

# Epidemiological Overview of Brazilian Hospital Records of Vascular Trauma by Anatomical Region Over the last 20 years

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## Abstract

Trauma is an important cause of hospitalizations and surgeries in emergency services, with high morbidity and mortality rates and in Brazil, it presents relevant statistics, with variations in mechanisms and topographies depending on the context. This study analyzed hospital data on vascular traumas by anatomical region in the Unified Health System (SUS) over the past 20 years, seeking to highlight relevant epidemiological information according to the particularities of vascular injuries in the Brazilian context. Ecological, descriptive, time-series study with a quantitative approach. Data were obtained through SIH/SUS, via TABWIN/DATASUS, between February and April 2024, referring to hospital admission records for the surgical treatment of vascular trauma, according to specific coding. There was a higher concentration of hospitalizations between 2012 and 2016, peaking in 2012, and a slight declining trend until 2024, with the highest number of hospitalizations (32%) in the Southeast. Men accounted for 76.6% of hospitalizations, but the relative risk of death was higher among women (RR=1.36). Upper limbs were the most affected, while abdominal traumas presented the highest lethality (22.1%) and lower limbs the longest hospital stay (6.6 days). Most procedures were performed under emergency conditions (88.4%), representing the highest mortality rate (6.3%). Although the majority of hospitalizations occurred among the population aged 15 to 49 years (60%), the highest mortality rates were observed at the age extremes: infants (11%) and the group over 50 years (10%).

**Keywords:** vascular trauma; vascular injuries; vascular accidents

## Introduction

Trauma is a cause associated with hospital admissions and surgical interventions in urgent and emergency hospitals, with high morbidity and mortality rates, and in Brazil, its statistics have been increasing like a major epidemic. Considering that deaths from trauma worldwide are estimated to be 1.7 times more frequent than deaths caused by HIV/AIDS, tuberculosis, and malaria combined, and that, of this index, injuries to large vessels and associated hemorrhagic shock are the main causes of mortality and sequelae among victims, it is clear that vascular trauma needs to be addressed as an important focus for further study at the public health level. In this context, vascular trauma refers to traumatic injuries that compromise the integrity of blood vessels, constituting an important complication associated with trauma.

For clinical and therapeutic purposes, traumatic vascular injuries have several classifications. Regarding the nature of the injury, they are segmented into blunt and penetrating injuries, each with their respective associated trauma mechanisms. Blunt injuries are mainly linked to car accidents, falls, crushing, and assaults, while penetrating injuries are linked to injuries caused by firearms and bladed weapons.<sup>3</sup> In terms of etiopathogenesis, the injury is classified according to histological damage. The main documented types correspond to laceration (simple; with partial wall loss), punctiform injury, complete section, contusion (simple; with intimal injury with flap; with spasms; with subintimal hematoma or dissection), pseudoaneurysms, and arteriovenous fistula.<sup>3</sup> Vascular trauma is also classified according to the affected topography in

cervical, thoracic, abdominal, and extremities (upper and/or lower limbs, unilateral or bilateral). This segmentation is essential for identifying which vascular segments and associated anatomical structures are injured, guiding reasoning and stratifying risk and prognosis.

The vast majority of injuries occur among young men, but there are variations in the mechanisms and anatomical regions most affected depending on the context of the analysis. For example, while in European countries, Australia, and Japan, blunt force mechanisms, such as traffic accidents, are the most prevalent, in Brazil and the United States, most injuries result from penetrating trauma by firearms and knives. In Brazil, these differences are also vast, given that it is a country of continental dimensions.

There are socioeconomic, cultural, political, and educational differences between states that explain their different prevalences of traumatic vascular injuries. For example, a study conducted in the south, at the General Trauma Hospital in Canoas/Rio Grande do Sul, found that blunt injuries prevailed over penetrating injuries, and most affected the lower limbs. Another study conducted in the North of the country, at the Metropolitan Emergency Hospital of the State of Pará, found a prevalence of penetrating firearm injuries, predominantly affecting the upper limbs.

The vast continental expanse of Brazil reflects different epidemiological characteristics of vascular trauma. This study aims to analyze and compare hospital data on vascular trauma by anatomical region in the Unified Health System (SUS) over the last 20 years, considering regional singularities in order to highlight, according to the topography of the injury, relevant epidemiological information according to the particularities of vascular injuries.

