SUS Reimbursement Values for Major Cardiovascular Disease Hospitalizations in Brazil, 2014–2024: Comparisons Across Regions and COVID-19 Periods

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Introduction

Cardiovascular diseases (CVDs) are the leading cause of death in Brazil, causing over 400,000 deaths annually and imposing a substantial clinical and economic burden on the healthcare system.[1,2] Despite this burden, nationwide evidence on the hospital expenditures associated with CVDs remains limited and methodologically heterogeneous, reducing its usefulness for health planning in a country marked by substantial regional differences. In Brazil, hospital care financed by the Brazilian Unified Health System (*Sistema Único de Saúde*—SUS) is administratively recorded through amounts approved for reimbursement, which provide a standardized measure of direct hospital expenditure within the public health system. Understanding these reimbursement patterns became particularly relevant during the COVID-19 pandemic, which disrupted chronic disease management and altered healthcare utilization patterns.[3] However, variations in SUS reimbursement values for CVD hospitalizations across regions and pandemic periods remain insufficiently characterized. This study aimed to compare inflation-adjusted SUS reimbursement values for hospitalizations due to CVDs in Brazil between 2014 and 2024 across geographic regions, sociodemographic and healthcare-related characteristics, and the pre-pandemic, pandemic, and post-pandemic periods.

Methods

This nationwide ecological study used secondary data from the Hospital Information System of the Brazilian Unified Health System (*Sistema de Informações Hospitalares do Sistema Único de Saúde*—SIH/SUS), accessed through the Department of Informatics of SUS (DATASUS). We included hospitalizations of individuals aged ≥15 years with a primary diagnosis of essential hypertension (ICD-10: I10), acute myocardial infarction (I21), heart failure (I50), or unspecified stroke (I64) recorded across Brazil's 5,570 municipalities between January 2014 and December 2024. Surgical, obstetric, and psychiatric admissions, as well as records with incomplete information required for the analyses or diagnoses unrelated to the conditions of interest, were excluded.

Based on World Health Organization (WHO) milestones, the study period was divided into pre-pandemic (January 2014–February 2020), pandemic (March 2020–May 2023), and post-pandemic (June 2023–December 2024) periods. March 2020 corresponds to the WHO characterization of COVID-19 as a pandemic, while May 2023 was selected because the WHO declared on May 5, 2023, that COVID-19 no longer constituted a Public Health Emergency of International Concern. Because data were analyzed monthly, the post-pandemic period began in June 2023. This operational definition does not imply the end of SARS-CoV-2 circulation. The study began in 2014, when Ordinance GM/MS No. 483/2014 reorganized the chronic care network within SUS.[4]

The primary outcome was the mean SUS reimbursement value per hospitalization, expressed in Brazilian reais (BRL). The monetary values recorded in SIH/SUS correspond to the amounts approved for reimbursement under the Hospital Admission Authorization (*Autorização de Internação Hospitalar*—AIH) system and do not represent estimates of the full economic costs incurred during hospitalization. AIH values comprise the components covered by the SIH/SUS reimbursement schedule, including hospital and professional services, procedures, inpatient and intensive care unit daily charges, when applicable, and materials and medications incorporated into or separately reimbursed under the corresponding procedure. Because SIH/SUS is an administrative reimbursement system, these values may not reflect the actual resources consumed or the full costs borne by healthcare providers.

Monetary values were adjusted for inflation to December 2024 prices using the Brazilian Extended National Consumer Price Index (*Índice Nacional de Preços ao*

Keywords

Cardiovascular Diseases; Heart Failure; Stroke; Hypertension; COVID-19.

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Consumidor Amplo—IPCA). Mean reimbursement values per hospitalization were calculated by dividing the total inflation-adjusted amount approved for reimbursement by the number of hospitalizations and were compared according to sex, age group, race/skin color, geographic region, admission type, and study period. Aggregated monthly observations were treated as independent analytical units. Normality and homogeneity of variances were assessed using the Shapiro–Wilk and Levene tests, respectively. Two-group comparisons used the independent-samples Student's *t*-test or Mann–Whitney *U* test, while comparisons involving three or more groups used one-way analysis of variance or the Kruskal–Wallis test, as appropriate. Significant global tests were followed by Tukey's test or Dunn's test with Holm adjustment, respectively. Statistical significance was set at a two-sided p-value <0.05. Analyses were performed using JASP, version 0.97.1 (JASP Team, Amsterdam, the Netherlands).

