drop of 11% in 2023 and 21% in [year missing]. 2024, bringing the rate closer to values below the average for the period.

Figure 2. Number of hospitalizations (left Y-axis) and mortality rate (right Y-axis) due to acute myocardial infarction in the Lower Tocantins region, per year, during the period of January 2015 to December 2024.



Source: Ministry of Health – SUS Hospital Information System (SIH/SUS).

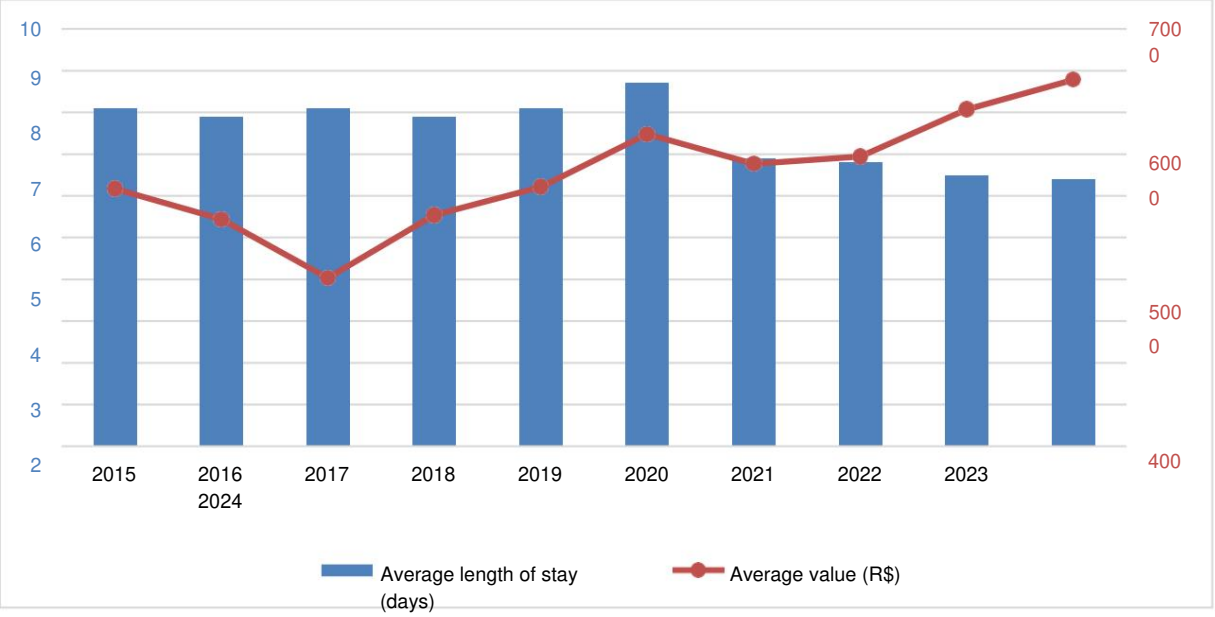
The average length of hospital stays for AMI remained around 7.4 days throughout the period. The study period showed relatively slight annual variations. Stability was observed until... 2020, when there was an increase of approximately 7%, followed by successive reductions. in subsequent years — with the most significant drop in 2021 (ÿ21%) and reductions smaller additional figures in 2022, 2023, and 2024. Overall, the final trend points to shortening the length of hospital stay.

Regarding the average cost per hospitalization, an overall average of approximately R$ was identified. 4,700, with marked fluctuations between years. After significant reductions in 2016 (ÿ12%) and,

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In particular, in 2017 (ÿ26%), there was a resumption of growth, with significant increases.
in 2018 (ÿ37%), 2020 (ÿ20%) and 2023 (ÿ16%). In more recent years, the values have continued
rising, albeit more moderately, reflecting a trend of gradual increases in spending.
for hospitalization.

Figure 3. Average length of stay (left Y-axis) and average cost of hospitalization. (right Y-axis) due to acute myocardial infarction in the Lower Tocantins region, by year, from January 2015 to December 2024.



Source: Ministry of Health – SUS Hospital Information System (SIH/SUS).

2.2. Municipalities of residence

The distribution of hospitalizations due to acute myocardial infarction (AMI) among the municipalities revealed a strong...
Concentration in a few centers. Abaetetuba accounted for approximately 23% of all hospitalizations.
followed by Barcarena and Cametá, both with approximately 17% each. Next, the
Thailand reported approximately 14%, while Igarapé-Miri, Mocajuba, and Baião registered...
Intermediate participation, between 7% and 9%. The lowest volumes were observed in Moju.
(5%) and, more discreetly, in Oeiras do Pará and Limoeiro do Ajuru, both with less than
2%.

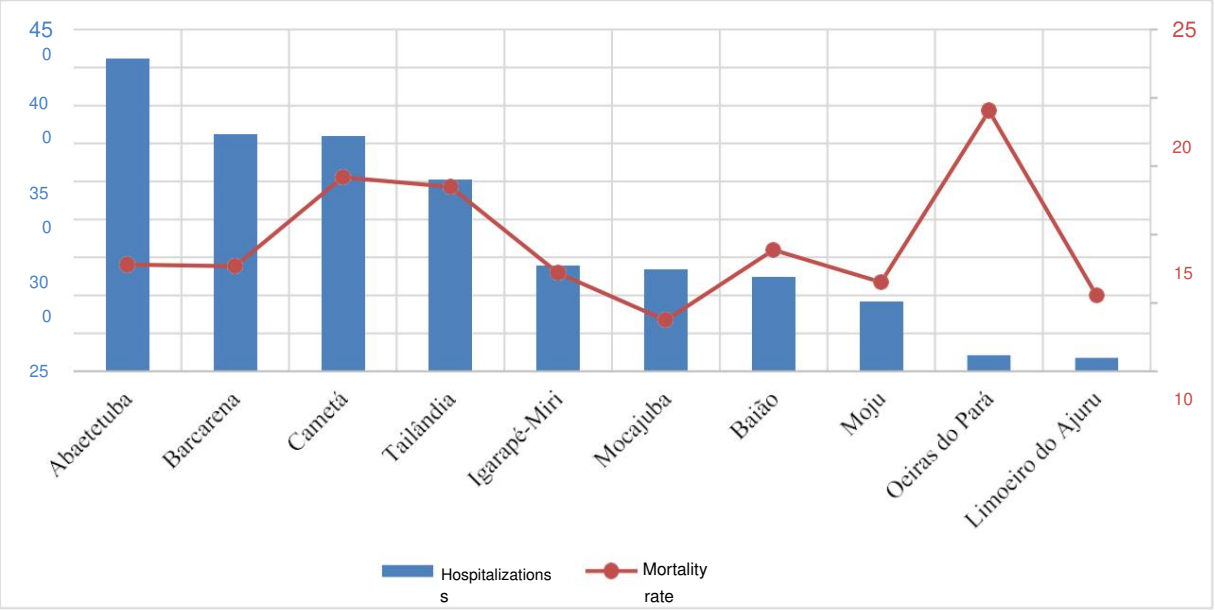
Regarding mortality rates from acute myocardial infarction (AMI), the variation between municipalities was wide.
Oeiras do Pará presented the highest value, followed by Cametá and Tailândia, all with
rates higher than 13%. In an intermediate group were Baião, Abaetetuba, and Barcarena.
and Igarapé-Miri, with rates between 7% and 9%. Moju, Limoeiro do Ajuru, and especially...

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Mocajuba presented the lowest values, all below 7%, indicating lower lethality.
relative in these locations.

Figure 4. Number of hospitalizations (left Y-axis) and mortality rate (right Y-axis)
due to acute myocardial infarction in the Lower Tocantins region, according to the municipality.
residency, from January 2015 to December 2024.



