

Malignant Brain Neoplasms in Brazil: Epidemiological Trends, Mortality, and Regional Inequalities in the SUS (2015–2025)

Neoplasias Malignas do Encéfalo no Brasil: Tendências Epidemiológicas, Mortalidade e Desigualdades Regionais no SUS (2015–2025)

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ABSTRACT

Background: Malignant brain neoplasms are associated with high lethality and substantial healthcare burden within Brazil's Unified Health System (SUS), influenced by regional disparities in access to care.

Objective: To analyze morbidity, mortality, geographic distribution, and healthcare characteristics of malignant brain neoplasms in Brazil between 2015 and 2025.

Methods: Ecological, retrospective, population-based study using secondary data from the SUS Hospital Information System (SIH/SUS-DATASUS). Hospitalizations with a primary diagnosis of malignant brain neoplasm (ICD-10: C71) were included; IBGE population estimates were used to calculate rates per 100,000 inhabitants. Statistical analysis included frequency distributions, chi-square test, linear regression, and correlation analysis ($p < 0.05$).

Results: Between 2015 and 2025, 166,123 hospitalizations and 22,608 in-hospital deaths were recorded, an in-hospital mortality rate of 13.6%. Hospitalization rates increased progressively, reaching approximately 8.0 per 100,000 inhabitants in 2024 ($p < 0.05$), while mortality rates remained around 1.1 per 100,000 inhabitants. Emergency admissions accounted for 75.7% of hospitalizations and concentrated most deaths. The Southeast region had the highest concentration of hospitalizations, deaths, and procedures, with significant regional differences ($p < 0.001$). Case fatality was higher among Indigenous and Black patients. A total of 70,598 procedures were performed, mainly intracranial microsurgies and craniotomies; procedure-related mortality was approximately 7.0%, highest for brain biopsies and craniotomies, with a negative correlation between procedure volume and mortality ($r = -0.3$; $p < 0.05$).

Conclusion: Malignant brain neoplasms represent a major public health challenge in Brazil, with increasing hospital burden, high lethality, and regional inequalities, reinforcing the need for stronger neuro-oncological care within the SUS.

Keywords (MeSH): Brain Neoplasms; Hospitalization; Mortality; Epidemiology; Unified Health System; Neurosurgery

RESUMO

Introdução: As neoplasias malignas do encéfalo apresentam elevada letalidade e impacto assistencial no Sistema Único de Saúde (SUS), com desigualdades regionais no acesso ao cuidado.

Objetivo: Analisar a morbimortalidade, a distribuição geográfica e o perfil assistencial das neoplasias malignas do encéfalo no Brasil entre 2015 e 2025.

Métodos: Estudo ecológico, retrospectivo e de base populacional, com dados do Sistema de Informações Hospitalares do SUS (SIH/SUS-DATASUS). Foram incluídas internações com diagnóstico principal de neoplasia maligna do encéfalo (CID-10: C71), usando estimativas do IBGE para taxas por 100.000 habitantes. A análise estatística incluiu frequências, qui-quadrado, regressão linear e correlação de Pearson ($p < 0,05$).

Resultados: Entre 2015 e 2025, foram registradas 166.123 internações e 22.608 óbitos hospitalares, com mortalidade hospitalar de 13,6%. As taxas de internação aumentaram progressivamente, atingindo aproximadamente 8,0 por 100.000 habitantes em 2024 ($p < 0,05$), enquanto a mortalidade permaneceu em torno de 1,1 por 100.000 habitantes. As admissões de urgência corresponderam a 75,7% das internações e concentraram a maioria dos óbitos. A região Sudeste concentrou o maior número de internações, óbitos e procedimentos ($p < 0,001$). A letalidade foi mais elevada entre indígenas e pretos. Foram realizados 70.598 procedimentos, predominando microcirurgias intracranianas e craniotomias; a mortalidade associada foi de aproximadamente 7,0%, mais elevada nas biópsias encefálicas e craniotomias, com correlação negativa entre volume e mortalidade ($r = -0,3$; $p < 0,05$).

Conclusão: As neoplasias malignas do encéfalo representam importante problema de saúde pública no Brasil, com aumento da carga hospitalar, elevada letalidade e desigualdades regionais, reforçando a necessidade de fortalecer a rede neuro-oncológica no SUS.

