

COVID-19 pandemic impact on ambulatory care-sensitive condition hospitalizations in 253,564 Children

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Abstract

BACKGROUND

Analyzing Ambulatory Care-Sensitive Hospitalizations (ACSHs) is essential for reducing preventable hospitalizations and interventions through Primary Health Care (PHC), as well as for improving the health system and lowering costs.

OBJECTIVE

To analyze ACSHs in the pediatric population and assess the impact of COVID-19 on these hospitalizations.

METHODS

This epidemiological study used ACSH data from children and adolescents aged 27 days to 17 years between 2018 and 2024. Hospitalizations occurred in hospitals within the private healthcare system and the Unified Health System (SUS) across all five regions of Brazil, using the Diagnosis-Related Groups (DRG Brasil®) system.

RESULTS

A reduction in hospitalizations for lung diseases was observed. Heart failure and angina *pectoris* had the highest average number of procedures in 2018–2019, while hospitalizations for hypertension were most prevalent in 2020–2022. Mortality was highest for hospitalizations due to heart failure.

CONCLUSION

These findings emphasize the importance of strengthening PHC, focusing on prevention, continuous monitoring, and fair responses to children's needs across different regions.

INTRODUCTION

Universal health coverage is a shared goal of most countries worldwide[1]. Primary health care (PHC) is the backbone of the health care system, structured around Basic Health Units (UBS) and responsible for disease prevention and health promotion. The services provided by PHC to users include low-technology measures for prevention, promotion, and health education; epidemiological surveillance; and the monitoring and treatment of acute and chronic diseases[2]. The 2030 Agenda established Sustainable Development Goal (SDG) 2, which sets the target for countries to achieve universal health coverage, including financial risk protection, access to quality essential health services, and access to safe, effective, quality, and affordable essential medicines and vaccines for all[3].

According to the National Council of Health Secretaries (CONASS), approximately 564,232 patients are treated daily in PHC, with 85% of cases resolved without the need for referral to a more complex service[4]. Therefore, many complications and hospitalizations may be linked to deficient care and low resolution of the problems presented in PHC[5]. As for pediatric health care, PHC provides prenatal consultations, neonatal screening tests, breastfeeding monitoring, childcare consultations, growth and development assessment, and immunization[6].

In this regard, to assess the effectiveness of this level of care, several indicators were developed and incorporated[7–8] into Brazil's list of ambulatory care sensitive conditions (ACSCs). These indicators are used to evaluate PHC based on hospitalization rates and can be applied to measure the performance of the health system at the national, state, and municipal scale.

Thus, ambulatory care sensitive condition hospitalizations (ACSHs) are defined as hospitalizations that could be prevented or managed within the primary health care (PHC) setting, serving as a highly relevant indicator for assessing the level of problem-solving of this service. These rates reflect the effectiveness of PHC in preventing and treating both communicable and non-communicable diseases and constitute important measures of the health system's performance in delivering effective preventive care. Analyzing ACSHs is essential for reducing hospitalizations and avoidable interventions through PHC actions, as well as for improving the health system overall and lowering costs that can then be redirected to other services[9].

Among the factors contributing to the increase in ACSHs, the COVID-19 pandemic, declared in March 2020, stands out. It caused significant impacts on public health, including widespread disruption of healthcare services. By the end of 2021[10], interruptions in the provision of various essential health services had been reported in 93% of countries. Moreover, the organization of health services underwent substantial changes, primarily affecting Primary Health Care (PHC)[11].

Furthermore, in Brazil during the pandemic, a significant number of ACSHs related to urinary tract infections were detected in children aged 0 to 4 years across all five regions, making it the second most frequent cause[12]. Studies also indicate that, in Tocantins, diseases related to prenatal care and childbirth were the third leading cause of ACSHs in children under 1 year of age, and the second leading cause in teenagers aged 10 to 14 years[13].

This study aimed to analyze ambulatory care sensitive condition hospitalizations (ACSHs) in the pediatric population and to evaluate the potential repercussions of COVID-19 on ACSHs.

METHODS

This epidemiological study used hospitalization data from children and adolescents aged 27 days to 17 years, spanning 2018 to 2024, who experienced ACSHs. Admissions occurred in hospitals within both the private healthcare system and the Unified Health System (SUS), across all five regions of Brazil, and were classified using the Diagnosis-Related Groups (DRG Brasil®) system. Data collection was performed from patient records following hospital discharge, death, or transfer, and was entered into the DRG Brasil® system by nurse coders dedicated to this task.