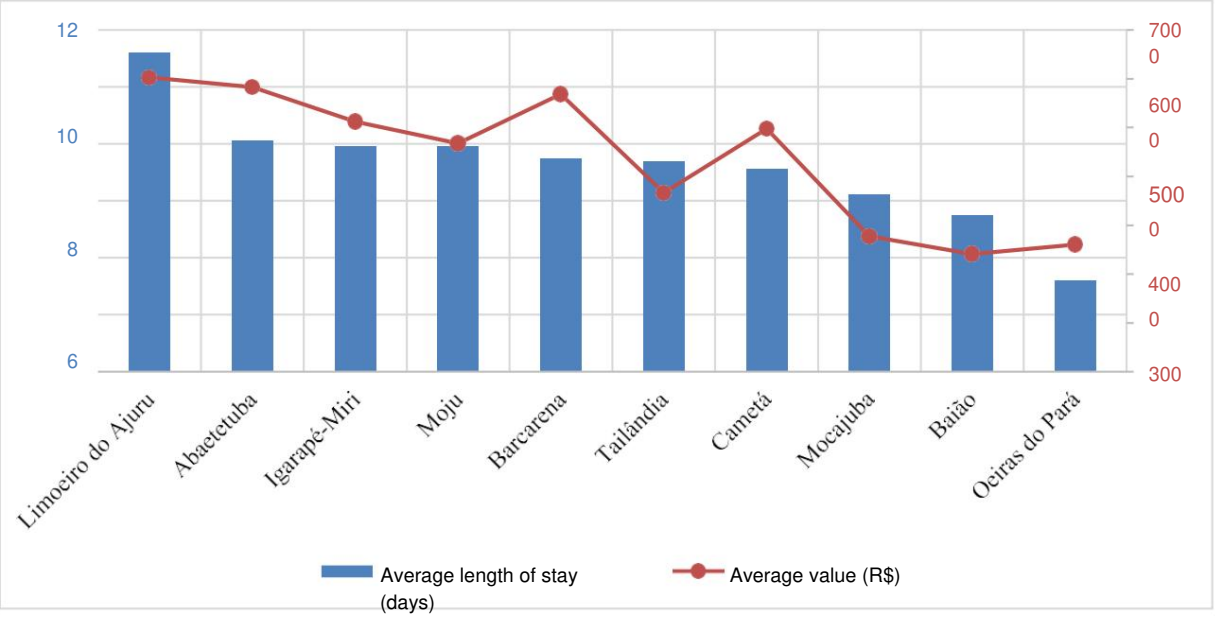
Source: Ministry of Health – SUS Hospital Information System (SIH/SUS).

Regarding the average length of hospital stay for AMI (Acute Myocardial Infarction), a wide variation was observed.
There was variation among the municipalities. Limoeiro do Ajuru presented the longest duration, with hospitalizations.
approximately 50% above the overall average, followed by Abaetetuba, Igarapé-Miri, and Moju, all with
Values close to or slightly above the regional average. Barcarena, Tailândia and Cametá
They formed an intermediate group, with slightly shorter times, while
Mocajuba and Baião registered the most significant reductions. Oeiras do Pará showed the smallest decrease.
permanence, with an average of about 60% lower than the highest value observed.

Regarding the average cost of hospitalizations for AMI (Acute Myocardial Infarction), the distribution also revealed...
There are striking differences. Limoeiro do Ajuru had the highest expenditure, about 30% above the overall average.
followed by Abaetetuba and Barcarena, both with high values. Igarapé-Miri, Cametá and
Moju formed an intermediate bloc, maintaining costs moderately lower than those of
leaders. Thailand and Mocajuba, on the other hand, presented substantially lower values, and the
The lowest costs were recorded in Oeiras do Pará and Baião, both with expenses around...
50% lower than those of municipalities with the highest spending.

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Figure 5. Average length of stay (left Y-axis) and average cost of hospitalization. (right Y-axis) due to acute myocardial infarction in the Lower Tocantins region, by municipality of residence, during the period from January 2015 to December 2024.



Source: Ministry of Health – SUS Hospital Information System (SIH/SUS).

2.3. Healthcare facilities

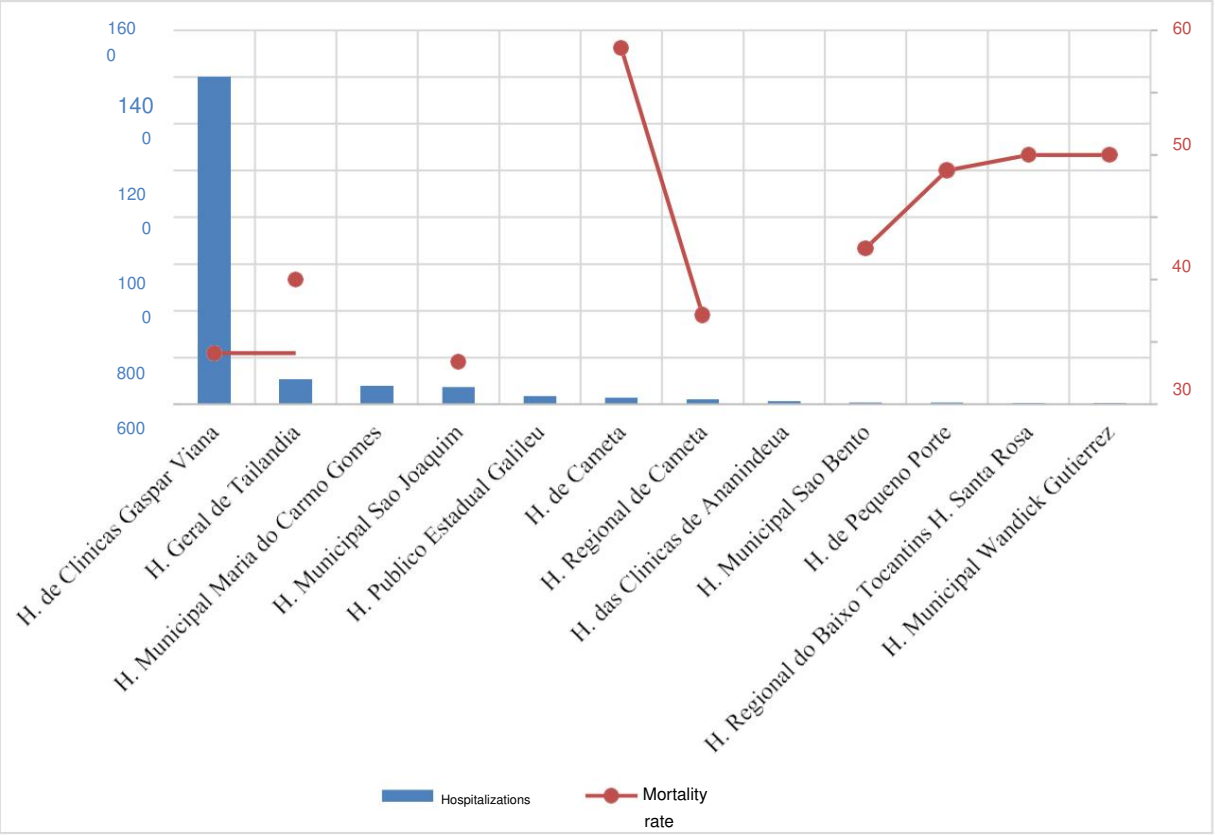
The distribution of hospitalizations for AMI (Acute Myocardial Infarction) among the establishments revealed a strong... concentration in a single service. The Gaspar Viana Clinical Hospital accounted for approximately It accounts for 78% of all hospitalizations, making it the main care center in the region. Next came the Thailand General Hospital, with approximately 6%, and the Maria hospitals. do Carmo Gomes and São Joaquim, each with about 4%. The remaining establishments recorded significantly lower proportions — generally less than 2% — and one The group of 15 units accounted for just over 3% of the services, with individual volumes. ranging from less than 1% to residual values.

