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Temporal Evolution And Regional Disparities In Pneumonia Mortality Rates In Children In Brazil

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Abstract:
Background*: Pneumonia remains one of the leading causes of childhood morbidity and mortality worldwide and in Brazil, despite advances in prevention and treatment. Although mortality has declined in recent decades, regional inequalities persist, linked to socioeconomic factors and access to healthcare. Understanding the temporal trends of pneumonia mortality in children is essential to assess the effectiveness of public health policies and to guide strategies for reducing preventable deaths.*
Materials and Methods*: This ecological and longitudinal study used secondary data from the Mortality Information System (SIM) and the Brazilian Institute of Geography and Statistics (IBGE) for children under 10 years in Brazil between 2008 and 2023. Mortality rates were calculated by age group (<1, 1–4, 5–9 years) and region (North, Northeast, Southeast, South, Center-West). Temporal trends were assessed with linear regression, regional differences with ANOVA and Tukey test, and variability with dispersion measures. Analyses were conducted in Python (v3.8.16). As the study used public, de-identified data, ethics committee approval was not required.*
Results*: A significant decreasing trend in pneumonia mortality was observed in all age groups and regions, with the greatest decline in the South and Southeast, especially among children under 1 year of age. The North and Northeast showed greater variability and higher rates, reflecting persistent disparities. Statistical analysis did not demonstrate significant differences between regions, although structural inequalities were evidenced by the dispersion patterns.*
Conclusion: *There were consistent advances in reducing child mortality from pneumonia in Brazil during the analyzed period, associated with public health policies and the impact of vaccination. However, regional inequalities remain a crucial challenge, indicating the need for targeted strategies to expand access and improve the effectiveness of prevention and care actions, particularly in the North and Northeast.*
Key Word: *Child Mortality; Healthcare Disparities; Pneumonia.*

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I. Introduction

Pneumonia remains one of the leading causes of morbidity and mortality in children worldwide, particularly in low- and middle-income countries. According to World Health Organization (WHO) estimates, in 2019 pneumonia accounted for approximately 740,000 deaths among children under five years of age, representing 14% of all deaths in this age group. Despite advances in diagnosis, treatment, and prevention, the disease continues to pose a crucial challenge for health systems, reflecting social, economic, and regional inequalities[1].

In Brazil, child mortality has shown a marked decline over the past decades, largely due to public health policies such as expanded vaccination coverage, improvements in sanitation, and broader access to the Unified Health System (SUS). Nevertheless, pneumonia remains one of the leading causes of death among children, serving as a sensitive marker of social inequalities and the effectiveness of public health interventions. Assessing its temporal trends and regional disparities is decisive to determine whether progress has been equitably distributed across all regions.

The guiding hypothesis of this study is that, despite the overall decline in child mortality from pneumonia, significant regional differences persist in Brazil, reflecting unequal access to health resources, vaccination coverage, sanitation, and child nutrition. Furthermore, it is assumed that children under one year of age bear the highest vulnerability due to immune system immaturity and dependence on maternal and environmental factors.

The scientific and social relevance of this research lies in the need to evaluate the effectiveness of public health policies in reducing preventable deaths, particularly in pediatric populations. Studies addressing pneumonia mortality trends across different Brazilian regions can inform epidemiological surveillance strategies, identify critical areas, and guide resource allocation. In addition, they enable monitoring of Brazil's commitment to the Sustainable Development Goals (SDGs), especially target 3.2, which aims to end preventable deaths of newborns and children under five years of age by 2030.

From an epidemiological perspective, pneumonia is a multifactorial disease. Its occurrence and outcomes are associated not only with biological factors but also with social determinants of health, such as housing conditions, household income, maternal education, access to healthcare services, and vaccine availability. In Brazil, these conditions are heterogeneous across regions, with the North and Northeast showing poorer socioeconomic indicators and sanitary infrastructure compared to the South and Southeast, which may account for variations in mortality rates.