## Materials and Methods

This is an ecological, descriptive study with a time series design and quantitative approach, based on secondary data from official publicly accessible databases. The unit of analysis was the Brazilian territory, subdivided into five major geographic regions (North, Northeast, Southeast, South, and Midwest), during the period from January 2008 to March 2025.

The information was obtained through the SUS Hospital Information System (SIH/SUS), accessed via the TABWIN platform, statistical tabulation software provided by the SUS IT Department (DATASUS), linked to the Ministry of Health. The research was conducted based on the extraction of hospital records related to hospitalization for the treatment of vascular trauma, according to specific coding in the SIH/SUS database.

We defined vascular trauma as an injury to a blood vessel (artery or vein), which can be caused by blunt trauma (such as crushing or twisting) or penetrating trauma (such as a cut or gunshot wound). This injury interrupts the supply of blood and oxygen to the tissues, which can lead to blood loss, ischemia (lack of oxygen), and, in severe cases, amputation or death, requiring immediate medical attention.

The spreadsheet constructed for analysis included the following variables: year of admission, sex, age group, color/race, geographic region, anatomical location of trauma, total number of admissions, absolute number of deaths, proportional hospital mortality rate (%), mean or median length of hospital stay (in days), and type of care (emergency or elective). Aggregate measures such as mean, standard deviation, and interquartile range (IQR) were also extracted according to the data distribution.

The hospital mortality rate was calculated from the ratio between the number of deaths and the total number of hospitalizations, expressed as a percentage. Relative risk (RR) was used as a measure of comparison between categories (e.g., female vs. male) in order to quantify the proportional risk of death between the analyzed groups.

Microsoft Excel and Jamovi software were used for statistical analysis. Categorical variables were described using absolute and relative frequencies. Quantitative variables were submitted to the Shapiro-Wilk normality test. For those with normal distribution, the results were expressed as mean and standard deviation, and for those with asymmetric distribution, as median and IQR. When relevant, comparative analyses between groups were applied using measures of association.

With regard to ethical aspects, this study did not require submission to the Research Ethics Committee, as it used only secondary data in the public domain, as recommended by current Brazilian legislation. Nevertheless, all stages of the research respected the ethical principles established in Resolution No. 466/2012 of the National Health Council, ensuring the responsible, honest, and anonymous use of the information analyzed.

## Results

Throughout the historical series analyzed, approximately 70,000 hospital admissions related to surgical procedures for the treatment of vascular trauma were recorded in Brazil, according to data obtained from the DATASUS system between January 2008 and March 2025.

The highest concentration of hospitalizations occurred between 2012 and 2016, peaking in 2012, when 4,759 hospitalizations were recorded. In more recent years (2019 to 2024), there was a slight downward trend, with the lowest annual number recorded in 2024, totaling 3,618 procedures. We believe that the coronavirus pandemic (and the effects of lockdown) may have influenced these data between 2020 and 2022.

In the analysis by gender, it was observed that males accounted for about 76.6% of hospitalizations, representing approximately three times more cases than females (23.4%).

Regarding the nature of care, most were performed on an emergency basis (88.4%), while 11.6% were elective.

The mortality rate was higher among emergency care (6.3%) when compared to elective procedures (5.7%).

Despite the predominance of hospitalizations among males, proportional mortality was higher among females, with a rate of 7.8%, in contrast to 5.7% among males. This finding corresponds to a relative risk (RR) of 1.36, indicating that, proportionally, women had a 36% higher risk of death from vascular trauma than men.