The mortality rate from myocardial infarction also showed great variability among the services. The highest values were observed in units with lower patient volume. like the Cametá Hospital and the Tucuruí Regional Hospital, both with rates higher than 50%, followed by some municipal and regional hospitals that reached values between 33% and 40%. The General Hospital of Thailand was situated at an intermediate level, with approximately 20%, while the Cametá Regional Hospital recorded around 14%. As for the... Lower rates were identified in larger hospitals with higher volumes of admissions. such as the Gaspar Viana Clinical Hospital (ÿ8%) and the São Joaquim Municipal Hospital (ÿ7%),

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suggesting a possible relationship between structural capacity and clinical outcomes.

Figure 6. Number of hospitalizations (left Y-axis) and mortality rate (right Y-axis) due to acute myocardial infarction in the Lower Tocantins region, by establishment, in period from January 2015 to December 2024.

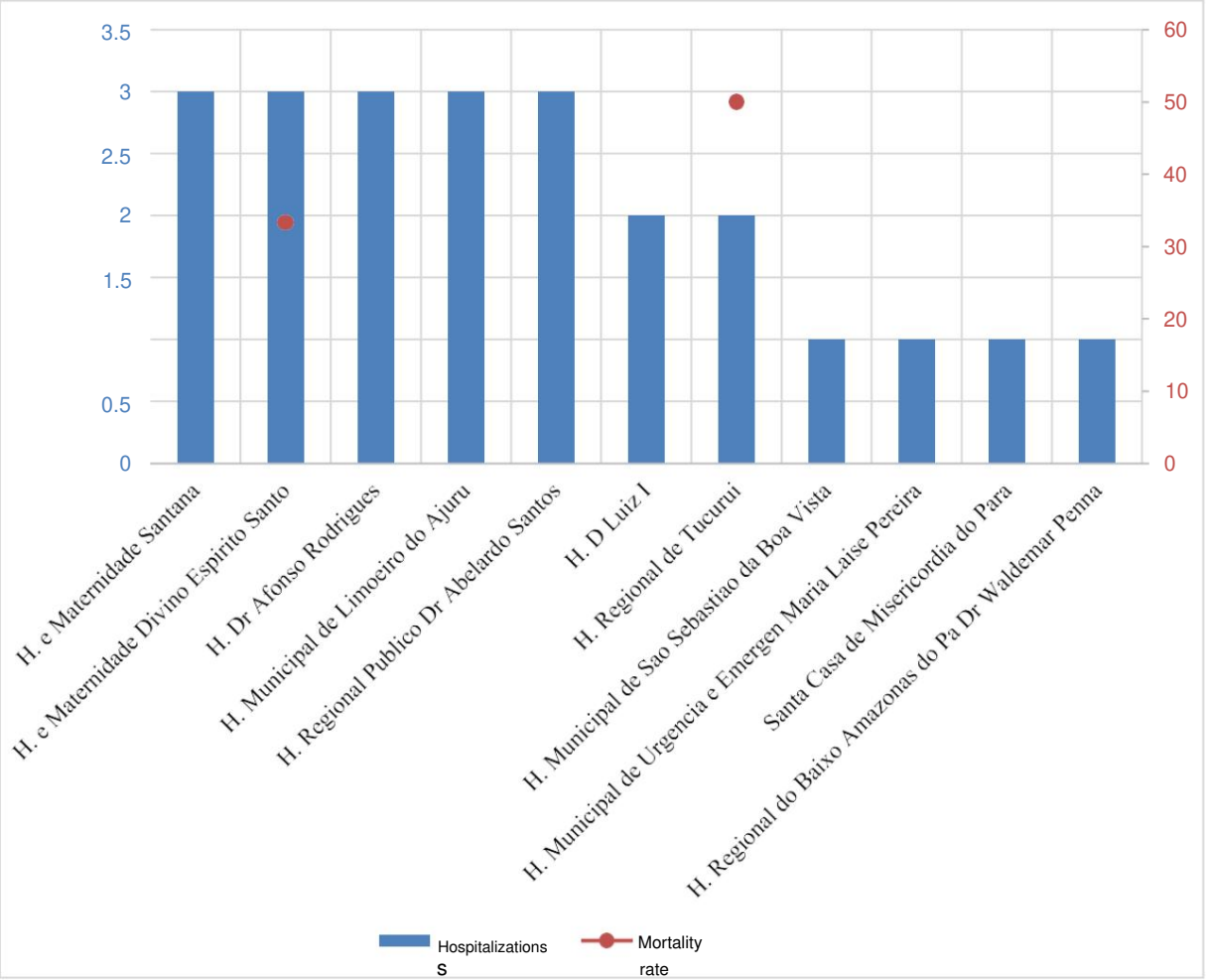


Source: Ministry of Health – SUS Hospital Information System (SIH/SUS).

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Figure 7. Continuation of Figure 6: Number of hospitalizations (left Y-axis) and rate of Mortality (right Y-axis) from acute myocardial infarction in the Lower Tocantins region. per establishment, for the period from January 2015 to December 2024.



Source: Ministry of Health – SUS Hospital Information System (SIH/SUS).

The average length of stay for AMI showed a large contrast between the establishments. The Santa Casa de Misericórdia of Pará and the Dr. Abelardo Regional Hospital Santos recorded the longest stays, with hospitalization times approximately 3 to 4 days. times higher than the average observed in other services. Next, units such as the Hospital Santa Rosa, Wandick Gutierrez, and Divino Espírito Santo maintained their presence. intermediate levels, ranging between 8% and 20% above the regional average. The remaining hospitals, including Gaspar Viana and smaller municipal units, presented shorter times, with stays predominantly ranging from 1 to 6 days, which corresponds to values between 60% and 80%. lower than the highest times recorded.

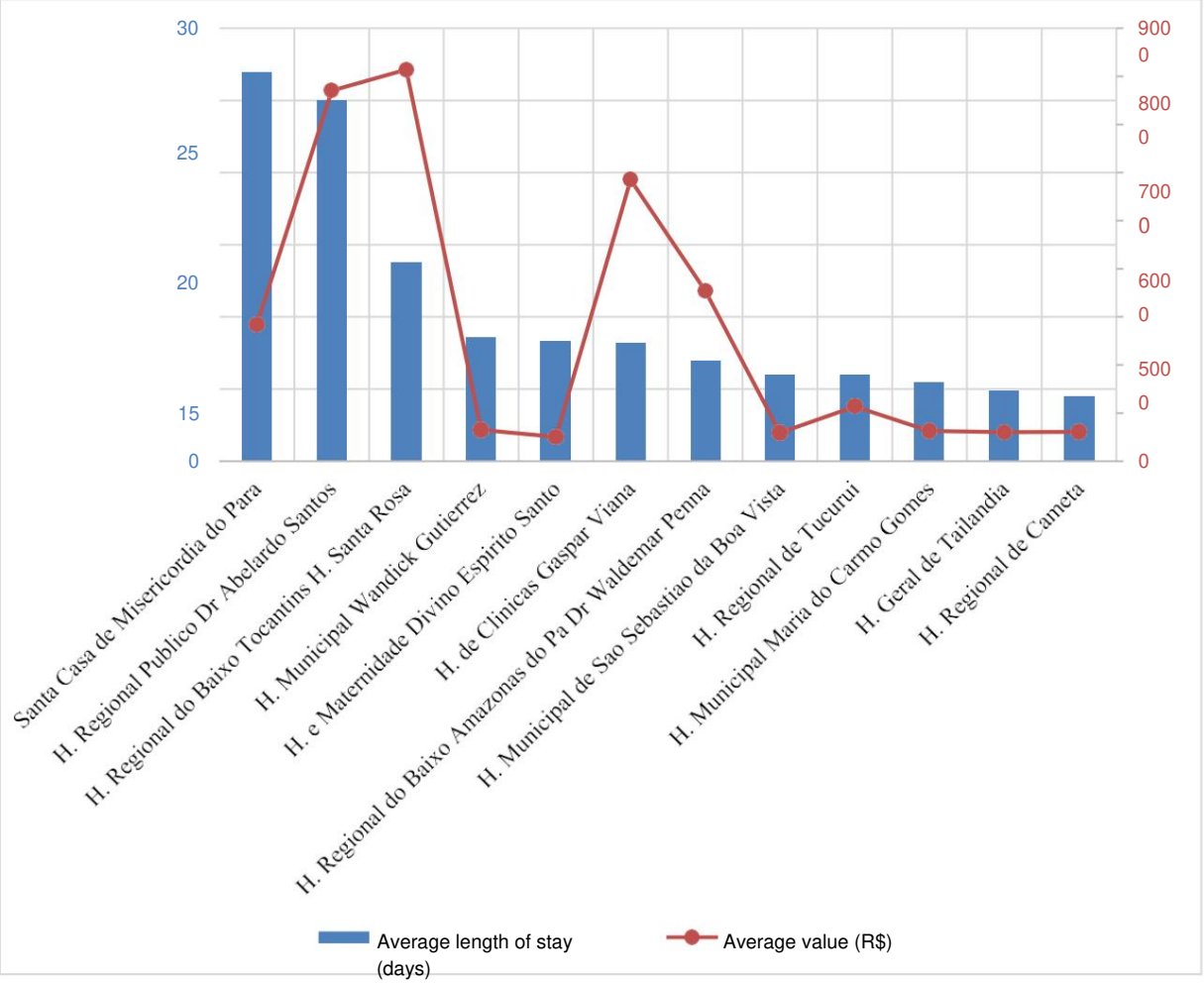
Regarding the average cost per hospitalization, the difference between the establishments also...