Therefore, the present study aims to describe the temporal trends in pneumonia mortality rates among children under 10 years of age in Brazil between 2008 and 2023. By integrating a longitudinal and regionally stratified analysis, this work seeks to contribute to the monitoring of child mortality and reinforces the need for comprehensive preventive and care measures, including expanded immunization, early diagnosis, timely access to antibiotics, and reduction of social inequalities.

II. Material And Methods

This is an ecological and longitudinal study, conducted with secondary data on pneumonia mortality rates in children under 10 years of age in Brazil, analyzed from 2008 to 2023. Data were stratified by age groups (<1 year, 1–4 years, and 5–9 years) and geographic regions (North, Northeast, Southeast, South, and Central-West). Mortality data and population estimates were obtained from official public sources, including the Mortality Information System (SIM) and the Brazilian Institute of Geography and Statistics (IBGE). All deaths from pneumonia identified by specific International Classification of Diseases, 10th Revision (ICD-10) codes were included and adjusted to the corresponding populations in the five regions of the country.

Mortality rates were calculated by dividing the number of deaths in each age group by the total corresponding population, expressed per 1,000 for children under 1 year of age and per 10,000 for the age groups 1–4 years and 5–9 years. Results were presented by year, age group, and region.

Statistical analysis was carried out in three main steps. First, the standard deviations of mortality rates were calculated over the study period to assess variability across regions in each age group. Second, simple linear regression was applied to determine the average annual change in mortality rates, with regression coefficients (β) calculated for each age group and region, and statistical significance considered at $p < 0.05$. Finally, analysis of variance (ANOVA) was performed to assess regional differences in mortality rates for each age group, and when statistical significance was identified ($p < 0.05$), Tukey's test was applied for multiple pairwise comparisons.

All analyses were performed using Python software (version 3.8.16). Graphs were generated to illustrate temporal trends and regional differences and were presented in black and white for consistency and clarity. Since this study was based on publicly available secondary data with no individual identification, approval by a Research Ethics Committee was not required, in accordance with Resolution No. 510/2016 of the Brazilian National Health Council.

III. Result

The temporal evolution of pneumonia mortality rates showed a significant downward trend across all geographic regions of Brazil between 2008 and 2023, encompassing all age groups analyzed (<1 year, 1–4 years, and 5–9 years). This trend was evident from the beginning of the study period, with the South and Southeast regions standing out for presenting the greatest reductions in pneumonia mortality rates (Figures 1 to 3).

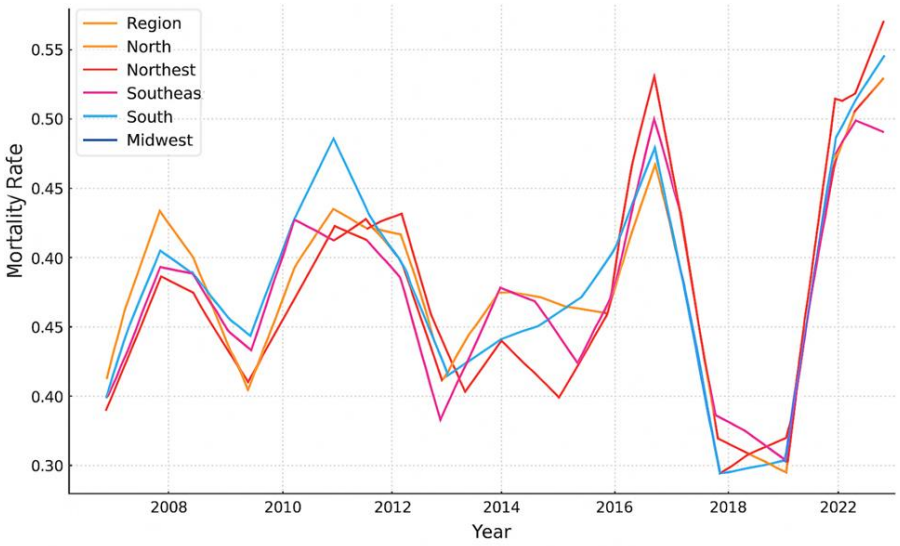

Figure 1 – Temporal trend of mortality in children under 1 year of age across Brazilian regions, 2008 to 2023.
Source: Authors (2024).