Results

From 2014 to 2024, Brazil recorded 5,983,340 hospitalizations for the four CVDs investigated among individuals aged ≥15 years (mean monthly rate: 27.7 per 100,000, based on the 2022 population of this age group), corresponding to BRL 13.07 billion in inflation-adjusted amounts approved for reimbursement by the SUS. Heart failure and stroke accounted for most hospitalizations, whereas acute myocardial infarction accounted for nearly half of the total reimbursement value (47.2%), followed by heart failure (30.4%) and stroke (20.7%).

Mean SUS reimbursement values per hospitalization differed across most sociodemographic and healthcare-related strata (Supplementary Table 1S). These values were consistently lower in the North and Northeast and higher in the other Brazilian regions. Elective admissions had higher mean reimbursement values than urgency admissions across all conditions (e.g., acute myocardial infarction: BRL 5,722.99 vs. BRL 3,958.66; p < 0.001). Overall, higher mean reimbursement values were observed for elective admissions, among men (except stroke), and among middle-aged and older adults. Mean values also varied across race/skin color categories (Supplementary Table 1S).

Mean SUS reimbursement values differed across the pre-pandemic, pandemic, and post-pandemic periods. The highest values were observed in the post-pandemic period, particularly for acute myocardial infarction, heart failure, and hypertension. For stroke, post-pandemic reimbursement values were higher than pre-pandemic values but did not differ significantly from those recorded during the pandemic period (Figure 1; Supplementary Figure 1S).

Discussion

This nationwide ecological assessment showed that SUS reimbursement values for CVD hospitalizations varied across the study period, with the highest values observed in the post-pandemic period and substantial differences across geographic and sociodemographic groups. Although heart failure and stroke accounted for most hospitalizations, acute myocardial infarction represented the largest share of

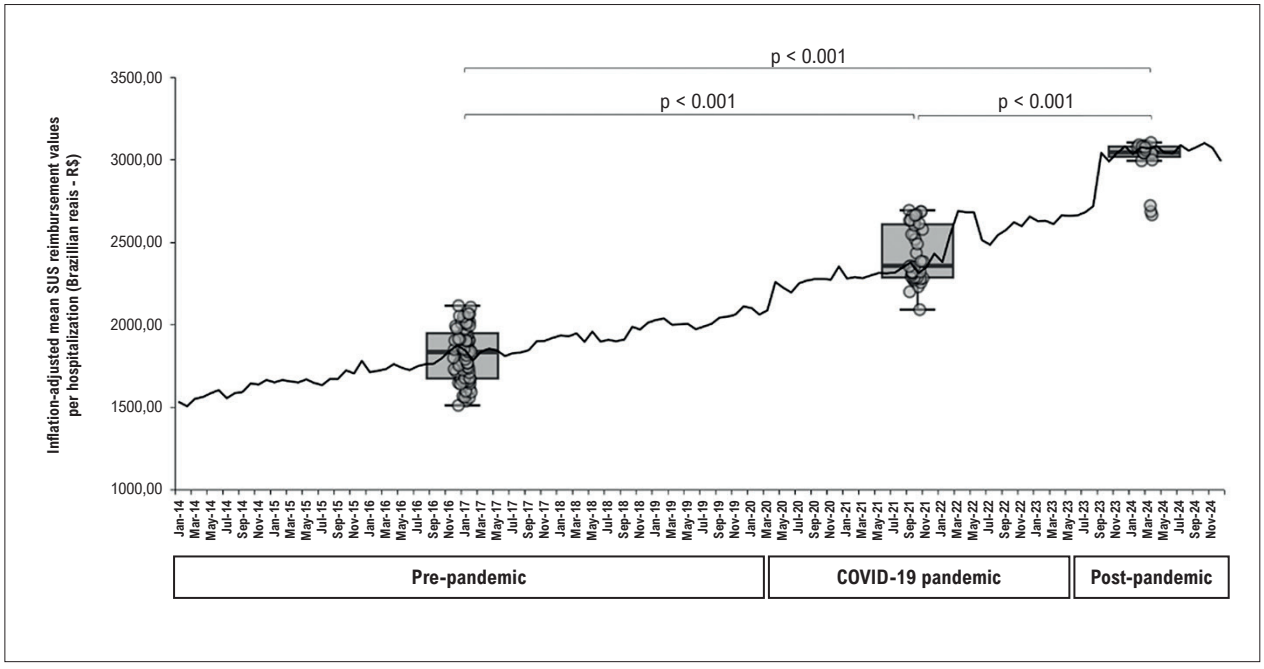

Figure 1 – *Monthly variation and comparison of inflation-adjusted mean SUS reimbursement values per hospitalization for selected major cardiovascular diseases across the pre-pandemic, pandemic, and post-pandemic periods in Brazil, 2014–2024. Values are expressed in Brazilian reais (BRL) and adjusted for inflation using the Brazilian Extended National Consumer Price Index (IPCA).*