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The increase was significant. Hospital D. Luiz I presented the highest value, approximately 100% above cost. medium regional level, followed by Hospital Santa Rosa and Hospital Abelardo Santos, both with Costs are between 60% and 80% above the regional average. The Gaspar Viana Clinical Hospital and other larger units were situated in the intermediate range, with moderately low values. high. In contrast, smaller regional hospitals and municipal units recorded the lower costs, many less than 20% of the highest value identified, demonstrating a strong disparity between service structures.

Figure 8. Average length of stay (left Y-axis) and average cost of hospitalization. (right Y-axis) due to acute myocardial infarction in the Lower Tocantins region, of in accordance with the establishment, for the period from January 2015 to December 2024.

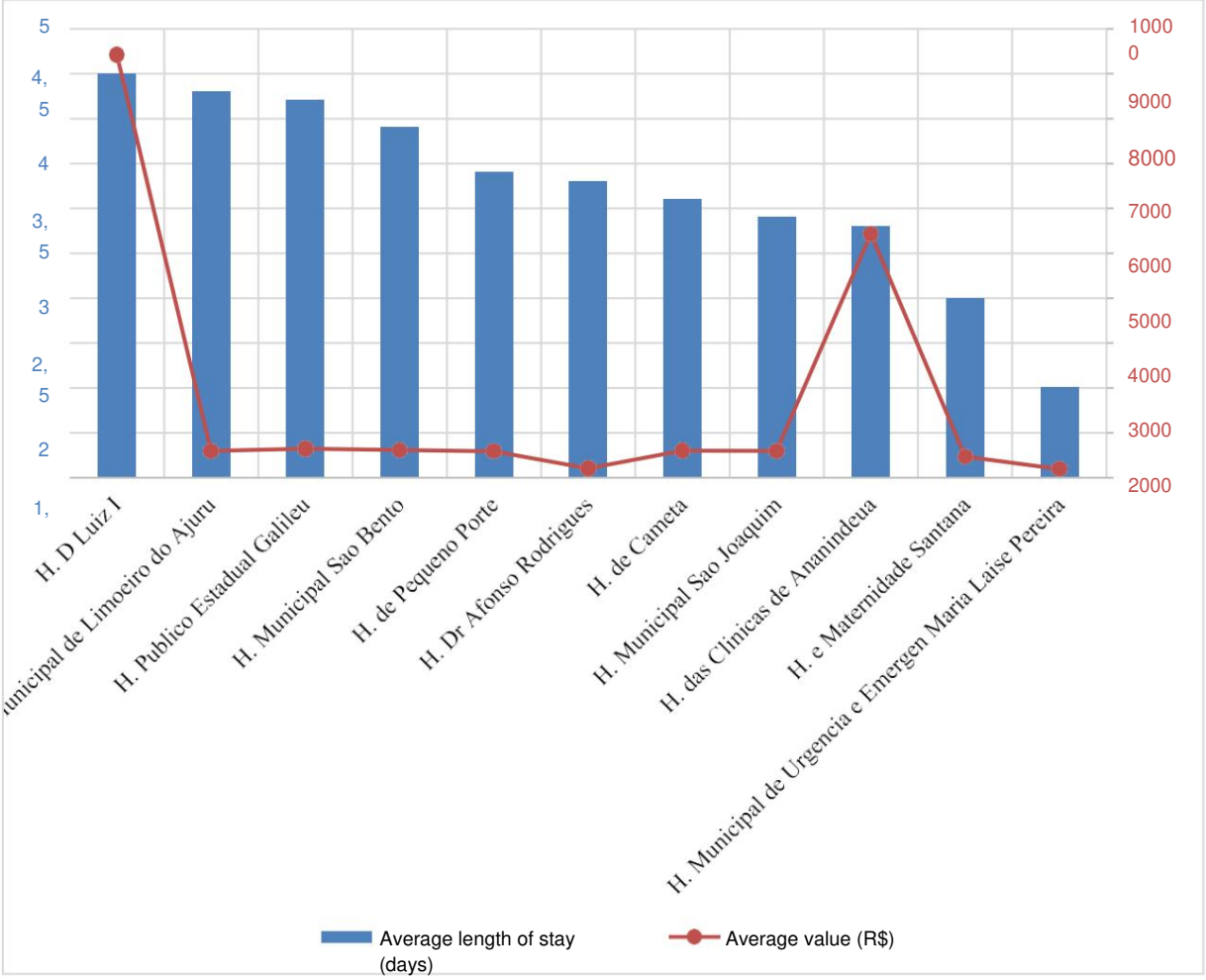


Source: Ministry of Health – SUS Hospital Information System (SIH/SUS).

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Figure 9. Continuation of Figure 8: Average length of stay (left Y-axis) and Average cost of hospitalization (right Y-axis) due to acute myocardial infarction in the region from the Lower Tocantins region, according to the establishment, during the period from January 2015 to December 2024.



Source: Ministry of Health – SUS Hospital Information System (SIH/SUS).

2.4. Age range

The distribution of hospitalizations due to AMI showed a clear predominance in the following age groups: Older age groups. Adults aged 60 to 69 accounted for the largest volume of cases. representing approximately 33% of all hospitalizations, followed by the 70-79 age group and The 50-59 age group, both with approximately 22% each. The 40-49 and 80 age groups Those aged 6 years or older showed smaller, but still relevant, proportions, between 9% and 10%. As for... Ages below 30 years accounted for a tiny percentage together, less than 2%. indicating a lower prevalence of the event in younger populations.