Palavras-chave (DeCS): Neoplasias Encefálicas; Hospitalização; Mortalidade; Epidemiologia; Sistema Único de Saúde; Neurocirurgia

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Conflict of interest

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Ethical Approval

This study used publicly available, aggregated, and anonymized secondary data obtained from the Hospital Information System of the Brazilian Unified Health System (SIH/SUS), available through DATASUS/TabNet. According to Resolution No. 510/2016 of the Brazilian National Health Council, studies using publicly accessible and non-identifiable data are exempt from Institutional Review Board approval.

Author Contributions (CRediT Taxonomy)

Pedro Carrión Carvalho: Conceptualization; Methodology; Formal analysis; Data curation; Investigation; Validation; Visualization; Writing – original draft; Writing – review & editing; Supervision; Project administration.

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Sabrina Louise Becker: Data curation; Investigation; Writing – original draft (Results); Writing – review & editing.

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All authors contributed to the discussion and conclusion sections, critically reviewed the manuscript, approved the final version, and agreed to be accountable for all aspects of the work.

INTRODUCTION

Malignant tumors of the central nervous system (CNS) comprise a heterogeneous group of neoplasms with high lethality, responsible for a clinical and social burden disproportionate to their relatively low incidence¹. Globally, these neoplasms account for approximately 1.4–1.8% of all malignant tumors; however, they present substantial mortality, largely attributable to the anatomical complexity of the brain, therapeutic challenges, and the high associated neurological morbidity². The distribution of these tumors varies according to age, sex, and geographic region, reflecting both biological factors and disparities in access to diagnosis and treatment^{1,2}.

Over recent decades, the classification of these neoplasms has evolved considerably, culminating in the 2021 World Health Organization (WHO) Classification, which integrated histological and molecular criteria as essential diagnostic elements^{3,4}. The incorporation of markers such as IDH mutations, 1p/19q codeletion, and epigenetic profiles redefined clinical and epidemiological entities, improving prognostic stratification and reinforcing the need for updated population-based studies that consider this new paradigm³.

Among malignant CNS tumors, diffuse gliomas represent the most prevalent group, with glioblastoma being the most aggressive subtype and accounting for more than 50% of adult cases⁵. Glioblastoma is characterized by rapid growth, infiltrative behavior, and therapeutic resistance, with a median survival of less than two years even under standard treatment based on surgical resection, radiotherapy, and chemotherapy⁶. Other neoplasms, such as astrocytomas and oligodendrogliomas, demonstrate clinical behavior strongly influenced by molecular characteristics, whereas ependymomas and embryonal tumors constitute an additional spectrum of clinical relevance^{3,4}.

In the pediatric population, medulloblastoma remains the most frequent malignant CNS tumor, presenting biological behavior distinct from adult tumors, including a greater propensity for cerebrospinal fluid dissemination and the need for intensive multimodal treatment⁷. This age-related and biological heterogeneity highlights the epidemiological complexity of these neoplasms and the necessity for specific analytical approaches.

In Brazil, estimates from the National Cancer Institute (INCA) indicate approximately 11,490 new cases of malignant CNS tumors annually during the 2023–2025 triennium⁸, underscoring their relevance within the national healthcare scenario. The burden of these neoplasms is further aggravated by regional disparities in access to diagnostic methods, neurosurgical services, and high-complexity oncological therapies, particularly within the context of the Brazilian Unified Health System (SUS), where the organization of healthcare networks directly influences

clinical outcomes.

In this context, health information systems such as the SUS Hospital Information System (SIH/SUS), available through DATASUS, allow comprehensive analyses of hospitalizations, in-hospital mortality, and healthcare production related to malignant brain neoplasms. The use of these databases enables the evaluation of temporal patterns, geographic distribution, and healthcare characteristics of the disease, contributing to public health planning.

Given this scenario, the present study aims to analyze morbidity and mortality, geographic distribution, and healthcare characteristics of malignant brain neoplasms in Brazil using DATASUS data and population estimates from the Brazilian Institute of Geography and Statistics (IBGE), seeking to provide evidence to support healthcare organization and the reduction of health inequalities.

METHODS

This is an ecological, retrospective, population-based study conducted using secondary data obtained from public Brazilian health information systems, covering the period from 2015 to 2025.