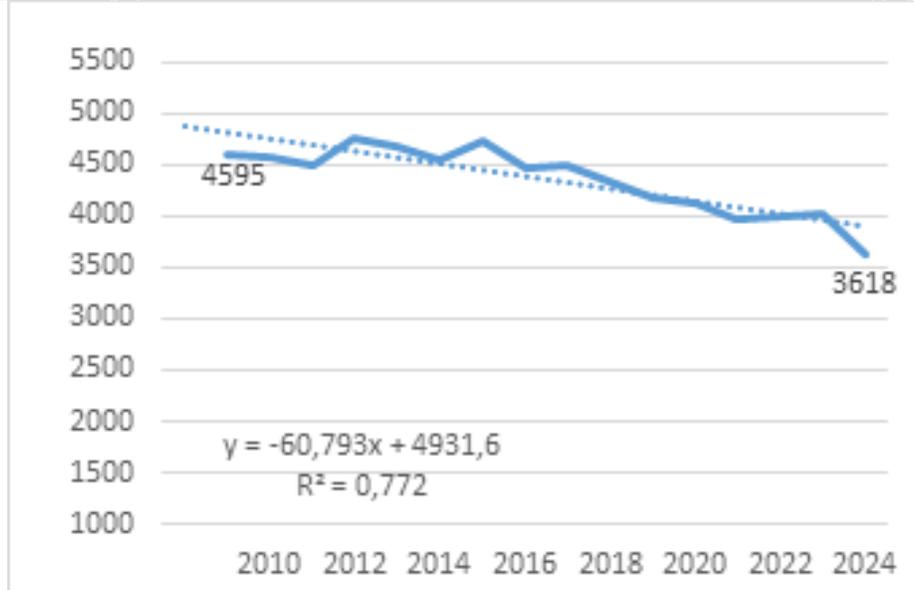
When broken down by geographic region, the Southeast had the highest number of hospitalizations, with 23,000 cases (32% of the total), followed by the South (4,074), Northeast (3,880), North (2,134), and Midwest (2,534).

In terms of distribution by anatomical topography, hospitalizations were most frequently associated with upper limb trauma, with an annual average of  $1,647 \pm 85$ , followed by lower limbs with  $1,283 \pm 147$ , the cervical region with  $1,042 \pm 143$ , and the abdominal region with a median of 382 cases (IQR: 103).

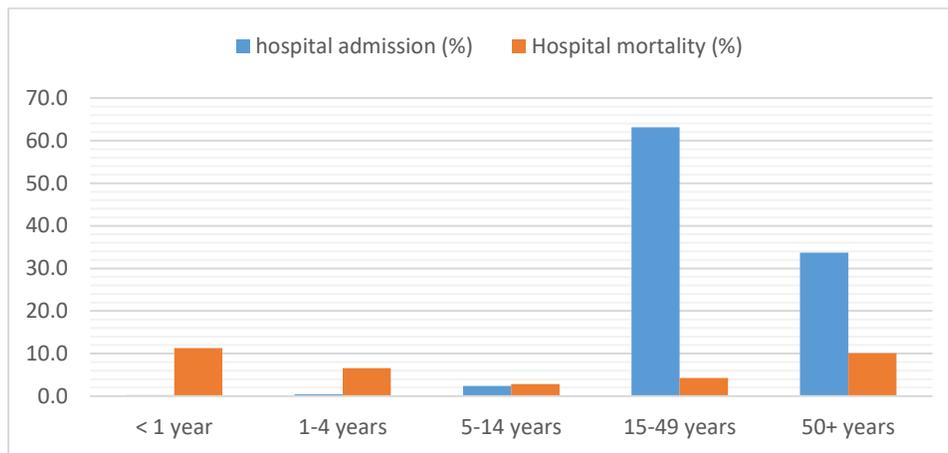
Regarding the length of hospitalization, the longest median hospital stay was observed in cases of lower limb trauma (6.6 days; IQR: 0.3), followed by the cervical region (5.8 $\pm$ 0.3 days), abdominal region (5.6 $\pm$ 0.4 days), and upper limbs (4.5 $\pm$ 0.2 days).

The mortality rate varied according to anatomical topography, being highest in abdominal trauma, at 22.1 $\pm$ 2.4%, followed by lower limbs (11.8 $\pm$ 2.87%), cervical region (7.4 $\pm$ 0.8%), and upper limbs (2.3%; IQR: 0.7).