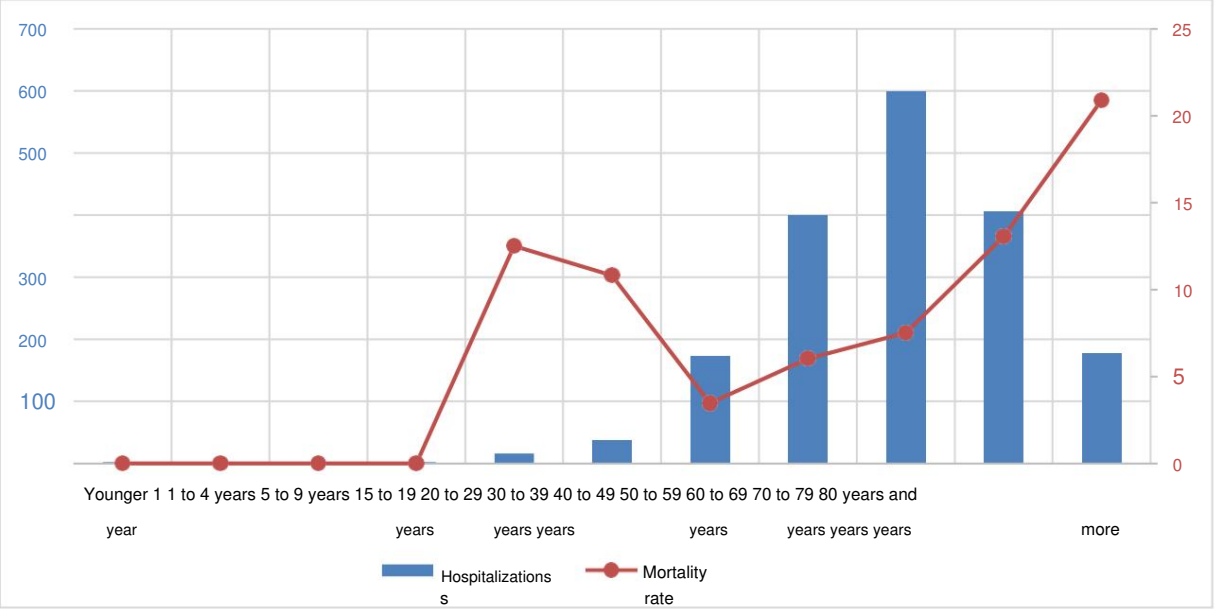
The mortality rate by age group also showed an increasing trend as the measure that age increased. While young adults had a mortality rate between 10% and 12%, the

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Values fell to around 3% to 7% in the middle age groups (40 to 69 years), then rose again.
Mortality rates increased significantly starting at age 70. Among seniors aged 70 to 79, mortality reached [a high level].
approximately 13% and peaked in the 80 years and older age group, at around 21%.
reinforcing the greater vulnerability of this population.

Figure 10. Number of hospitalizations (left Y-axis) and mortality rate (right Y-axis)
due to acute myocardial infarction in the Lower Tocantins region, by age group, during the period
From January 2015 to December 2024.



Source: Ministry of Health – SUS Hospital Information System (SIH/SUS).

The average length of stay for AMI (Acute Myocardial Infarction) showed a progressive increase as the
As people got older, children and young people generally stayed for 1 to 3 days, which represents a considerable amount of time.
significantly lower — 60% to 80% smaller — when compared to adults. Starting at age 40
Over the years, hospital stays have become longer, ranging from 6% to 20% above the overall average.
and reaching their highest values in the 60 to 79 age group, which recorded permanences of approximately
30% higher than those observed in the other groups. Among seniors aged 80 or older, there were
a slight reduction, with still moderate persistence, but lower than that of the immediately preceding bands.
previous.

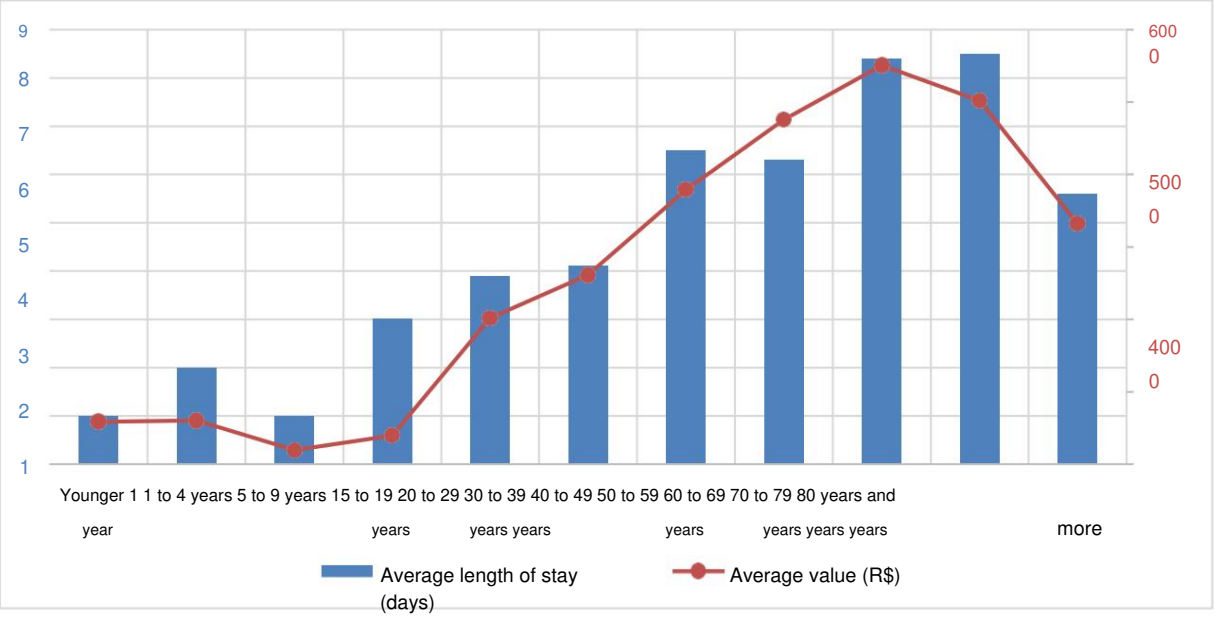
Regarding the average cost of hospitalization for AMI, a similar pattern was observed.
to the level of permanence. Younger age groups showed significantly lower values — less than
15% of typical adult spending — while costs have progressively increased to
Starting at age 30. The highest values were observed between 60 and 79 years of age, with expenses
approximately 30% to 40% higher than those in the intermediate age groups. The group aged 80 or older...
However, it showed a relative decrease, with expenses approximately 20% lower than the highest costs.

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recorded, suggesting a possible influence of shorter stay times or less use of advanced therapies.

Figure 11. Average length of stay (left Y-axis) and average cost of hospitalization. (right Y-axis) due to acute myocardial infarction in the Lower Tocantins region, by age group, from January 2015 to December 2024.



Source: Ministry of Health – SUS Hospital Information System (SIH/SUS).

2.5. Sex

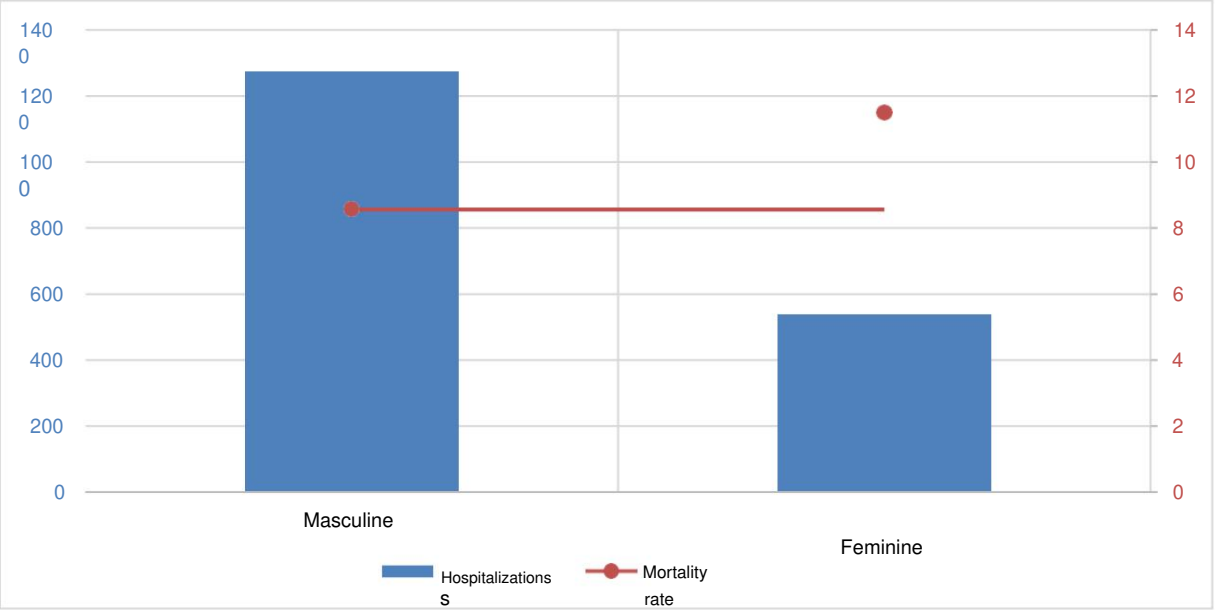
The distribution of hospitalizations by sex showed a marked predominance of the sex males accounted for approximately 70% of cases, while females represented approximately 30% of hospitalizations. Despite the smaller volume of cases, women They exhibited greater vulnerability to fatal outcomes: the female mortality rate (ÿ11.5%). It was approximately 34% higher than that observed among men (ÿ8.6%), highlighting a difference.