The DRG, or Diagnosis-Related Groups, methodology categorizes patients into homogeneous groups based on their characteristics and the complexity of care. This methodology applies to patients hospitalized in health services – that is, hospitals treating acute cases where the average length of stay does not exceed 30 days[14]. Group classification is based on the primary diagnosis, patient age and sex, the presence of comorbidities and complications (secondary diagnoses), and procedures performed[14-15].

The sample consisted of children and adolescents aged 27 days to 17 years. The initial database contained 903,677 patients, and after excluding those without ACSHs, the final sample comprised 253,564 children and adolescents. The classification of ACSHs was based on Ordinance SAS/MS No. 221 of April 17, 2008. According to this ordinance, 19 ICD diagnostic categories were extracted and grouped, namely: anemia, angina *pectoris*, asthma, nutritional deficiencies, diabetes mellitus, pelvic inflammatory disease, cerebrovascular diseases, vaccine-preventable diseases and sensitive conditions, lung diseases, diseases related to prenatal care and childbirth, epilepsy, infectious gastroenteritis and complications, hypertension, skin and soft tissue infections, kidney and urinary tract infections, ear, nose, and throat infections, heart failure, bacterial pneumonia, and gastrointestinal ulcer.

Regarding secondary diagnoses and hospital-acquired conditions, the International Classification of Diseases (ICD-10) was used. Procedures were coded according to the tables used in the Brazilian Unified Health System (SUS) and the private healthcare system – in this case, the Common Private Health Insurance and Plans Terminology – along with the length of hospital stay (in days). Furthermore, data were extracted on discharge outcome (death or survival), serious hospital-acquired conditions (HACs), and the type of surgical or clinical Diagnosis-Related Group (DRG) for the disease groups and periods.

The analyses in this study created graphical representations of data for better understanding. Initially, an area graph was generated to explore the distribution of ACSHs by age group, sex, and region of Brazil across the different diagnostic categories. Next, a heat map was created for the same diagnostic groups, in which quantitative variables (number of procedures, number of secondary ICD codes, and length of stay) were represented using mean values, while categorical variables (death, surgical DRG, and serious hospital-acquired conditions) were represented by relative proportions. This approach enabled the visual identification of the main clinical, demographic, care, and temporal characteristics associated with different hospitalization profiles. All analyses and representations were conducted in RStudio[16].

Consent to participate

This study was approved by the Research Ethics Committee (Comitê de Ética em Pesquisa) under CAAE: 09709118.0.0000.5149. This was a non-interventional, retrospective study based on data extracted directly from patients' medical records, with no direct contact with participants and no interference in clinical care. Since participants were no longer hospitalized at the time of data collection, obtaining signed informed consent was not feasible; accordingly, the Research Ethics Committee granted a waiver of informed consent.

Data confidentiality was ensured in accordance with Resolution 466/2012 of the Brazilian National Health Council, which guarantees the privacy of research subjects with respect to sensitive data, and all data were anonymized in the study database. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee, as well as with the 1964 Declaration of Helsinki and its subsequent amendments or comparable ethical standards.

RESULTS

Figure 1 presents the distribution of hospitalizations for each disease group by year of discharge, sex, and age group. The percentage of hospitalizations for lung diseases decreased for all age groups, while the percentage of hospitalizations for diabetes mellitus and epilepsy increased. The most significant difference between males and females was seen in kidney and urinary tract infections. Lung diseases were the most common reason for hospital stays for kids under five years old.

In 2020, this disease group recorded its lowest proportion of hospitalizations (11.9% for girls and 14.9% for boys), while the highest values occurred in 2024 (35.1% for boys and 41.1% for girls). Among children aged 5–9 years, asthma accounted for the largest share of hospitalizations throughout the period, peaking in 2022 at 39.4% for girls and 37.1% for boys. In the group aged 10 years and older, no single disease group predominated; however, kidney and urinary tract infections remained more frequent among girls during the entire period.

Figure 2 shows the percentage of hospitalizations for each disease group, according to the year of discharge and Brazilian regions. The North region had the highest number of hospitalizations due to bacterial pneumonia, while the Southeast region recorded the most for asthma. In contrast, the South region exhibited the highest incidence of hospitalizations for lung diseases.