Data were extracted from the Hospital Information System of the Brazilian Unified Health System (SIH/SUS), made available by the Department of Informatics of the Unified Health System (DATASUS) through the TabNet platform, within the section of hospital morbidity by place of hospitalization. All hospital admissions whose primary diagnosis corresponded to malignant neoplasm of the brain according to the International Classification of Diseases, 10th Revision (ICD-10), code C71, were included. Information regarding hospital procedures was obtained from the SUS hospital production database, also available through DATASUS.

Population estimates used for rate calculations were obtained from the Brazilian Institute of Geography and Statistics (IBGE), considering intercensal population projections corresponding to the analyzed period.

Demographic, healthcare-related, and geographic variables were analyzed, including sex, age group, race/skin color, region and federative unit of residence, number of hospitalizations, type of care (elective or emergency), number of in-hospital deaths, and type of procedure performed during hospitalization. Procedures were grouped according to their nature, with emphasis on neurosurgical interventions, including intracranial microsurgeries, craniotomies for tumor resection, and brain biopsies.

Hospitalization and mortality rates per 100,000 inhabitants were calculated by dividing the number of events by the estimated population and multiplying by 100,000. In-hospital mortality was estimated as the proportion of deaths relative to the total number of hospitalizations, expressed as a percentage. For hospital procedures, procedure-specific mortality was calculated,

defined as the proportion of deaths among patients undergoing each type of intervention.

Statistical analysis included descriptive evaluation of variables using absolute and relative frequencies. Associations between categorical variables and the outcome (in-hospital death) were assessed using Pearson's chi-square test. Temporal trend analysis was performed using simple linear regression, considering year as the independent variable and the number of hospitalizations or deaths as dependent variables. The relationship between procedure volume and associated mortality was evaluated using Pearson's correlation coefficient. For all analyses, a significance level of 5% ($p < 0.05$) was adopted, with calculation of 95% confidence intervals (95% CI) for the main estimates.

Because this study was based on publicly available secondary data without individual patient identification, approval by an Institutional Review Board was not required, in accordance with Resolution No. 510/2016 of the Brazilian National Health Council.

RESULTS

Between 2015 and 2025, a total of 166,123 hospitalizations due to malignant brain neoplasms were recorded in Brazil. During the same period, 22,608 in-hospital deaths occurred, corresponding to an in-hospital mortality rate of 13.6%. Considering population estimates from the Brazilian Institute of Geography and Statistics (IBGE), hospitalization rates increased progressively throughout the study period, reaching approximately 8.0 hospitalizations per 100,000 inhabitants in 2024, while mortality rates remained around 1.1 deaths per 100,000 inhabitants (Table 1).

Table 1. General indicators of hospitalizations and in-hospital deaths due to malignant brain neoplasms in Brazil, 2015–2025.

Indicator	Value
Total hospitalizations	166,123
Total deaths	22,608
In-hospital mortality (%)	13.6 (95% CI: 13.4–13.8)
Hospitalization rate in 2024 (per 100,000 inhabitants)	~8.0
Mortality rate (per 100,000 inhabitants)	~1.1

Abbreviation: 95% CI = 95% confidence interval.

Temporal analysis demonstrated a progressive increase in hospital burden throughout the analyzed period. The number of hospitalizations increased from 13,441 in 2015 to 16,966 in 2024, with a slight reduction to 16,346 in 2025. Deaths followed a similar trend, increasing from 1,834 in 2015 to 2,356 in 2024, with a small decline to 2,194 in 2025. Temporal trend analysis demonstrated a significant increase in both hospitalizations and deaths throughout the historical series ($p < 0.05$), as illustrated in Figure 1.

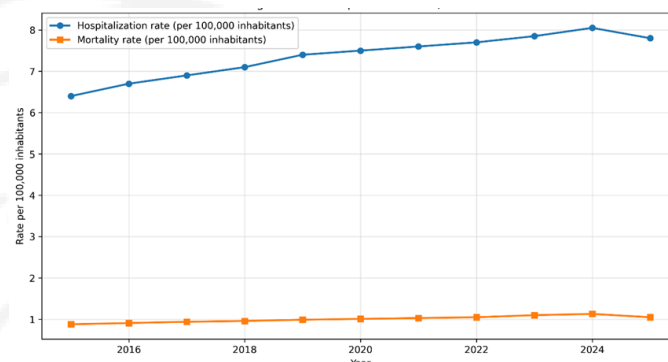


Figure 1. Temporal evolution of hospitalization and in-hospital mortality rates for malignant brain neoplasms in Brazil, 2015–2025. Rates calculated using SIH/SUS hospitalization records and IBGE population estimates. A progressive increase in hospitalization and mortality rates was observed throughout the period analyzed, with a slight reduction in 2025.