There is a significant difference between the sexes in the risk of death from myocardial infarction.

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Figure 12. Number of hospitalizations (left Y-axis) and mortality rate (right Y-axis) due to acute myocardial infarction in the Lower Tocantins region, by sex, during the period of January 2015 to December 2024.

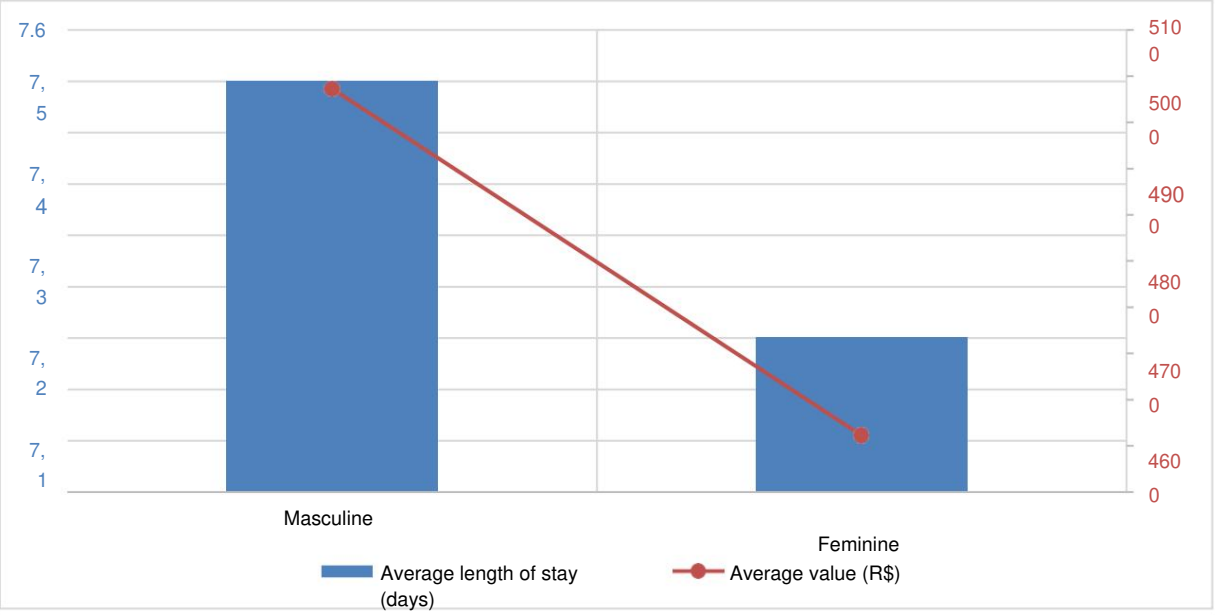


Source: Ministry of Health – SUS Hospital Information System (SIH/SUS).

Regarding length of stay, men and women presented averages similar, with males staying hospitalized for about 7% longer than females. the female version. Regarding costs, however, the difference was more significant: the average value The rate of hospitalization for myocardial infarction among men was approximately 18% higher than that observed among women. women, indicating greater use of resources or greater complexity of care in the group masculine.

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Figure 13. Average length of stay (left Y-axis) and average cost of hospitalization. (right Y-axis) due to acute myocardial infarction in the Lower Tocantins region, by sex, during the period from January 2015 to December 2024.



Source: Ministry of Health – SUS Hospital Information System (SIH/SUS).

3. DISCUSSION

3.1. Summary of the topic in relation to the literature.

Statistical analysis of hospitalizations for AMI in the Lower Tocantins region between 2015 and 2024 reveals a progressive growth in hospital demand, especially in the last three years. years, accompanied by a significant increase in average hospitalization costs. The rate of Mortality, although unstable, showed a downward trend compared to the early years. which may reflect advances in regional cardiology care, even though fluctuations persist that They denote inequality in welfare.

The reduction in average length of stay since 2021 suggests greater efficiency. in care flows or changes in discharge criteria, although the impact cannot be ruled out. premature mortality in certain periods. Taken together, the data point to a scenario where the challenge is to balance the growth in demand with maintaining quality. healthcare and cost control, reinforcing the need for investments in prevention. cardiovascular and in expanding the high-complexity network in the region.

In addition to local findings regarding increased demand and average costs per

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Hospitalization, national studies point to a similar trend of increasing numbers of hospitalizations due to AMI and an increase in hospital expenditures in the recent period, attributable both due to population aging and the expansion of the use of high-risk procedures complexity (e.g., angioplasty and revascularization), which corroborates the need regional efforts to align budget planning with the expansion of technical services. These efforts Domestic countries also highlight the increase in aggregate costs, even when there is a relative decrease. in mortality rates, a phenomenon that may reflect greater investment in technology and in invasive therapies (Viana et al., 2023; Marques et al., 2012).

The analysis of patients by municipality of residence reveals strong inequalities. Intra-regional care for AMI in the Lower Tocantins region. While Abaetetuba, Barcarena and Cametá accounts for the majority of hospitalizations, while smaller municipalities, such as Oeiras do Pará and Limoeiro do Ajuru exhibits disproportionately high mortality rates, suggesting Access barriers and delays in reaching specialized care. Furthermore, it was observed... significant heterogeneity in average length of stay and average cost of hospitalizations, indicating variations in both care protocols and complexity of cases treated in each locality. These findings reinforce the need for policies of Regionalization of cardiology care, with the strengthening of equitable access to services. of high complexity and the expansion of the problem-solving capacity of smaller municipalities, the in order to reduce the observed disparities.

The high mortality rate among residents of municipalities further from the metropolis. They are probably related to specific characteristics of the region such as: average distance to Hospital with hemodynamics in Pará or Amazonas: 120–350 km exclusively by river. (Garrido et al., 2022; Oliveira et al., 2023), average travel time by fast boat: 8– 18 hours; by regular speedboat: 12–36 hours (Oliveira et al., 2023). Only 3 municipalities Amazonian hospitals offer 24-hour hemodynamics services: Manaus, Belém, and Macapá. Consequence Directly: only 4.8% of riverside patients with AMI arrive within the reperfusion window; 71% They arrive after 12 hours with extensive myocardial necrosis and a 4–6 times higher mortality rate (Santos). et al., 2023; Rocha, 2024).

Regarding intra-regional inequalities between municipalities, Brazilian findings They show a consistent pattern: municipalities with less developed healthcare infrastructure and greater distances. Reference centers show worse outcomes and higher mortality rates from myocardial infarction. reinforcing the hypothesis of delays in the recognition and transport of severe cases observed in the Lower Tocantins. National and regional ecological studies also document that the Regionalization of cardiology care — with referral protocols and networks of Telecardio/tele-ECG — reduces door-to-balloon times and mortality, suggesting interventions.