Figure 3 presents a heat map illustrating the average number of procedures and of secondary ICDs, and the length of stay for each disease group and period. In each column of this graph, the colors indicate a ranking of the observed values: that is, redder tones (blue) indicate higher values (low). Regarding the number of procedures, heart failure (1.82) and Angina *pectoris* (1.71) had the highest averages in 2018–2019.

Over the years, cerebrovascular diseases required the highest number of procedures, reaching an average of 1.54 in 2023–2024. In contrast, asthma and other lung diseases demanded the fewest procedures. Heart failure and nutritional deficiencies had the highest average rates of secondary ICDs during all three periods under analysis. The lowest average number of secondary ICDs was found in hospitalizations for angina *pectoris* in 2018–2019, while the lowest values were found for asthma and pelvic inflammatory disease in later periods. Such a finding reflects the low percentage of angina *pectoris* in the pediatric population (0.04% of cases), of which 54% involved children aged ten or older, and the low number of procedures for this group can be explained by the fact that only 3.2% of these cases required surgical intervention. As for length of stay, hospitalizations for nutritional deficiencies and heart failure had the longest durations, with a peak of 70.84 days in 2023–2024. Throughout the period analyzed, ear, nose, and throat infections, asthma, and angina *pectoris* showed the shortest stays.

Figure 4 presents a heat map showing the percentages of deaths, serious hospital-acquired conditions (HACs), and surgical DRGs for each disease group across the analyzed periods. The greatest mortality rate was from heart failure hospitalizations, which rose to 20% in 2023–2024. To this group, the numbers increased across the years. Cerebrovascular disorders, vaccine-preventable diseases, and other sensitive conditions showed a similar pattern. No deaths were recorded for anemia, angina *pectoris*, or prenatal and childbirth-related diseases throughout the period. In 2020–2022, hospitalizations for hypertension reached 6.45%, and the percentages of severe HACs are preserved in the mortality rate. Moreover, values for heart failure and nutritional deficiencies increased steadily. Lastly, from 2020–2022 to 2023–2024, the percentage of surgical DRGs decreased or remained unaltered for all disease groups, with the lowest values for asthma and the highest for pelvic inflammatory disease.

DISCUSSION

By examining health conditions and sociodemographic factors like age group, sex, year of hospital discharge, and geographic region, the findings allow a deeper understanding of ACSHs in Brazil from 2018 to 2024. The percentage of hospitalizations for lung diseases decreased significantly, with the North region having the highest percentage of hospitalizations for bacterial pneumonia.

Next, angina *pectoris* and heart failure had the highest average number of procedures in 2018–2019, while hospitalizations for hypertension were most common in 2020–2022. Hospitalizations for heart failure had the highest mortality rates.

The most common reason for hospitalization among children under five was lung diseases. Some of these illnesses, like bacterial pneumonia and whooping cough, can be prevented with vaccination; therefore, they should be given in PHC from the first few months of life[17]. Low vaccination coverage is concerning, as unvaccinated children are more susceptible to serious cases and complications from these diseases[18]. Breastfeeding is also a strategy to increase immunity and prevent diseases, since it allows children developing immune systems passive protection by transferring antibodies through milk[19]. Therefore, this practice needs to be strongly promoted and assisted in the PHC context[20].

In this study, the percentage of hospitalizations for diseases like diabetes mellitus and epilepsy increased across age groups. Hospitalization rates for diabetes mellitus showed an upward trend among children and adolescents aged 5–14 years, according to a national study reporting expenditures on hospitalizations for this condition[21]. These findings align with global trends, indicating a growing demand for diabetes-related hospitalizations with age, including cases of diabetic ketoacidosis[22-23]. This scenario raises epidemiological concerns for the coming decades[21]. Prospective follow-up studies are essential to better understand mitigating factors related to psychosocial and financial burdens that could potentially be prevented [23], given the disease's epidemiological scenario.

Females exhibited the highest percentage of hospitalizations for kidney and urinary tract infections throughout the study period. Urinary tract infections (UTIs) are among the most common bacterial infections in childhood[24-25] and vary according to age, race, sex[10,24,26], and circumcision status. A Spanish study reported a reduction in UTI-related hospitalizations and attributed this decline at the national level to the adoption of more restrictive diagnostic criteria and improvements in prenatal diagnosis of urinary tract anomalies[27].