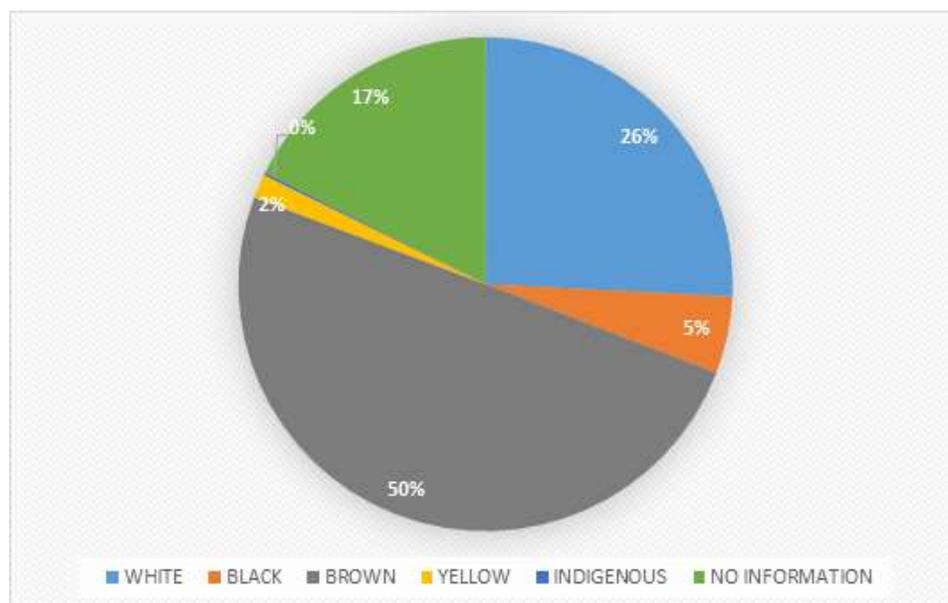
The integrated analysis shows that, although lower limb trauma accounted for most hospitalizations during the period, abdominal trauma, although less frequent, was proportionally the most lethal among all anatomical locations evaluated.



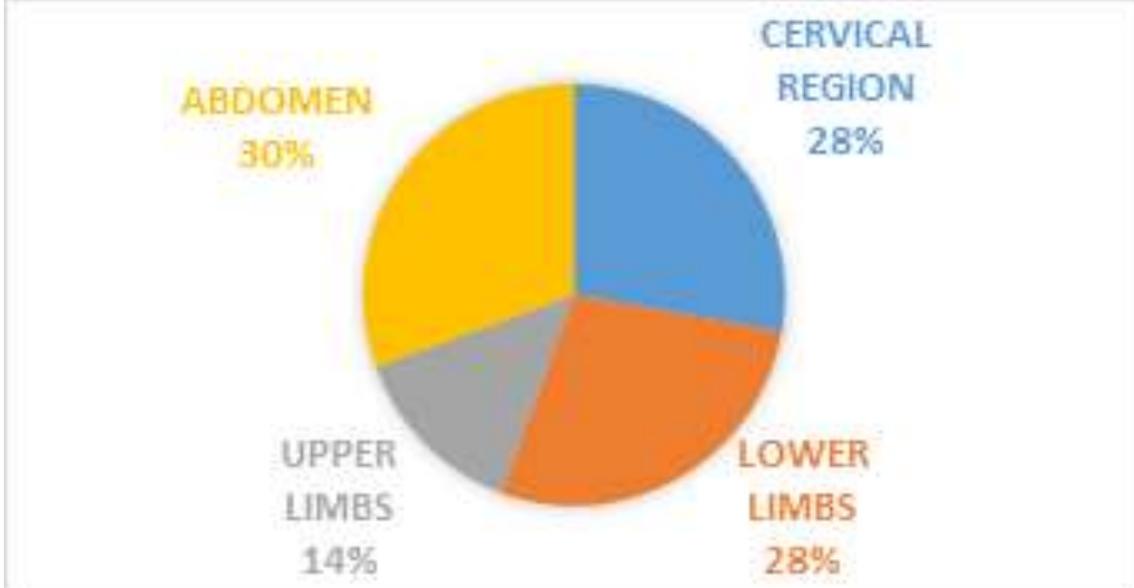
Time series of hospital admissions from 2008 to 2024