the total amount approved for reimbursement. This finding may reflect the higher reimbursement values assigned to invasive procedures and other components of resource-intensive cardiovascular care. Higher mean reimbursement values were observed for elective admissions and in strata defined by male sex, age 50–69 years, and White race/skin color. Because these findings were derived from aggregated data, the mechanisms underlying these differences cannot be determined at the individual level.

The higher aggregate reimbursement values observed in the post-pandemic period occurred in the context of widespread disruptions in chronic disease monitoring and healthcare utilization during the COVID-19 pandemic. Delays in seeking healthcare and more advanced clinical presentations have been proposed in the literature as potential consequences of these disruptions. However, the present study did not assess the timing of healthcare-seeking, clinical severity at admission, or individual care trajectories. These mechanisms therefore constitute contextual hypotheses and cannot be causally linked to the observed reimbursement patterns.

Regional differences were also evident, with lower mean reimbursement values in the North and Northeast. At the aggregate level, these differences may be related to geographic variation in case mix, service availability, coding and reimbursement practices, procedure intensity, and the distribution of specialized cardiovascular services. Lower reimbursement values should not be interpreted as evidence of lower cardiovascular burden or greater efficiency. In regions characterized by socioeconomic vulnerability and healthcare barriers, these patterns may coexist with unmet healthcare needs and limited availability of high-complexity services.[5,6] Nevertheless, the present ecological analysis cannot determine whether individual patients experienced restricted access to specialized care.

Differences according to sex and race/skin color may also be interpreted within this context. Lower use of outpatient healthcare services among men may contribute to delayed diagnosis and admissions requiring more intensive care;[7] in 2019, 69.4% of men reported a medical consultation in the preceding year, compared with 82.3% of women.[8] The literature also describes racial inequalities in access to timely diagnostic assessment and specialized care.[9] These findings provide contextual support for interpreting the aggregate patterns observed in the present study, but they do not demonstrate that the reimbursement differences resulted from individual healthcare-seeking behavior or access to high-complexity interventions. The present analysis did not measure healthcare access, clinical severity, procedures received, or individual care pathways. Individual-level studies with appropriate adjustment for clinical and healthcare-related factors are required to investigate these potential mechanisms.

This study has limitations. SIH/SUS records administrative amounts approved for reimbursement under the AIH system, which may differ from actual resource use, costs incurred by healthcare providers, and final amounts transferred. It also excludes hospitalizations financed exclusively by the private or supplementary healthcare sectors. The ecological design precludes individual-level inferences, and comparisons may be influenced by case mix, coding practices, procedure profiles, and other unmeasured factors. Monthly observations were treated as independent; however, unmodeled serial autocorrelation may have underestimated uncertainty, warranting cautious interpretation of statistical significance. The findings should therefore be regarded as exploratory aggregate comparisons across predefined periods, not as formal estimates of temporal trends or pandemic effects, nor as comprehensive estimates of the societal, hospital, or provider-level costs of CVD hospitalizations.

Despite these limitations, the nationwide coverage and extended study period provide relevant evidence for health-system planning. In a rapidly aging country facing an increasing burden of chronic diseases, improving the allocation of public resources and reducing healthcare inequalities require stronger prevention and early detection, continuity of chronic care, and integrated cardiovascular care pathways responsive to regional and sociodemographic differences.

Author Contributions

Conception and design of the research; Data collection; Data analysis and interpretation; Statistical analysis; Manuscript drafting and Critical revision of the manuscript for important intellectual content: Andrade AFSM, Carvalho TA, Sousa ACS, Martins-Filho PR.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

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Ethics Approval and Consent to Participate

This article does not contain any studies with human participants or animals performed by any of the authors.

Use of Artificial Intelligence

The authors did not use any artificial intelligence tools in the development of this work.

Availability of Research Data

All datasets supporting the results of this study are available upon request from the corresponding author.

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*Supplemental Materials

For additional information, please click here.

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