While asthma accounted for the largest percentage of hospitalizations overall during the period under analysis, the northern region of Brazil stood out as having the highest percentage of hospitalizations for bacterial pneumonia in children aged 5 to 9. A study conducted in Rondônia from 2008 to 2019, which aimed to outline the profile of ACSHs in children, suggested that this pattern may be related to the limited identification and early management of these conditions in PHC. Significant geographic differences show that the Southeast had a high hospitalization rate for asthma, which may be related to increased urbanization and pollution in the region's major cities[28-29]. Therefore, PHC services are necessary to guarantee early symptom and risk factor detection, allowing for successful preventive treatment[19]. Furthermore, patients have experienced extrapulmonary symptoms since the start of COVID-19 as a result of postviral complications and inflammatory reactions brought on by the illness. Potential adverse effects of medications used to control the immune response brought on by SARS-CoV-2[30] must also be closely monitored.

Diseases related to nutritional deficiencies and heart failure stood out, as they had the highest mean values of secondary ICDs across the three periods analyzed. In children under one year of age, nutritional deficiencies showed a persistently stable trend throughout the years in a state in northern Brazil[28]. An analysis of data from the 2019 Global Burden of Disease Study (GBD) examined the disease burden and trends in nutritional deficiencies among children under five from 2010 to 2019 and found that in 2019, the highest rates were observed in sub-Saharan African countries, with the incidence of nutritional deficiencies inversely related to the Sociodemographic Index[31].

The pediatric population affected by heart failure shows high mortality, as well as substantial morbidity, evidenced by frequent hospitalizations, readmissions, and functional impairment[32,33]. A retrospective multicenter cohort study highlighted the importance of age-specific stratification when treating pediatric heart failure and reveals significant clinical and prognostic differences across developmental stages[34].

The highest percentage of deaths occurred in hospitalizations for heart failure during 2023–2024. The post-pandemic period had negative consequences for this population due to the lack of adequate monitoring and treatment necessary for disease management[35]. Health education is particularly important for these patients, as self-care is essential in chronic diseases to maintain health, manage the condition, and enable a rapid response to signs of decompensation[36].

During the pandemic, primary health care (PHC) services were reorganized to respond to the high demand for COVID-19 cases during the critical phase, with changes in care workflows, particularly in programmatic care. To address the increased need for measures to prevent and control the spread of SARS-CoV-2, many routine PHC activities, such as childcare, were rearranged, postponed, or suspended[37].

Furthermore, the highest percentages were observed for vaccine-preventable diseases and ambulatory care-sensitive conditions. Ecological studies conducted in Piauí and Minas Gerais[38-40] indicate decreasing or stagnant trends in vaccination coverage. According to a national study, this decline is not exclusive to Brazil; similar patterns have been documented in other nations as well. This highlights the necessity of creating public policy initiatives to educate and recruit individuals who did not receive childhood vaccinations.

A limitation of these findings is the lack of sample representativeness, which may not reflect the entire Brazilian health care system. However, considering the unique characteristics of each age group and clinical condition, the findings may help health managers and health personnel strengthen primary care by focusing on prevention, ongoing monitoring, and fair responses to children's needs across various regions.

Based on the analysis and findings, a complex and concerning pattern is observed in pediatric hospitalizations for several health conditions, particularly lung diseases, asthma, urinary tract infections, and cerebrovascular disorders. This scenario emphasizes the consequences of interrupted health care during the pandemic, including delays in the diagnosis, prevention, and appropriate treatment of preventable diseases, as well as the impact of regional disparities in the availability and quality of health services[35,40].

Declarations

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Ethics approval and consent to participate

The study was approved by the Research Ethics Committee of the Federal University of Minas Gerais (CAAE: 09709118.0.0000.5149). All procedures followed the ethical guidelines described in Resolution No. 466 of the National Health Council, dated 12 December 2012, which deals with research involving human subjects. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee, as well as with the 1964 Declaration of Helsinki and its subsequent amendments or comparable ethical standards. It should be noted that, as the data was collected directly from patient records, children and adolescents were exempted from signing the consent form, and parents or guardians were exempted from signing the informed consent form.

Clinical trial number

Not applicable.

Author Contributions

ACA, RCC, TMGP, TPRS and FPM participated in the conception and design of the study. BFF, GATC and TMO performed the literature review. BFF, GATC, KSAP, TPRS, FPM and TMO drafted the manuscript. BFF, GATC, KSAP, CHASO, TMO, ACA, RCC, TMGP, TPRS and FPM closely reviewed the manuscript for intellectual content and participated in revising and finalizing the manuscript. All authors read and approved the final manuscript.