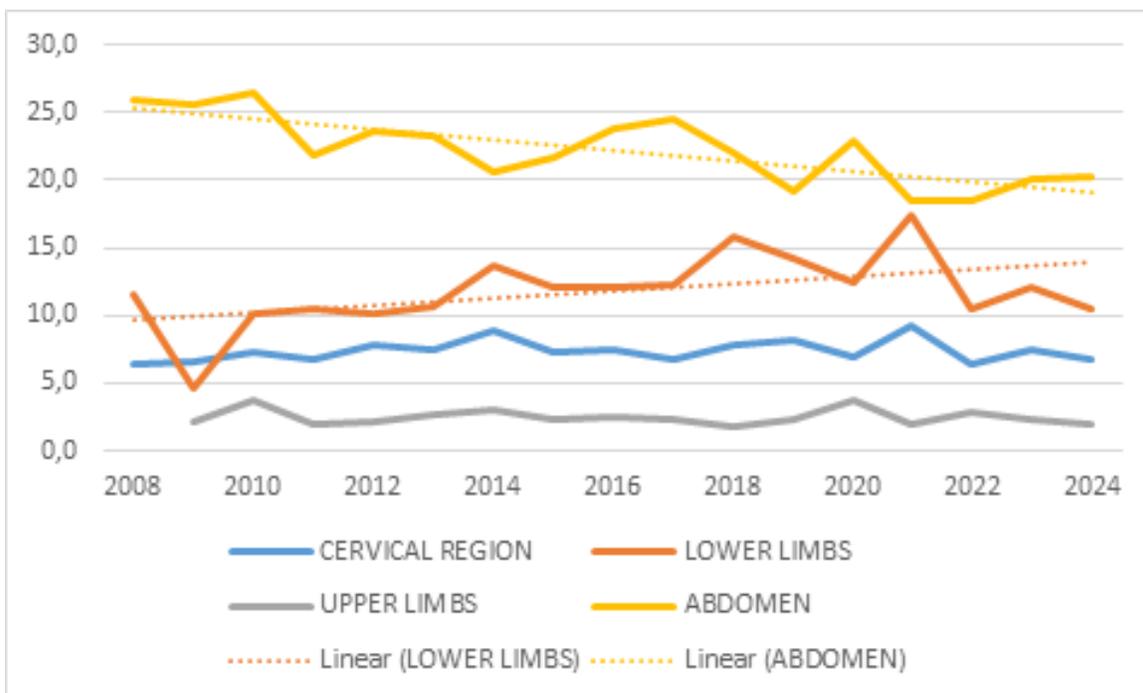
Comparison between proportional hospital admission and in-hospital mortality from 2020 to 2025 by age group



Proportional hospital admission from 2020 to 2025 by race group



Deaths by anatomical site



Hospital mortality rate between 2008 and 2024 by anatomical region.

**Discussion**

The increase in the number of hospital records may be related not only to greater demand for care, but also to improvements in hospital information systems, given that, as of January 1998, it became mandatory to include the secondary diagnosis referring to the external cause of the injury (ICD-10: V01-Y98) in Hospital Admission Authorization (AIH) records, in addition to the description of the nature of the injury (ICD-10: S00-T98)<sup>6</sup>, which was an initial step toward improving the accuracy of trauma notifications in the SIH/SUS databases.

The slight decline in the number of hospitalizations for vascular trauma in SUS 2019-2024, with the lowest annual number recorded in 2024, totaling 3,618 procedures, can be attributed to the effects of the COVID-19 pandemic on health services. The literature explains that there was a significant reduction in the number of hospitalizations for traumatic

causes during the most critical periods of the pandemic, given the prioritization of public resources to combat COVID-19 and social distancing measures, with mobility restrictions and lockdowns imposed throughout the country and worldwide. The population's reduced exposure to risk situations and the overload and fragility of the health system during this period, especially in 2020 and 2021, may have contributed to the reduction in demand for emergency care and the limitation of hospital response capacity, including an increase in underreporting.

The male population representing the majority of victims is evident in the study. Despite the higher number of male hospitalizations, the proportional mortality among women is more significant than among men. This represents a relative risk (RR) of 1.36, showing that, proportionally, women victims of vascular trauma have a 36% higher risk of death compared to men. The greater exposure of men to traumatic

injuries leads us to assume that the relative risk of death would be higher in the male group, proportionally consistent with the group with the highest percentage of victims.

