

Distribution And Analysis Of Pediatric Hospitalizations For Varicella And Herpes Zoster In Brazil: Differences Between Public And Private Sectors

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Abstract:

Background: Pediatric hospitalizations for varicella and herpes zoster in Brazil reflect socioeconomic disparities in access to healthcare. This study analyzes differences in hospitalization rates, costs, and outcomes between public and private sectors, considering demographic and regional factors. These data aim to inform policies for equitable healthcare and improved immunization strategies.

Materials and Methods: Data from the Brazilian Unified Health System (SUS) between 2007 and 2024 were analyzed. Hospitalizations for children aged 0 to 14 years were categorized by age, gender, race, region, and type of care (elective or urgent). Statistical analyses, including ANOVA and t-tests, were performed to assess differences in hospitalization rates, costs, length of stay, and mortality across groups.

Results: Significant differences were observed in hospitalization rates among racial groups and regions, with the public sector managing most urgent cases. Costs were higher and more variable in the private sector, but clinical outcomes showed no statistically significant differences between sectors. The length of stay was slightly longer in public hospitals, though not significantly. Immunization disparities and socioeconomic inequities were identified as contributing factors.

Conclusion: Structural disparities between public and private healthcare sectors in Brazil affect costs and resource allocation but not clinical outcomes. Policies to expand vaccination coverage and address regional and racial inequities are critical to reducing preventable hospitalizations and achieving a more equitable healthcare system.

Key words: Pediatrics, varicella, herpes zoster, public health, healthcare disparities, vaccination.

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I. Introduction

Infections caused by varicella and herpes zoster represent significant challenges for public health, particularly in countries with profound socioeconomic inequalities such as Brazil. Varicella, common in childhood and highly contagious, is generally benign, but in some cases, it can progress to severe conditions requiring prolonged hospitalization and intensive care¹. Although herpes zoster is more prevalent in adults, it can also affect immunocompromised children, imposing an additional burden on the pediatric healthcare system, with more severe consequences for vulnerable populations².

In Brazil, the healthcare system is characterized by the coexistence of public and private sectors, each with distinct features, resources, and capacities. This duality exacerbates disparities in access to and quality of healthcare services, including hospitalizations for preventable diseases such as varicella and herpes zoster³. The Unified Health System (SUS) is responsible for most of the population's healthcare, particularly among the most

vulnerable groups, but faces notable challenges, including budget constraints, frequently overburdened infrastructure, and a lack of resources for vaccination campaigns and prevention efforts³.

While SUS grapples with limitations, the private sector, with greater financial flexibility, is able to provide more advanced and personalized treatments, especially for patients who can afford the high costs associated with such care. However, the treatments available in the private sector often involve high costs, creating a considerable disparity compared to the public sector, both in terms of quality of care and variability in expenses. This difference impacts not only hospitalization costs but also clinical outcomes and hospital stay duration, with the private sector enabling a more intensive approach in some cases, though not necessarily ensuring better clinical results⁴.

Regional disparities are also a significant factor in the analysis of hospitalizations for varicella and herpes zoster. Regions such as the North and Northeast often face more limited healthcare infrastructure and less access to immunization campaigns, resulting in higher hospitalization rates compared to the Southeast and South, where the availability of specialized services and preventive campaigns is more robust. These regional differences reflect historical and structural factors affecting healthcare access in different geographic areas, emphasizing the need for public health policies that address these specificities and promote greater equity in healthcare services⁵.

In addition to regional disparities, racial issues significantly influence access to and outcomes in healthcare, highlighting inequalities in vaccination coverage and adherence, which directly impact hospitalization rates. In Brazil, Black and Indigenous populations still face considerable barriers to accessing healthcare, resulting in higher hospitalization rates for preventable diseases such as viral infections, which could be mitigated with adequate preventive measures. These racial inequalities underscore the need for health policies that address structural disparities and promote equity in care, with specific strategies to increase vaccination adherence among vulnerable groups⁶.

Given this complexity, analyzing hospitalizations for varicella and herpes zoster across public and private sectors provides better insight into the impact of these infections on Brazil's healthcare system. Examining the characteristics of care, cost patterns, and variability in clinical outcomes in each sector is fundamental for identifying opportunities to optimize and reduce existing inequalities⁷. This study, by exploring the distribution of cases and hospitalization costs, seeks to provide information that supports the development of more effective and equitable health policies, promoting a more integrated and inclusive approach to addressing public health challenges in the country.