Competing Interests

The authors declare that they have no relevant conflicts of interest.

Data Availability

The data generated and/or analyzed during this study are not publicly available due to ethical and confidentiality restrictions and cannot be shared publicly. The data may be available from the corresponding author upon reasonable request, subject to approval by the appropriate ethics committee and applicable data protection requirements.

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Figures

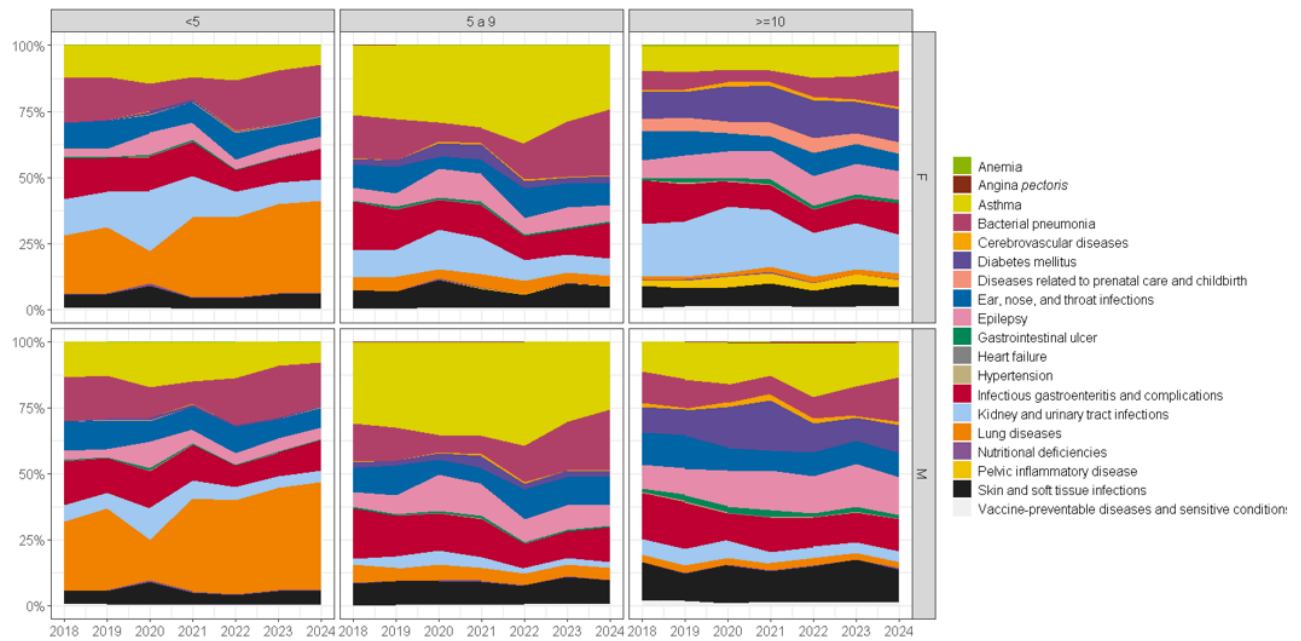


Figure 1

Area chart with the percentage of hospitalizations for each disease group by age group, sex, and year of discharge. Brazil, 2018 to 2024.

Source: Prepared by the authors, 2024.