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concrete measures that could be prioritized in municipalities with disproportionately high mortality rates.
high (Ferreira et al., 2020; Medeiros, 2012).

The analysis by hospital establishment demonstrates a strong concentration of
hospitalizations for AMI at the Gaspar Viana Clinical Hospital, highlighting the central role of this
as a state reference center in cardiology, while the other units absorb volumes
very few cases. However, marked heterogeneity is observed in the rates of
mortality, length of stay, and average cost per hospitalization, indicating that hospitals
Smaller scale projects present worse outcomes and lower costs, possibly related to...
due to low problem-solving capacity, while referral centers have higher costs.
These findings are associated with complex care, but with more controlled mortality.
They highlight the inequality in hospital management of AMI in the region, reinforcing the need for
Strengthen the network of cardiac care, ensuring greater consistency in the quality of care.
Providing service and expanding the effectiveness of regional services in order to reduce overload.
in the reference centers.

Analysis by age group shows that AMI is predominantly an adult event.
middle-aged and elderly people, with a concentration of cases between 50 and 79 years of age, a period in which they also
Longer lengths of stay and higher hospital costs are observed. The mortality rate
It increases sharply after age 70, peaking at ÿ 80 years, suggesting a
The direct impact of clinical frailty and the presence of comorbidities in this population.
Interestingly, young adults (<30 years old), although representing a small percentage of hospitalizations,
The literature shows that myocardial infarction (MI) in young people is frequently underdiagnosed or poorly managed.
inappropriately, since symptoms may be atypical and there is less clinical suspicion, leading to
Delays in recognition and treatment, in addition to pathophysiological mechanisms such as dissection.
Spontaneous coronary artery disease, vasospasm, drug use, and hypercoagulability are more prevalent causes.
in this age group, which can result in more severe presentations and a higher risk of
acute complications, contributing to increased mortality in this group (Tudurachi et
al., 2025; Gulati et al., 2020; Yang et al., 2020). Taken together, the findings reinforce that age
It is a determining factor in both the frequency and outcomes of myocardial infarction, indicating the need for
preventive strategies focused on middle-aged adults and care protocols
Specialized care for the elderly, who represent the group most vulnerable to complications and death.

Regarding the age profile, recent Brazilian studies document a relative increase of
ischemic events in young adults, while maintaining higher mortality in
elderly people — a pattern that mirrors their finding of increasing mortality from the ages of 70–80 and of
Relatively high mortality rate in those under 30 years old. The national explanation for the increase between
Younger children are more affected by risk factors (obesity, smoking, early-onset diabetes).

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and late diagnosis; this evidence supports the recommendation of preventive actions aimed at middle-aged adults and symptom recognition campaigns aimed at older audiences young people (Aggarwal et al., 2023; APM, 2025).

Analysis by sex shows that, although myocardial infarction is more frequent in men, Women experience proportionally higher mortality rates, suggesting inequalities in Prognosis between the sexes. The longer length of stay and the average cost observed in the sexes. Males indicate greater use of healthcare resources, while female progression, Although less expensive, it is associated with higher mortality. These findings corroborate the literature. which identifies women as a risk group for adverse outcomes in myocardial infarction, due to multifactorial factors such as sex-specific biology (smaller arterial diameter, larger prevalence of microvascular disease, higher incidence of spontaneous coronary dissection), In addition to social and access barriers, such as less recognition of symptoms, delays in Seeking care and reducing the use of recommended invasive and drug therapies, Furthermore, hormonal differences, such as the protective effect of estrogen before menopause, They also influence the risk and pathophysiology of AMI in women (Mehta et al., 2016; Alkhouli et al., 2021; DeFilippis et al., 2020; Nussbaum et al., 2022; Clayton et al., 2022). Therefore, it is essential that prevention and management strategies take into account the specificities Gender in cardiovascular care, in order to reduce the observed disparities.

The sex discrepancy observed in the Lower Tocantins (higher frequency in men, but higher relative lethality in women) is consistent with Brazilian literature, which reports worse outcomes in women after myocardial infarction, attributed to atypical clinical presentation, delay in diagnosis and undertreatment in revascularization procedures. National studies They also show that, after adjusting for age and comorbidities, the difference in mortality between Sex differences may decrease, suggesting that interventions to reduce diagnostic delay and equalize outcomes may be necessary. Access to invasive therapies could mitigate the higher female mortality rate observed. locally (Oliveira et al., 2023).

The concentration of services in a few referral centers, especially in Gaspar Viana Clinical Hospital reveals the fragility of the regionalization of care and the There is an urgent need to strengthen the problem-solving capacity of smaller municipalities, due to through increased access to early diagnosis and reperfusion therapy. These findings These findings align with national studies that point to an imbalance between the supply and demand for services. high-complexity cardiology procedures as a determinant of regional inequalities in mortality from AMI in Brazil (Ribeiro et al., 2016; Lorenzo, 2018).

The observed age and sex distribution follows the national pattern described in several cohorts, in which the highest frequency of cases occurs among middle-aged and elderly adults, but

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with proportionally higher mortality among women, suggesting the impact of factors.
biological and care-related (Oliveira, 2022; Soeiro, 2018; Brant, 2025). The increase in cases...
in young adults, it reinforces the Brazilian trend of epidemiological transition, marked by
elevation of modifiable risk factors, such as smoking, sedentary lifestyle and obesity (Santos,
2024; Pereira, 2022).

3.2. Study limitations

The first relevant limitation of this study relates to the use of secondary data.
originating from official health information systems, which, although widely used
In epidemiological research, data entry is subject to inconsistencies.
Underreporting and a lack of standardization between municipalities and health facilities.
Essential variables — length of stay and hospital costs — showed gaps or
incomplete records, which may have influenced the interpretation of inequalities between the
population groups. Furthermore, since it is an administrative base, it is not possible
To verify the diagnostic accuracy of AMI cases, as there may be miscategorization between types.
of infarction, atypical forms, or differential diagnoses that impact the indicators of
mortality and hospitalization.

Another limitation is the lack of individual clinical information, such as risk factors.
cardiovascular conditions, comorbidities, therapies used, door-to-balloon time, severity of the condition and
reperfusion strategies employed — fundamental elements for determining the
hospital outcomes. The inability to adjust the results for these variables may
to generate residual bias and limit causal inference between demographic characteristics, conditions
structural aspects of municipalities or establishments and the observed outcomes. In this sense,
findings of higher mortality among women and the elderly, although consistent with the literature,
These cannot be fully attributed to local health services without considering differences in
clinical and risk profile intrinsic to these groups.

Finally, the ecological and descriptive design of this study imposes limits on generalization.
of the results, since it is based on population aggregates and does not allow for evaluation
Individual relationships between exposure and outcome, in addition to being subject to the ecological fallacy. Another
The critical point refers to the heterogeneity among the municipalities in the Lower Tocantins region.
with regard to the organization of the healthcare network, primary care coverage, and availability of
emergency units and access to referral centers. These structural differences, not
Measured directly, they can explain some of the inequalities identified in the rates of
mortality and costs, but these could not be explored in depth due to limitations.

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from the available data. Thus, complementary studies, with a clinical approach and analyses Adjustments are needed to clarify the determining factors of these disparities and to guide more precise public policies.

3.3. Implications for management and public policies

The heterogeneity observed between municipalities and establishments highlights the There is an urgent need to strengthen the regionalization of cardiology care in the Lower Tocantins region. Smaller municipalities, which presented proportionally higher mortality rates, They depend on management strategies that expand access to early diagnosis and transportation. fast, including integrated referral and counter-referral protocols and investments in Telecardiology. Such actions can reduce the time to specialized care and improve significantly the outcomes.

Furthermore, the results highlight the importance of expanding problem-solving capacity. of local hospital services, especially those with higher mortality rates and lower Infrastructure. The standardization of care flows, the training of teams, and the guarantee of access to more effective therapies – such as thrombolysis and angioplasty in a timely manner – They should be prioritized. The concentration of cases in referral centers also indicates that The need to redistribute resources, avoiding overload and improving equity in supply. of care.