Considering the above, this research aimed to analyze pediatric hospitalizations for varicella and herpes zoster in Brazil between 2007 and 2024, focusing on differences between public and private sectors as well as the influence of demographic and regional factors, aiming to identify disparities in access, cost, and clinical outcomes, thereby providing a foundation for public policies that promote greater equity in pediatric healthcare.

II. Material And Methods

This study utilized data on hospitalizations for varicella and herpes zoster in Brazil, obtained through the SUS Hospital Information System (SIH/SUS) on the DATASUS platform, covering the period from January 2007 to August 2024. Data were collected for pediatric patients (0 to 14 years), considering variables such as age group, gender, race, region of hospitalization, healthcare sector (public and private), type of care (elective or emergency), length of stay, and deaths.

To ensure the validity of the results, the data were organized into specific categories. Age groups were divided into four categories: under 1 year, 1 to 4 years, 5 to 9 years, and 10 to 14 years. Geographical regions were classified according to Brazil's five macro-regions (North, Northeast, Midwest, Southeast, and South). For analyses of race and gender, the categories considered were gender (male and female) and five racial groups (white, black, mixed race, yellow, and Indigenous).

After organizing the data, an initial descriptive analysis was conducted to explore hospitalization patterns, calculating means and standard deviations for each categorized variable, including age group, gender, race, and region. Next, an inferential analysis was performed to evaluate potential differences among the groups of interest, such as age groups, genders, races, regions, and healthcare sectors (public and private).

Statistical analysis

Before applying parametric tests, data normality was assessed using the Shapiro-Wilk test, which determines whether the data follow a normal distribution. For each variable of interest, normality was tested separately within groups, such as age groups, genders, and sectors. When the test indicated $p > 0.05$, the data were considered normally distributed, allowing the use of parametric tests. When $p < 0.05$, normality was rejected, and non-parametric tests were applied.

To assess differences in mean hospitalizations among age groups and racial groups, one-way analysis of variance (ANOVA) was applied, considering assumptions of normality and homoscedasticity (homogeneity of variances). Homoscedasticity was verified with the Levene test. When both normality and homogeneity conditions

were met ($p > 0.05$ in the Shapiro-Wilk and Levene tests), ANOVA was applied. In cases where variances were not homogeneous, robust ANOVA was applied, which adjusts for variance differences among groups.

If ANOVA revealed statistically significant differences ($p < 0.05$), Tukey’s post hoc test was performed to identify specific pairs of groups with differences. When data were not normally distributed, the non-parametric Kruskal-Wallis ANOVA was used to compare medians among multiple groups. In cases where Kruskal-Wallis indicated significance, Dunn's post hoc test was applied for multiple group comparisons.

To evaluate differences in mean hospitalizations between genders, healthcare sectors (public and private), types of care (elective vs. emergency), length of stay, and deaths between sectors, the t-test for independent samples was applied, provided the data met normality and homoscedasticity assumptions (tested by Shapiro-Wilk and Levene). In cases where these assumptions were not met ($p < 0.05$), the non-parametric Mann-Whitney test was used as an appropriate alternative for comparisons between two independent samples without normal distribution. This procedure allowed for the comparison of the average number of hospitalizations by gender and healthcare sector, hospital stay length, number of deaths, and total costs associated with hospitalizations, identifying potential significant differences in case severity, type of care, and costs between public and private sectors.

All statistical analyses were conducted using the R software. The significance level adopted was 5% ($p < 0.05$) for all analyses, ensuring rigor in the interpretation of results. This statistical procedure provided a detailed understanding of differences in hospitalizations and associated costs among the analyzed variables, offering a robust basis for discussing the implications of these differences in the Brazilian healthcare system.

III. Result

From 2008 to August 2024, 51,331 pediatric hospitalizations for varicella and herpes zoster were recorded in Brazil. The ANOVA analysis of hospitalizations among the different age groups (under 1 year, 1 to 4 years, 5 to 9 years, and 10 to 14 years) revealed no statistically significant differences between the means of these age groups ($F=2.37, p=0.075$). The age groups showed distinct hospitalization averages, with the 1 to 4-year-old group having the highest mean hospitalizations (884.96), followed by the under 1-year-old group (480.70), 5 to 9-year-old group (347.11), and 10 to 14-year-old group (188.37).