Source: Hospital Information System of the Brazilian Unified Health System (SIH/SUS), DATASUS, and IBGE population estimates.

Regarding the type of care, emergency admissions predominated, totaling 125,819 hospitalizations and corresponding to 75.7% of all admissions, whereas elective admissions accounted for 40,304 cases (24.3%). This pattern was also reflected in mortality outcomes. Between 2015 and 2025, deaths associated with emergency admissions totaled 19,073 cases, while deaths during elective admissions reached 3,535 cases. Consequently, in-hospital mortality was substantially higher among emergency admissions than among elective admissions, reinforcing the greater clinical severity of patients admitted outside scheduled therapeutic management.

Geographic distribution revealed a marked concentration of healthcare burden within the most economically developed regions of the country. The Southeast region remained the primary concentration area for hospitalizations, deaths, and procedures throughout the entire series, followed by the South and Northeast regions, whereas the North and Central-West regions presented lower absolute volumes. Regional differences were statistically significant ($p < 0.001$), suggesting important heterogeneity in the territorial distribution of diagnosis and hospital treatment of the disease (Table 2; Figure 2).

Table 2. Distribution of hospitalizations and in-hospital deaths according to sociodemographic variables in Brazil, 2015–2025. P-values were obtained using Pearson's chi-square test.

Variable	Category	Hospitalizations (%)	Deaths (%)	p-value
Sex	Male	52.3	52.6	0.01
	Female	47.7	47.4	
Race/skin color	White	43.8	44.2	<0.001
	Brown	39.1	37.0	
	Black	3.6	4.4	
Region	Southeast	43.1	46.3	<0.001
	South	~23	~21	
	Northeast	~21	~20	

Abbreviation: p-values calculated using Pearson's chi-square test.

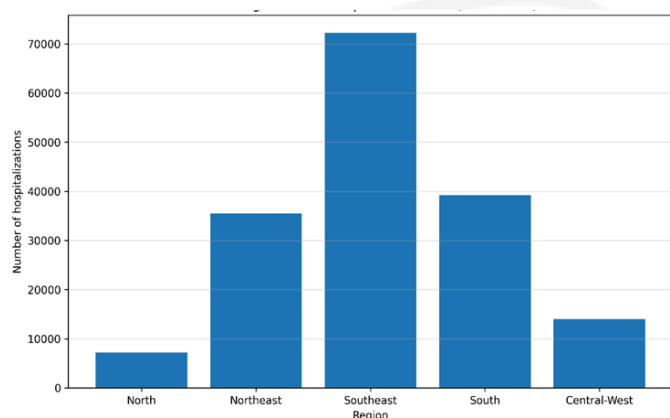


Figure 2. Regional distribution of hospitalizations for malignant brain neoplasms in Brazil, 2015–2025. The Southeast region concentrated the highest number of hospitalizations, followed by the South and Northeast regions, demonstrating marked regional inequalities in the distribution of hospital care related to malignant brain neoplasms.

Source: Hospital Information System of the Brazilian Unified Health System (SIH/SUS), DATASUS.

Regarding sex distribution, a slight predominance of males was observed in both hospitalizations and deaths, a pattern that remained stable throughout the analyzed period. Differences between sexes were statistically significant ($p < 0.01$), although in-hospital mortality rates were very similar between men and women, suggesting that sex may influence hospitalization frequency but does not appear to substantially modify in-hospital prognosis (Table 2).

Age-group distribution demonstrated a higher concentration of hospitalizations among adults and older individuals, with a peak between 50 and 69 years, particularly among those aged 60–69 years. A similar pattern was observed for deaths, which were mainly concentrated in older age groups. Nevertheless, an expressive participation of the pediatric population was identified, especially among children aged 5–9 years, resulting in a bimodal age distribution with relevance both in early ages and later adulthood.