Finally, inequalities based on gender and age reinforce the need for public policies. Guided by equity, taking into account social vulnerabilities and barriers to access. Educational campaigns targeting at-risk groups, improving record-keeping in the systems of Information and continuous monitoring of indicators can support more effective interventions. Precise and efficient. Management committed to prevention, monitoring, and reduction of Inequalities tend to have a direct impact on reducing mortality and associated costs. to IAM in the region.

Statistical analysis of hospitalizations for AMI in the Lower Tocantins region between 2015 and 2024 reveals a progressive growth in hospital demand, especially in the last three years, accompanied by a significant increase in average hospitalization costs. The rate Mortality rates, although unstable, showed a downward trend compared to the early years. which may reflect advances in regional cardiology care, even though fluctuations persist. which denote inequality in welfare.

The reduction in average length of stay since 2021 suggests greater efficiency. in care flows or changes in discharge criteria, although the impact cannot be ruled out.

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premature mortality in certain periods. Taken together, the data point to a scenario where the challenge is to balance the growth in demand with maintaining quality. healthcare and cost control, reinforcing the need for investments in prevention. cardiovascular and in expanding the high-complexity network in the region.

CONCLUSION

This study shows that IAM in the Lower Tocantins region constitutes a a significant public health problem, characterized by the progressive growth of Hospitalizations and an increase in average hospital costs over the analyzed period. Mortality showed fluctuating behavior, without a consistent downward trend; Furthermore, significant inequalities are observed between municipalities, age groups, and genders. which reflects structural and care disparities in the cardiovascular care network.

The findings regarding pediatric age groups suggest that a portion of hospitalizations A high incidence of myocardial infarction (MI) in children may reflect typing errors or inconsistencies in the system records. of information, given the rarity of the event in this age group. This limitation reinforces the importance of improving the quality of completed forms and enhancing surveillance. epidemiological, especially in regions where underreporting and inconsistent variables occur. are recurrent. In addition, the significantly higher mortality rate observed in Small hospitals indicate structural and care weaknesses that compromise the Proper management of severe cases.

Another relevant aspect concerns the geographical characteristics of the Lower region. Tocantins, characterized by vast distances, limited logistics, and transportation challenges, factors which likely impact the time it takes to receive care and the severity of cases. attended. These elements reinforce that addressing mortality from AMI requires not not only strengthening health services, but also policies that consider the territorial and socioeconomic specificities of the region.

This study presents limitations inherent to the use of secondary data from... SIH/SUS, which, although an important epidemiological surveillance tool, does not provides essential variables for a more comprehensive analysis of acute myocardial infarction. myocardium. Among the gaps, the absence of information on comorbidities stands out. associated conditions (such as hypertension, diabetes mellitus, and dyslipidemia), lifestyle habits (smoking, alcohol consumption, sedentary lifestyle), socioeconomic status, education and the time elapsed between the onset of symptoms and hospital care, recognized factors as key determinants of clinical outcomes and prognosis in AMI.

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To overcome these limitations, future studies with prospective designs, multicenter and population-based studies, as well as cohort analyses that integrate information Clinical, laboratory, and socioeconomic data can contribute to a more comprehensive understanding. precision in the epidemiological profile, prognostic factors, and inequalities in the management of AMI. in the Lower Tocantins region and in similar contexts in Brazil.

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APPENDIX 1. COMPLETE STUDY RESULTS

Table 1 - Number of hospitalizations, mortality rate, average length of stay (days) and average cost (R$) due to acute myocardial infarction in the Lower Tocantins region, from January 2015 to December 2024 (continued).

Variables	Hospitalizations	Rate mortality and	Average length of stay ia (days)	Average value (R$)
Processing year				
2015	148	13.51	8.1	4,316.91
2016	161	13.04	7.9	3,807.92
2017	150	5.33	8.1	2,821.77
2018	139	7.19	7.9	3,877.92
2019	157	7.64	8.1	4,350.73
2020	157	8.28	8.7	5,236.03
2021	166	8.43	6.9	4,737.83
2022	223	11.66	6.8	4,859.25
2023	253	10.28	6.5	5,651.36
2024	259	8.11	6.4	6,145.44
Municipalities of residence				
Abaetetuba	411	7.79	8.1	5,825.15
Barcarena	312	7.69	7.5	5,686.14
Cametá	310	14.19	7.1	4,975.76
Thailand	252	13.49	7.4	3,668.79
Igarapé-Miri	139	7.19	7.9	5,119.41
Mocajuba	134	3.73	6.2	2,774.28
Baião	124	8.87	5.5	2,410.40
Moju	92	6.52	7.9	4,677.50
Oeiras do Pará	21	19.05	3.2	2,601.99
Limoeiro do Ajuru	18	5.56	11.2	6,027.95
Establishments				
Gaspar Viana Clinical Hospital	1,400	8.21	8.2	5,847.67

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General Hospital of	105		20	4.9	604.89
Thailand, Municipal Hospital Maria do Carmo Gomes	79	0		5.5	630.45
Municipal Hospital of São	74		6.76	2.9	597.44
Joaquim, State Public Hospital of Galileu	35	0		4.2	644.87
H. de Cametá	28		57.14	3.1	606.65
Cametá Regional Hospital	21		14.29	4.5	608.59
H. das Clinicas de Ananindeua	13	0		2.8	5,428.49
Municipal Hospital of São	8		25	3.9	619.12
Bento, Small-Scale	8		37.5	3.4	588.12
Hospital, Lower Tocantins Regional Hospital H. Santa Rosa	5		40	13.8	8,139.91
Wandick Gutierrez Municipal Hospital,	5		40	8.6	651.05
Santana Hospital and Maternity	3	0		2	470.46
Hospital, Divino Espírito Hospital and Maternity Hospital Holy	3		33.33	8.3	504.25

Source: Ministry of Health – SUS Hospital Information System (SIH/SUS).

Table 1 - Number of hospitalizations, mortality rate, average length of stay (days) and average cost (R$) due to acute myocardial infarction in the Lower Tocantins region, during the period of January 2017. 2015 to December 2024 (completion).

Variables	Hospitalizations	Mortality rate	Average length of stay	Average value (R$)
Establishments				
Dr. Afonso Rodrigues	3	0	3.3	205.80
Municipal Hospital of Limoeiro do Ajuru	3	0	4.3	593.45
Regional Public Hospital Dr. Abelardo Santos	3	0	25	7,703.53
H. D Luiz I	2	0	4.5	9,417.19
Tucuruí Regional Hospital	2	50	6	1,137.58
Municipal Hospital of São Sebastião da Boa Vista	1	0	6	588.12
Municipal Emergency and Urgent Care Unit Maria Laise Pereira	1	0	1	195.13
Santa Casa de Misericórdia do Para	1	0	27	2,841.38
Regional Hospital of the Lower Amazon of PA Dr. Waldemar Penna	1	0	7	3,536.43
Age range				
Under 1 year	2	0	1	588.12
1 to 4 years	1	0	2	604.12
5 to 9 years	1	0	1	195.13

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15 to 19 years old	2	0	3	395.63
20 to 29 years old	16	12.5	3.9	2,017.46
30 to 39 years old	37	10.81	4.1	2,614.59
40 to 49 years old	173	3.47	6.5	3,789.56
50 to 59 years old	399	6.02	6.3	4,757.34
60 to 69 years old	599	7.51	8.4	5,507.88
70 to 79 years old	406	13.05	8.5	5,019.86
80 years and more	177	20.9	5.6	3,322.64
Sex				
Masculine	1.274	8.56	7.5	4,972.52
Feminine	539	11.5	7	4,222.55
Total	1,813	9.43	7.4	4,749.56

Source: Ministry of Health – SUS Hospital Information System (SIH/SUS).