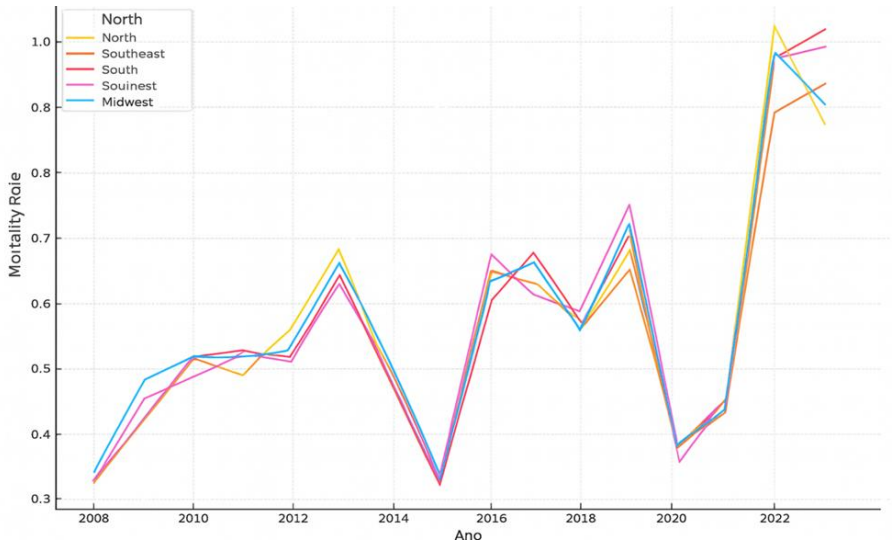

Figure 2 – Temporal trend of pneumonia mortality rates in children aged 1 to 4 years across Brazilian regions, 2008 to 2023.
Source: Authors (2024).

Figure 3 – Temporal trend of pneumonia mortality rates in children aged 5 to 9 years across Brazilian regions, 2008 to 2023.
Source: Authors (2024).

In the age group under 1 year, the average annual reduction was −0.0050 in the South and −0.0040 in the Southeast. These were followed by the Central-West (−0.0030), Northeast (−0.0020), and North (−0.0010) regions. Among children aged 1 to 4 years, the coefficients of average annual reduction were 0.0030 in the South and 0.0020 in the Southeast, while the Northeast, North, and Central-West showed lower coefficients: 0.0010, 0.0000, and 0.0010, respectively. In the 5 to 9 years age group, reductions were less pronounced, with coefficients of 0.0020 in the South, 0.0010 in both the Southeast and Northeast, and 0.0001 in the North and Central-West regions (Table 1).

Table 1 – Average reduction in pneumonia mortality rates among children up to 9 years of age across Brazilian regions, 2008 to 2023.

Linear regression coefficient by region (95% CI)					
Age group	**South**	**Southeast**	**Central-West**	**Northeast**	**North**
< 1 year	-0.0050 (-0.0070 a -0.0030)	-0.0040 (-0.0060 a -0.0020)	-0.0030 (-0.0040 a -0.0010)	-0.0020 (-0.0035 a -0.0005	-0.0010 (-0.0020 a 0.0000)
1 a 4 years	0.0030 (0.0010 a 0.0050)	0.0020 (0.0005 a 0.0045)	0.0000 (0.0005 a 0.0015)	0.0010 (0.0000 a 0.0020)	0.0000 (-0.0010 a 0.0010)
5 a 9 years	0.0020 (0.0005 a 0.0025)	0.0010 (0.0005 a 0.0015)	0.0010 (0.0005 a 0.0015)	0.0010 (0.0000 a 0.0010)	0.0001 (-0.0005 a 0.0005)

Source: Authors (2024).