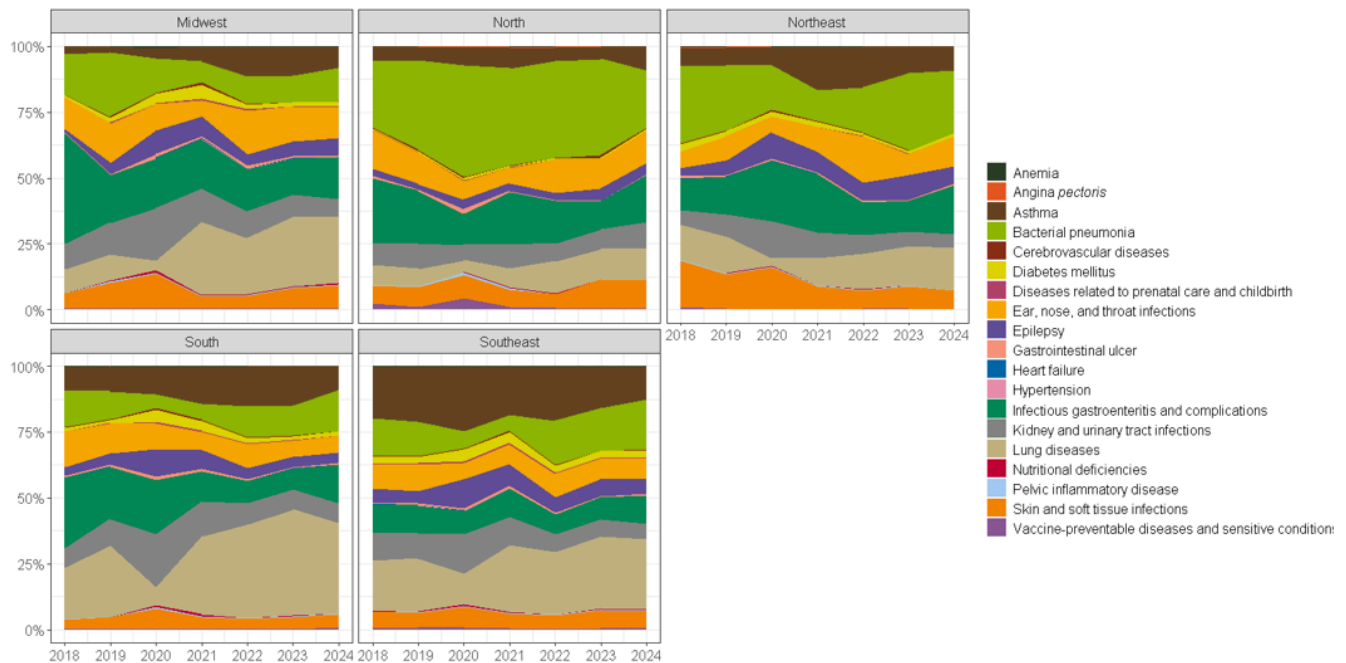


Figure 2

Area chart with the percentage of hospitalizations for each disease group by region and year of discharge. Brazil, 2018 to 2024.

Source: Prepared by the authors, 2024.