Analysis according to race/skin color demonstrated predominance of hospitalizations and deaths among self-reported White and Brown individuals, with statistically significant differences in case distribution among racial groups ($p < 0.001$). When in-hospital mortality by race/skin color was evaluated, the highest percentages were observed among Indigenous and Black individuals, whereas White and Brown individuals presented lower case fatality rates. Quantitatively, in-hospital mortality was approximately 21.9% among Indigenous individuals, 16.6% among Black individuals, 14.1% among Asian individuals, 13.7% among White individuals, and 12.9% among Brown individuals. This gradient suggests relevant inequalities in hospital outcomes according to race/skin color (Table 2).

Between 2015 and 2025, a total of 70,598 hospital procedures related to the management of malignant brain neoplasms were performed within the SUS. An overall increasing trend in the annual number of procedures was

observed, rising from 6,602 in 2015 to 7,827 in 2024, followed by a slight reduction to 7,311 in 2025. Surgical procedures predominated, particularly intracranial microsurgies, with or without complementary techniques, and craniotomies for tumor resection, whereas brain biopsies accounted for a smaller proportion of the total.

Among all procedures, intracranial microsurgery with complementary techniques accounted for 27,118 records, followed by intracranial microsurgery without complementary techniques (24,206 procedures). Among craniotomies, 7,599 craniotomies for intracranial tumor resection and 4,924 craniotomies for brain tumor resection, including posterior fossa tumors, were identified.

A total of 4,919 deaths associated with hospital procedures were recorded, corresponding to an overall procedure-related mortality of approximately 7.0%. Mortality varied according to the procedure performed, being higher among brain biopsies (11.7%) and craniotomies for intracranial tumor resection (9.3%), whereas microsurgies presented lower mortality rates, ranging from approximately 6.0% to 7.1% (Figure 3).

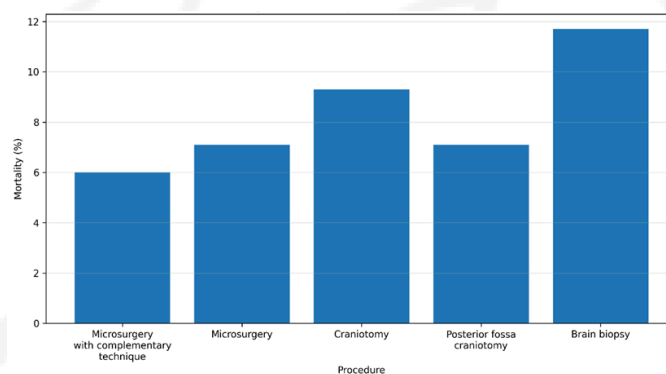


Figure 3. Procedure-specific in-hospital mortality for malignant brain neoplasms in Brazil, 2015–2025. Mortality was calculated as the proportion of in-hospital deaths among patients undergoing each neurosurgical procedure. Brain biopsies and craniotomies presented the highest mortality rates, whereas intracranial microsurgies demonstrated lower mortality percentages.

Source: Hospital Information System of the Brazilian Unified Health System (SIH/SUS), DATASUS.

Analysis of the relationship between procedure volume and mortality demonstrated a negative correlation between greater availability of interventions and lower associated mortality ($r \approx -0.3$; $p < 0.05$), suggesting that regions with greater neurosurgical capacity tend to present more favorable hospital outcomes.

Overall, the results demonstrate a temporal increase in the hospital burden of malignant brain neoplasms in Brazil, predominance of emergency admissions, marked regional concentration of cases and procedures, inequalities according to race/skin color, and an association between higher healthcare volume and lower procedure-related mortality.

DISCUSSION

The findings of this study demonstrate that malignant brain neoplasms represent an important cause of morbidity and mortality in Brazil, with a progressive increase in hospitalizations throughout the analyzed period, as shown in the temporal trend analysis (Figure 1). This pattern is consistent with global data indicating an increasing burden of central nervous system tumors, particularly in middle-income countries, driven by population aging, improved diagnostic capacity, and greater access to healthcare services¹.

The regional distribution observed (Table 2; Figure 2) reinforces the existence of structural inequalities within the Brazilian healthcare system. The Southeast and South regions concentrated the highest numbers of hospitalizations, deaths, and procedures, likely reflecting greater availability of specialized diagnostic and therapeutic resources, including neuroimaging, neurosurgical services, and high-complexity oncology centers. Similar patterns have been reported internationally, where access to specialized healthcare infrastructure directly influences the detection and treatment of central nervous system tumors².