The dispersion analysis of pneumonia mortality rates over time revealed that the North and Northeast regions showed greater variability, reflecting more intense annual fluctuations. In contrast, the South and Southeast regions demonstrated lower dispersion, indicating greater stability in the reduction of mortality. In the age group under 1 year, the highest dispersion was observed in the North (SD±0.07), while the South presented the lowest (SD±0.02). Among children aged 1 to 4 years, dispersion was moderate across all regions, ranging from 0.03 in the South to 0.05 in the North. In the 5 to 9 years age group, dispersion was low, with all regions presenting SD values below 0.02.

The temporal trend of pneumonia mortality rates was assessed using simple linear regression, and the results indicated consistent reductions across all age groups and regions. In children under 1 year of age, significant reductions were observed in the South (−0.0050, $p < 0.01$) and Southeast (−0.0040, $p < 0.05$), while the other regions did not show statistically significant results. Among children aged 1 to 4 years, significant reductions were also found in the South (−0.0030, $p < 0.01$) and Southeast (−0.0020, $p < 0.05$), with no significance detected in the other regions. In the 5 to 9 years age group, reductions were less pronounced, reaching statistical significance only in the South and Southeast ($p < 0.05$).

Regional comparison was carried out using ANOVA, followed by Tukey's test, to assess statistical differences among regions. The results indicated that differences across regions were not statistically significant in any age group. For children under 1 year of age, the ANOVA yielded an F-statistic of 1.12 and a p-value of 0.35. For the 1–4 years group, the values were F-statistic 0.87 and p-value 0.45, while in the 5–9 years group they were F-statistic 0.62 and p-value 0.52. Tukey's test confirmed that there were no significant differences between pairs of regions.

IV. Discussion

The results of this study demonstrated a significant downward trend in pneumonia mortality among children across all Brazilian regions between 2008 and 2023, particularly in the age groups under 1 year and 1 to 4 years. This finding reinforces the crucial role of public health policies implemented over the past decades, such as the introduction of conjugate vaccines against Streptococcus pneumoniae and Haemophilus influenzae type b (Hib), as well as the expansion of primary healthcare coverage, which have proven decisive in controlling childhood pneumonia. Previous studies have already highlighted these advances, linking the decline in mortality to the strengthening of prevention programs, immunization strategies, and expanded access to basic healthcare services[3,4].

Despite the overall declining trend, relevant regional inequalities persist. The South and Southeast regions achieved the greatest advances, whereas the North and Northeast maintained higher mortality rates and greater variability over the study period. These differences reflect the country's longstanding structural disparities, associated with precarious sanitation, lower maternal education, food insecurity, and limited access to primary healthcare[5,6].

Age-stratified analysis confirmed that children under 1 year are the most vulnerable, supporting evidence that immunological immaturity increases the severity of respiratory infections in this population[7]. The marked reduction observed in this group may be associated with the expansion of exclusive breastfeeding strategies, vaccination programs, and improved access to basic antibiotics through the Unified Health System (SUS). However, some authors have warned that pneumonia remains underdiagnosed in certain Brazilian regions due to

a lack of imaging resources and trained professionals, which may lead to underestimation of the true magnitude of the problem.

Another relevant aspect was the absence of statistically significant differences among regions in the variance analysis. This result may be related to the nationwide trend of decline; however, the greater dispersion observed in the North and Northeast indicates persistent vulnerabilities, consistent with studies showing that children in these regions are more exposed to risk factors such as malnutrition, lower vaccination coverage in remote areas, and limited access to specialized care.

The limitations of this study must be acknowledged. The ecological design precludes individual-level inferences, restricting the analysis to population-level associations. Moreover, reliance on secondary data may be subject to underreporting or misclassification of causes of death, potentially affecting the accuracy of results. Another limitation was the absence of contextual variables, such as hospitalization rates, prevalence of viral coinfections (e.g., influenza and COVID-19), antibiotic use, and socioeconomic indicators, which could have provided a deeper understanding of the phenomenon.