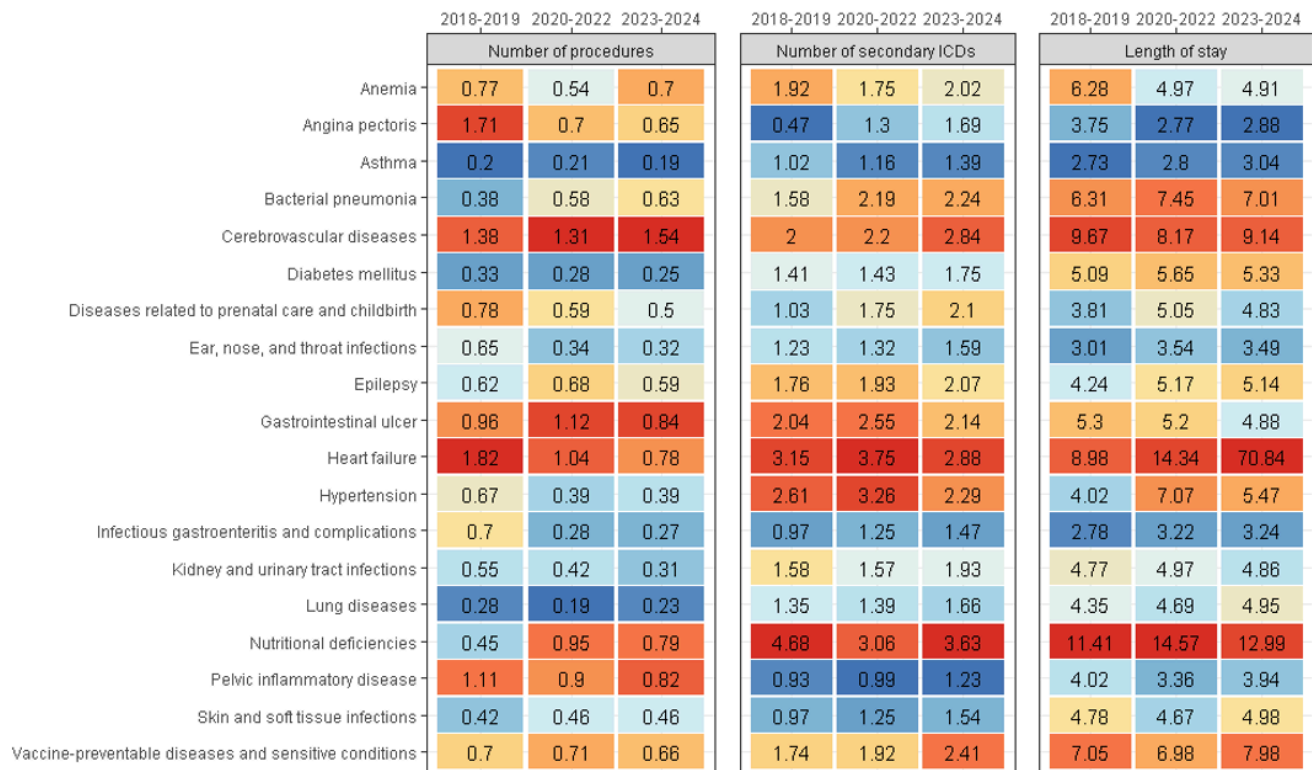


Figure 3

Heat map of the average number of procedures, number of secondary ICDs, and length of stay for disease groups across time periods. Brazil, 2018 to 2024.

Source: Prepared by the authors, 2024.

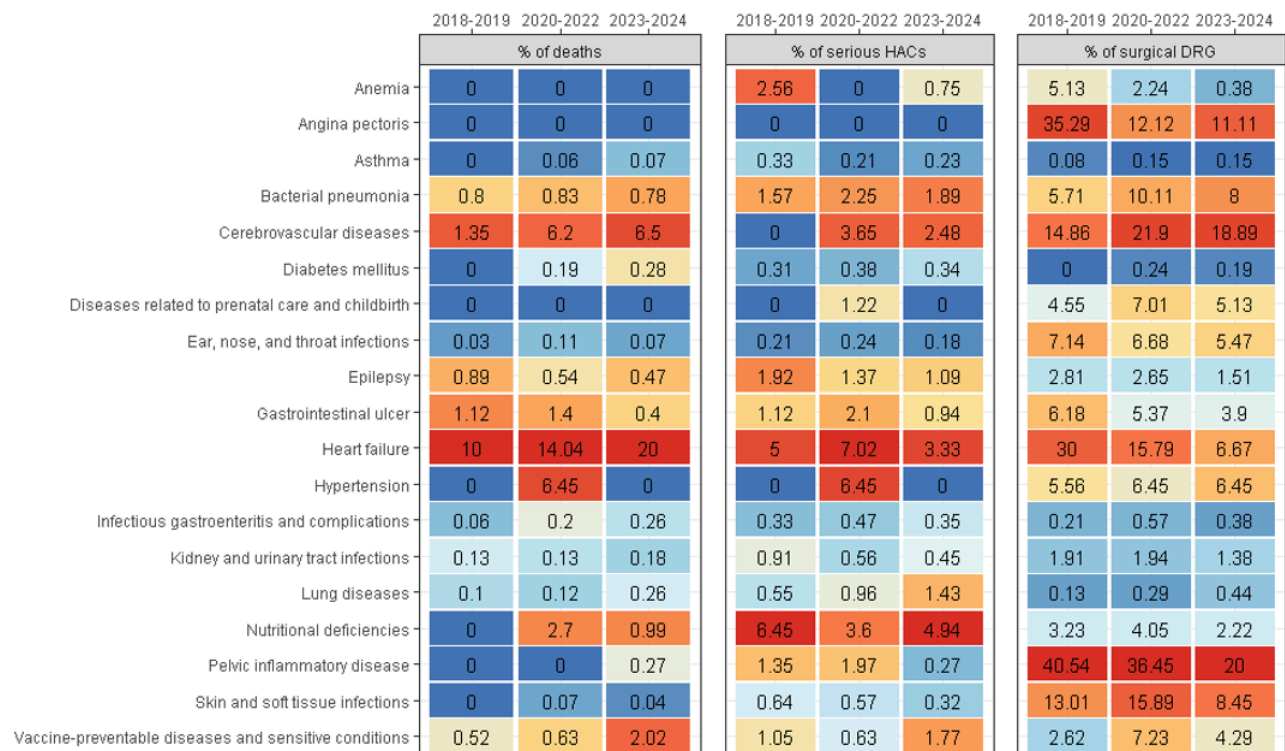


Figure 4

Heat map of the percentages of deaths, severe hospital-acquired conditions, and surgical DRGs for disease groups across time periods. Brazil, 2018 to 2024.

Source: Prepared by the authors, 2024.