A study by Haider et al. analyzed the difference in survival between men and women in trauma scenarios, showing that women not only have higher survival rates after a traumatic injury when compared to men with similar injuries, but also demonstrate less susceptibility to the development of fatal complications. The authors also point out that when these complications occur, the relative risk of death in women becomes higher than that observed in men.<sup>10</sup> Therefore, the relative risk of death found in this study may suggest that women victims of vascular trauma in the SUS experience a more significant rate of in-hospital complications than men, which increases the relative risk of death in this group. Given the limitations of DATASUS, which does not provide medical record data related to the complications and specific characteristics of these patients, this hypothesis cannot be explored in this study. However, it is of interest to the scientific community to compare the risk of death between men and women victims of vascular trauma hospitalized in the SUS, using medical record data as a basis, seeking to explain why in Brazil women have a higher risk of death compared to men after traumatic vascular injuries, even though they represent less than ¼ of the victims, in addition to exploring the impact of complications on these rates and, possibly, evaluating the effectiveness of managing these complications.

Hospitalizations occurred predominantly among patients aged 15 to 49 years. This finding reinforces the literature, which points out that victims of vascular trauma are generally mostly young.<sup>1,2,3,4,5</sup> The justification, according to the study by Góes Junior et al, is that the group that makes up the main economically active portion is more exposed to traffic accidents, work accidents, and urban violence, which makes them more susceptible to blunt and penetrating trauma.<sup>5</sup> Another study, conducted by Lentsck, Sato, and Mathias, reinforces this picture by highlighting the epidemiological relevance of trauma in this population profile.<sup>11</sup>

Data related to the color/race of hospitalized patients show that most victims identified themselves as brown/black. To analyze these data, it is necessary to interpret them based on some social, historical, and cultural particularities of the country. Brazil, despite being ethnically diverse, is a predominantly black country (including black and brown), with this group representing 55.4% of the Brazilian population, according to the latest census by the IBGE (Brazilian Institute of Geography and Statistics) in 2022.<sup>12</sup>

At the same time, it is a country with a long history of slavery, which makes the role of color/race as a social determinant that permeates issues of inequality and prejudice in different structural spheres, including public health, undeniable. The study by Souza, Barros, and Silva analyzed the completion of the race/color question in patient identification and showed that this practice has important limitations, since it depends on self-declaration in a country with a strong history of denial of Afro-descendant identity.<sup>13</sup> Complementarily, Albuquerque et al. investigated regional health inequalities in Brazil between 2000 and 2016 and highlighted that this fragility in the collection of hospital records reflects and reinforces structural disparities in the health system.<sup>14</sup>

The data reveal a predominance in the Southeast region (32% of the total), followed by the South (4,074), Northeast (3,880), North (2,134), and Midwest (2,534) regions. These results can be explained by some regional disparities. The first corresponds to population distribution, which is not uniform throughout Brazil. According to the latest IBGE census, in 2022, the Southeast region comprised 42.99% of the country's population, followed by the Northeast region with 27.27% of the total, then the South region with 15.11%, the North region with 8.78%, and the Midwest region with 8.12% of the country's inhabitants. The most populous regions have more specialized services, more hospital beds, and a greater number of professionals. The significant proportion of victims in the Southeast region reflects, among other parameters, the larger population in that

region and, following the same logic, the North and Midwest regions have the lowest hospitalization rates.

The study by Lima et al. identified that, despite the expansion of service provision among the SUS Health Regions, the groups with higher levels of socioeconomic development and better service provision remained concentrated mainly in the South and Southeast regions. In addition, the AMIB/2024 Census showed that the North and Northeast regions have less hospital infrastructure, reduced availability of ICU beds and specialized teams, which limits access to intensive care and is reflected in the hospitalization rates observed in this study.

The density of car accidents and rates of urban violence in these regions, factors linked to the urbanization process, are also important parameters to be considered in the analysis of the results, since it is widely reinforced in the literature that penetrating injuries from firearm projectiles and blunt injuries from car accidents are the main causes of vascular trauma in the country.