The descriptive analysis of cases between males and females showed that the average number of cases for the male group was $1,116.04 \pm 1,796.24$, while the average for the female group was $951.43 \pm 1,535.39$. These values indicate that, on average, the number of cases among males is slightly higher than that of females, although both groups show high variability. However, the independent t-test conducted to compare the means between genders showed no statistically significant differences ($t=0.369, p=0.714$), suggesting that the observed difference in cases between males and females may be due to chance, with insufficient evidence to confirm a real difference between genders.

The analysis revealed statistically significant differences between the mean cases in racial groups (white, black, mixed race, yellow, and Indigenous) [$F(4,5)=6.35, p<0.001$]. Tukey’s test results showed significant differences between some pairs of racial groups. The white race had a significantly higher mean of cases compared to the yellow race, with a mean difference of 890.5 ($p=0.0013$) and a 95% confidence interval between 260.87 and 1,520.13. Additionally, the white group had a significantly higher mean compared to the Indigenous group, with a mean difference of 896.73 ($p=0.0012$) and a 95% confidence interval between 267.10 and 1,526.36. It was also observed that the white group had a significantly higher mean than the black group, with a mean difference of 858.43 ($p=0.0022$) and a 95% confidence interval between 228.80 and 1,488.06.

The one-way ANOVA test revealed a statistically significant difference between the mean hospitalizations across Brazil’s regions [$F(4,5)=3.52, p=0.022$]. The p -value < 0.05 allowed the null hypothesis of mean equality to be rejected. Tukey’s post hoc test demonstrated differences between the Southeast and Northeast regions, and between the Southeast and North regions (Table 1).

Table 1: One-way ANOVA Results and Confidence Intervals (CI) for Regional Averages

Group 1	Group 2	Mean Difference	p-value	95% Confidence Interval
Midwest	Northeast	-361.88	0.9995	-5,412.18 to 4,688.41
Midwest	North	-500.42	0.9985	-5,768.04 to 4,767.18
Midwest	Southeast	4,978.20	0.1014	-659.51 to 10,615.91
Midwest	South	858.00	0.9945	-5,560.81 to 7,276.81
Northeast	North	-138.54	1.0000	-4,373.86 to 4,096.78
Northeast	Southeast	5,340.09	0.0202	652.45 to 10,027.73
Northeast	South	1,219.89	0.9661	-4,382.91 to 6,822.69
North	Southeast	5,478.63	0.0240	557.63 to 10,399.62
North	South	1,358.43	0.9561	-4,441.02 to 7,157.88
Southeast	South	-4,120.20	0.3045	-10,257.76 to 2,017.36

Temporal data analysis indicated a statistically significant difference between the mean hospitalizations for the analyzed years [$F(17,18)=4.00$, $p<0.001$]. Tukey's test for year-to-year comparisons revealed some statistically significant differences between specific year pairs. The mean for 2008 was significantly higher than for 2007, with a mean difference of 273.03 ($p=0.0077$; 95% CI: 36.02 to 510.05), and the mean for 2010 was also significantly higher than for 2007, with a mean difference of 274.24 ($p=0.0072$; 95% CI: 37.22 to 511.26).

Regarding care provided in public and private sectors, the mean for the public sector was $890.54 \pm 1,498.84$, while the mean for the private sector was $706.89 \pm 1,361.70$. Data analysis revealed no statistically significant difference between the mean values for the public and private sectors ($t=0.48$, $p=0.633$). Regarding elective and emergency care, an average of 117.14 ± 178.60 elective cases and $1,922.89 \pm 3,210.76$ emergency cases were observed ($t=-2.97$, $p=0.006$).

Data analysis on the average length of stay in the public sector (6 ± 1.61 days) and private sector (4.84 ± 2.66 days) revealed that, although the mean length of stay in the public sector was slightly higher, this difference was not statistically significant ($t=1.94$, $p=0.059$). No statistical differences were observed between the number of deaths and mortality rate in the public and private sectors. The mean number of deaths in the public sector was 4.54 ± 6.98 ($t=-0.38$, $p=0.704$), while the private sector had a mean of 5.88 ± 16.50 ($t=-0.49$, $p=0.625$).