Regional inequalities identified in the present study may also reflect historical disparities in the distribution of specialized healthcare resources within Brazil. Previous national investigations have demonstrated lower availability of magnetic resonance imaging scanners, computed tomography equipment, neurosurgical services, and high-complexity oncology centers in the North and Northeast regions when compared with the South and Southeast. These structural limitations may contribute to delayed diagnosis, restricted access to specialized treatment, and worse clinical outcomes, reinforcing the territorial disparities observed in the present analysis⁹⁻¹¹.

The elevated in-hospital mortality rate observed in this study (Table 1) is consistent with the aggressive biological behavior of malignant brain tumors, particularly high-grade gliomas. Glioblastoma, the most common malignant primary brain tumor in adults, is characterized by rapid progression, infiltrative growth, and poor prognosis, with median survival remaining below two years despite advances in surgical, radiotherapeutic, and systemic treatment modalities⁶. This clinical profile contributes substantially to the high mortality burden associated with malignant brain neoplasms.

Another relevant finding was the progressive increase in hospitalizations over time (Figure 1). This trend may be explained by multiple factors, including population aging, expansion of access to neuroimaging examinations, and improvements in case identification and referral pathways. Global epidemiological analyses have similarly demonstrated an increase in the burden of central nervous system cancers over recent decades, particularly among older populations¹.

The biological heterogeneity of these tumors, consolidated by the 2021 World Health Organization Classification, introduced important changes in the diagnostic and prognostic definition of central nervous system neoplasms^{3,4}. The incorporation of molecular markers, including IDH mutations and 1p/19q codeletion status, redefined several tumor entities and improved prognostic stratification. Consequently, comparisons between contemporary classifications and administrative databases such as DATASUS should be interpreted cautiously, since these systems do not incorporate molecular or histopathological information.

Although not stratified in detail in the present study, tumors affecting the pediatric population present distinct biological and clinical characteristics. Medulloblastoma remains the most frequent malignant central nervous system tumor in childhood and requires intensive multimodal treatment, including surgery, radiotherapy, and chemotherapy⁷. These differences highlight the importance of future investigations focusing on age-specific epidemiological patterns.

Despite the relevance of the findings, some limitations should be acknowledged. The use of administrative databases restricts the analysis to hospitalizations recorded within the Brazilian Unified Health System and may be subject to coding inconsistencies and underreporting. Furthermore, the absence of detailed clinical information, such as histological subtype, molecular profile, tumor staging, and therapeutic regimens, limits more refined analyses and direct comparisons with clinical series³.

Nevertheless, this study presents important strengths, including nationwide coverage, a large sample size, standardized methodology, and an extended temporal analysis. The integration of hospitalization, mortality, and procedural data provides a comprehensive overview of the burden imposed by malignant brain neoplasms on the Brazilian healthcare system.

Therefore, the results reinforce the need to strengthen healthcare networks through expansion of diagnostic capacity, equitable distribution of specialized neurosurgical and oncological services, and reduction of regional disparities in access to high-complexity care. Such measures may contribute to earlier diagnosis, improved treatment access, and ultimately better outcomes for patients with malignant brain neoplasms in Brazil.

CONCLUSION

Malignant brain neoplasms represent an important public health challenge in Brazil, characterized by a progressive increase in hospitalizations throughout the analyzed period and elevated in-hospital mortality rates (Figure 1; Table 1). A heterogeneous regional distribution was observed, with greater concentration of cases in regions

with more structured healthcare systems, highlighting inequalities in access to diagnosis and specialized treatment (Table 2; Figure 2).

These findings reflect not only the clinical impact of these neoplasms but also structural limitations in the organization of healthcare networks, particularly within the Brazilian Unified Health System (SUS). The high mortality identified reinforces the aggressive nature of these tumors and underscores the need for strategies focused on early diagnosis, expansion of access to specialized centers, and optimization of therapeutic management.

Therefore, the results of this study contribute to the understanding of the national epidemiological profile of malignant brain neoplasms and provide relevant evidence to support public health planning, with emphasis on reducing regional inequalities and strengthening oncological and neurosurgical care in Brazil.

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