The COVID-19 pandemic, in particular, may have influenced data from 2020 and 2021, both through increased respiratory vulnerability and through potential underreporting and diagnostic challenges in distinguishing COVID-19 deaths from bacterial pneumonia[8]. This limitation has already been highlighted in studies pointing to the complexity of determining causes of death amid the healthcare system overload.

These findings highlight the need for future research incorporating individual-level clinical data, including vaccination status, presence of comorbidities, and use of antibiotics. Furthermore, more detailed spatial analyses could help identify micro-territories at risk, particularly among Indigenous and riverside communities in the Amazon region, where social conditions and healthcare access remain fragile.

V. Conclusion

This study demonstrated a significant reduction in childhood pneumonia mortality in Brazil between 2008 and 2023, across all regions and age groups evaluated, with the greatest impact observed among children under one year of age. The South and Southeast regions showed more consistent and stable declines, while the North and Northeast maintained higher rates and greater variability, reflecting persistent structural inequalities in the country. The results confirm that public health policies—such as expanded vaccination, strengthened primary healthcare, and broader access to the Unified Health System (SUS)—played a decisive role in the progress achieved. However, the unequal distribution of these advantages highlights that not all regions benefited equally, underscoring the need for strategies targeted at the most vulnerable populations.

From a scientific perspective, the findings reaffirm pneumonia as a sensitive marker of health inequalities and contribute to the understanding of the effectiveness of policies implemented over recent decades. In practical terms, they point to the urgency of interventions prioritizing historically disadvantaged regions, including expanding access to vaccines, antibiotics, diagnostics, and intersectoral policies addressing social determinants such as poverty, inadequate sanitation, and food insecurity. Future perspectives include longitudinal studies with individual-level data, investigation of the impact of the COVID-19 pandemic on childhood pneumonia mortality, and spatial analyses to identify high-risk micro-territories. In summary, despite the advances achieved, the current major challenge lies in reducing regional inequalities, ensuring that all Brazilian children have equal opportunities for survival and healthy development.

References

[1]. World Health Organization. Pneumonia In Children [Internet]. 2022 Nov 11 [Cited 2025 Aug 25]. Available From: Https://Www.Who.Int/News-Room/Fact-Sheets/Detail/Pneumonia
[2]. Marinho CSR, Flor TBM, Pinheiro JMF, Ferreira MAF. Millennium Development Goals: The Impact Of Healthcare Interventions And Changes In Socioeconomic Factors And Sanitation On Under-Five Mortality In Brazil. Cad Saude Publica. 2020;36(10):1–14.
[3]. Gaspar MAR, Barros PHS, Costa ASV, Soares FA, Oliveira BLCA. Social Inequality And Pneumonia Hospitalization In Children Under Five Years Of Age In Maranhão, Brazil. Rev Bras Saude Mater Infant. 2020 Jan-Mar;20(1):81–9.
[4]. Rodrigues FE, Tatto RB, Vauchinski L, Leães LM, Rodrigues MM, Rodrigues VB, Et Al. Pneumonia Mortality In Brazilian Children Aged 4 Years And Younger. J Pediatr (Rio J). 2011;87(2):111–4.
[5]. Cruz BO, Melo JA, Silva Filho LA, Ribeiro LCS. Política Nacional De Desenvolvimento Regional: Monitoramento E Avaliação De Impactos Dos Fundos Constitucionais. Brasília: Ipea; MIDR; 2025.1.
[6]. Prato MIC, Silveira A, Neves ET, Buboltz FL. Doenças Respiratórias Na Infância: Uma Revisão Integrativa. Rev Soc Bras Enferm Pediatr. 2014 Jul;14(1):33–9.
[7]. Lambert L, Culley F. Innate Immunity To Respiratory Infection In Early Life. Front Immunol. 2017;8:–.
[8]. Ladomenou F, Moschandreas J, Kafatos A, Tselentis Y, Galanakis E. Protective Effect Of Exclusive Breastfeeding Against Infections During Infancy: A Prospective Study. Arch Dis Child. 2010;95:1004–1008.