For hospitalization quantity, the independent t-test revealed a mean of $861.59 \pm 1,519.40$ in the public sector, while the private sector had a mean of $595.78 \pm 1,251.61$ ($t=0.70$, $p=0.486$). Regarding total hospitalization costs, the public sector had a mean expenditure of R\$ 348,204.40 \pm 516,432.25, while the private sector had a mean of R\$ 405,184.00 \pm R\$ 764,357.61 ($t=-0.32$, $p=0.750$). Although the private sector showed slightly higher mean expenditures, this difference was not statistically significant, indicating comparable hospitalization costs between the sectors.

Relating hospitalization quantity to expenditures, it was observed that, despite similarities in hospitalization means, the private sector showed greater cost variability (reflected in the high standard deviation). This may indicate that, although the number of hospitalizations is similar to the public sector, hospitalizations in the private sector may involve higher-cost treatments or broader variability in procedures and resources used, resulting in higher values in some cases. However, the absence of a statistically significant difference in both variables suggests that, on average, hospitalization burden and financial impact are similar between the sectors, possibly indicating similarities in hospitalization practices and overall associated costs.

IV. Discussion

The analysis of hospitalization data for varicella and herpes zoster from 2008 to 2024 provides insights into hospitalization dynamics in Brazil, considering age, regional, and racial differences, but especially the relationship between the public and private sectors. Hospitalizations are concentrated among children aged 1 to 4 years, reflecting the importance of health policies focused on immunizing this age group to reduce severe complications and unnecessary hospitalizations. However, the similarity in hospitalization rates across different age groups and genders reinforces the unpredictable nature of infections, requiring swift responses from both sectors to prevent worsening conditions and reduce the hospital burden.

Focusing on sectoral differences, it is observed that, although average hospitalization rates are similar, the variability in hospitalization costs in the private sector is remarkable. This aspect may be related to broader access to advanced technologies and high-cost treatments in the private sector, in contrast to the public sector, which tends to adopt more standardized and cost-contained approaches⁸. This greater financial flexibility in the private sector is reflected in clinical practices that, while increasing costs, allow for a more personalized approach, especially in emergency cases where faster and more intensive interventions may be necessary⁹.

Regional and racial disparities also contribute to the complexity of the relationship between the public and private sectors. Significant differences in hospitalizations by region, particularly between the Southeast and the Northeast and North regions, may indicate variations in the quality and access to public health services, which directly influence hospitalization rates for preventable infections. In the racial context, observed disparities indicate that the public sector faces greater challenges in serving vulnerable populations, which can lead to service overloads and limitations in resources available for preventive and high-complexity interventions¹⁰.

Despite differences in resources and approaches between sectors, both present similar hospitalization durations, suggesting that clinical management practices are comparable in moderately severe cases. However, greater variability in spending in the private sector, highlighted by a high standard deviation, may indicate that hospitalizations in this sector involve higher-cost procedures in certain cases, without necessarily translating into superior clinical outcomes¹¹. This characteristic suggests that, while the public sector focuses on efficiency and cost containment, the private sector may offer more comprehensive treatments, which do not significantly alter the average hospitalization days and clinical outcomes¹².

The analysis of elective and emergency care highlights the role of sectors in responding to acute infections. The public sector, with a higher average number of emergencies, assumes the primary responsibility for meeting immediate demands, especially from vulnerable populations without access to private health

insurance. This data underscores the need to strengthen the public system to respond to outbreaks and infections requiring rapid interventions, as public health often faces high-complexity demand¹³.

Finally, the absence of significant differences in deaths and mortality rates between the public and private sectors indicates that, although the private sector has greater financial flexibility, the final clinical outcomes are equivalent. This finding reinforces the importance of a well-structured public system capable of providing effective care even with limited resources. However, the greater variability in spending in the private sector suggests that, in some cases, hospitalizations involve higher-cost technologies and treatments that may not directly impact outcomes but offer more intensive support, reflecting a difference in practices between sectors that manifests more in costs than in clinical results¹⁴.

V. Conclusion

The findings of this study indicate that, despite the structural differences between the public and private sectors, such as variability in costs and resources applied, these distinctions do not translate into significantly better clinical outcomes. The variations in spending reflect more the management characteristics and financial flexibility of each sector than the effectiveness of care itself. However, the regional and racial disparities observed in hospitalizations highlight persistent challenges in healthcare access, pointing to the need for public policies that expand vaccination coverage and improve access to preventive care, especially in the most vulnerable regions and populations. Investments in these areas are essential to reduce avoidable hospitalizations and promote a fairer and more equitable healthcare system.

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