In 2022, the urban population represented 87.4% of Brazilians, with the highest percentages observed in the Southeast (94.44%) and Midwest (91.35%) regions, followed by the South (88.24%), North (78.47%), and Northeast (77.64%) regions. According to the National Road Safety Observatory (2023), also in 2022, the Southeast and Northeast regions had the highest percentages of deaths from car accidents compared to other regions of the country. At the same time, the Atlas of Violence 2025, prepared by Cerqueira et al. (2025), pointed out that the lowest homicide rates per 100,000 inhabitants were recorded in the southern states, in addition to São Paulo and Minas Gerais, while the highest rates were concentrated in the North and Northeast. In terms of urbanization, the South and Southeast stand out again. However, the North and Northeast have higher rates of urban violence and, after the Southeast, the Northeast stands out with the highest density of car accidents, corroborating the findings of this study in explaining why these regions have numbers of hospitalizations of vascular trauma victims close to those of the Southeast and South, and higher than those of the Midwest, despite disparities in population, urbanization, and the provision of specialized services.

The most frequent cases of hospital admission for vascular trauma occurred in the upper limbs. There are variations in the most affected anatomical regions depending on the context of the analysis. However, the literature supports that, in general, the extremities are more commonly affected in vascular trauma in Brazil.<sup>1,4,15</sup>

Although less prevalent, abdominal vascular trauma has the highest mortality rate, accounting for 22.1% of vascular trauma deaths recorded in DATASUS, followed by trauma to the lower limbs (11.8%), cervical region (7.4%), and upper limbs (2.3%). The abdominal cavity houses large, high-caliber vessels capable of generating difficult-to-control bleeding when injured. Reinforcing this perspective, Perkins et al. demonstrated that bleeding and shock are among the main factors contributing to complexity and mortality in these cases. This understanding had already been proposed previously by Kashuk et al., who suggested a unified approach to the management of abdominal vascular trauma given the severity of the outcomes.<sup>16,17</sup> Furthermore, success in this scenario presupposes the presence of trained teams, vascular surgeons, and adequate hospital infrastructure, which, as previously discussed, is not always available due to disparities in the concentration of specialized services in the country. The high mortality rate may also reflect delays in prehospital care and difficulty in accessing referral centers.

Regarding hospital stay, the data showed that lower limb trauma required the longest hospital stay, with a median of 6.6 days, while cervical and abdominal trauma had similar times (5.8 and 5.6 days, respectively), and upper limb trauma resulted in shorter hospital stays, with a mean of 4.5 days. These results can be correlated with the susceptibility of these injuries to develop complications that prolong ICU hospitalization and require multiple interventions. The literature argues that factors such as

prolonged ischemia (>6 h), blunt trauma, associated fractures, compartment syndrome, and hemodynamic instability are strongly associated with prolonged hospital stays in patients with vascular trauma, especially in the lower limbs, 18-24 corroborating the findings of this study.

Regarding the nature of care, 88.4% were urgent/emergency cases, while 11.6% were elective. The mortality rate followed the same trend, being higher among urgent care cases. Trauma accounts for high morbidity and mortality rates and requires rapid intervention precisely because of the potential severity of the injuries and, in vascular trauma, the hemodynamic instability of patients. Therefore, the results reflect the profile of this type of injury, especially in Brazil, where these injuries are mainly caused by firearm projectiles and car accidents. The most prevalent mechanisms of vascular trauma in Brazil are associated with more complex injuries, requiring rapid prehospital and intrahospital care to control bleeding and repair damage. This scenario justifies a prevalence of emergency care, which, in turn, has higher mortality rates due to the greater severity of the injuries.<sup>25,26</sup>

The study has limitations related to underreporting of data due to failure to collect and record data not controlled by these researchers. More multicenter and comparative studies are needed to better determine the interference of other variables.

## Conclusion

Young black men are the majority of vascular trauma victims in Brazil, with most cases requiring emergency care and the highest concentration of cases in the most populous and developed regions, especially in the Southeast, reflecting regional disparities in the country.

The upper limbs were most affected (defensive injuries), while lower limb injuries accounted for the longest hospitalization time, suggesting that associated complications prolong the period of hospitalization.

Abdominal vascular trauma, although less prevalent, showed higher mortality rates, reflecting the complexity of this type of injury and the structural challenge in the face of the need for rapid and specialized pre- and intra-hospital care in a context of strong regional socioeconomic disparities.

There was a higher relative risk of death among female victims, contrasting with the international literature and suggesting that, in Brazil, this group may experience high rates of intra-hospital complications.

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