

ORIGINAL ARTICLE

Temporal trend of the mortality coefficient and proportional mortality due to stroke in the populations of the states of Rio Grande do Norte and Paraíba, in northeastern Brazil

Everson Vagner de Lucena Santos^{a,b*}, Yasmin Esther Barreto^d, Marcelo Ferraz de Campos^a, Vithor Ely Bortolin da Silva, Orivaldo Florencio de Souza^{c,e}, Luiz Carlos de Abreu^{a,c,d,e}

 Open access

^aPós-graduação Programa de Ciências da Saúde, Centro Universitário da Faculdade de Medicina do ABC, Santo André, SP, Brasil, CEP 09060-650;

^bCentro Universitário de Patos, Belo Horizonte, Brasil;

^cUniversidade Federal do Acre, Rio Branco, AC, Brasil;

^dPrograma de Pós-Graduação em Ciências Médicas, Faculdade de Medicina, Universidade de São Paulo, São Paulo, SP, Brasil;

^eLaboratório de Desenho de Estudos e Escrita Científica, Universidade Federal do Espírito Santo, Vitória, ES, Brasil.

Corresponding author

eversonlucena@fiponline.edu.br.

Manuscript received: december 2024

Manuscript accepted: december 2024

Version of record online: april 2025

ORCID and e-mails of all authors:

Everson Vagner de Lucena Santos;

ORCID: 0000-0002-3869-1607;

eversonlucena@fiponline.edu.br;

Yasmin Esther Barreto;

ORCID: 0000-0002-3259-8508;

yasminebarreto@usp.br;

Vithor Ely Bortolin da Silva

ORCID: 0000-0002-1740-850X;

vithorely@gmail.com

Orivaldo Florencio de Souza; ORCID:

0000-0002-3148-6870; orivaldo.

souza@ufac.br;

Luiz Carlos de Abreu; ORCID: 0000-

0002-1387-6373; luizcarlos@usp.br.

Marcelo Ferraz Campos

ORCID: 0000-0002-6939-8390

Abstract

Introduction: among the main causes of death, the stroke representing a public health problem that is difficult to control, with high death rates. Analysis of mortality patterns reveals risk factors and pre-existing conditions that increase the risk of cerebrovascular diseases, highlighting the importance of tracing the regional epidemiological profile.

Objective: evaluating the temporal trends in the mortality coefficient and proportional mortality due to stroke in the populations of the states of Rio Grande do Norte and Paraíba, in the Northeast region of Brazil.

Methods: a time series study analyzed secondary data on deaths from stroke in adults in the states of Paraíba and Rio Grande do Norte, from 2004 to 2023. The data was extracted from the Unified Health System database. Joinpoint regression, annual percentage changes and annual averages with 95% confidence intervals were used.

Results: in the state of Paraíba, the highest number of deaths occurred in females with 1,5206 deaths (51.3%) and in the age group 65 years or older with 22,238 deaths (75.0%). In the state of Rio Grande do Norte, the majority of deaths were registered among females with 9,558 deaths (51.2%) and in the age group 65 years or older with 14,092 (75.4%).

Conclusion: in the period analyzed from 2004 to 2023, the state of Paraíba maintained the highest mortality coefficients compared to Rio Grande do Norte. However, proportional mortality showed a reversal in 2023, with Rio Grande do Norte excelling, especially in the 65 and over age group.

Keywords: mortality, incidence, stroke, Ischemic stroke, hemorrhagic stroke.

Suggested citation: Santos EVL, Barreto YE, Campos MF, Bortolin da Silva VE, Souza OF, Abreu LC. Temporal trend of the mortality coefficient and proportional mortality due to stroke in the populations of the states of Rio Grande do Norte and Paraíba, in Northeastern Brazil. *J Hum Growth Dev.* 2025; 35(1):46-55. DOI: <http://doi.org/10.36311/jhgd.v35.17294>

Authors summary

Why was this study done?

The study evaluated the temporal trends in stroke mortality in the states of Rio Grande do Norte and Paraíba, in northeastern Brazil. As the leading cause of death and disability in the country, epidemiological analysis is essential for the development of prevention and control strategies.

What did the researchers do and find?

The researchers conducted a time series study with secondary data on stroke deaths between 2004 and 2023. The information was extracted from the DATASUS database and analyzed using statistical models to assess variations in mortality over time. The results showed a continuous reduction in proportional mortality trends due to strokes in all age groups and in both sexes. At the beginning of the period, Paraíba had a percentage difference in the mortality coefficient compared to Rio Grande do Norte. However, this difference was progressively reduced by 2023.

What do these findings mean?

The findings show that there have been advances in stroke prevention and treatment, which has contributed to a drop in mortality. However, regional inequalities and the lack of hospital infrastructure still pose challenges for adequate care, especially in inland regions. The results highlight the need to continue investing in public health policies to improve stroke prevention and treatment.

Highlights

During the period from 2004 to 2023, a declining trend in proportional mortality and mortality coefficient occurred in both the states of Rio Grande do Norte and Paraíba. This trend stood out in the female gender in both states and in the 45-64 age group in Paraíba.

INTRODUCTION

Stroke is the leading cause of death worldwide and is associated not only with high mortality, but also with significant rates of disability among survivors. Representing a serious public health problem, death from stroke can be considered preventable, both due to the availability of effective treatments and the adoption of successful preventive measures in the population at risk.

The increase in life expectancy to 76.6 years in the states of Paraíba and Rio Grande do Norte has changed the mortality landscape, previously dominated by infectious diseases, to one where chronic disease predominate¹. These are often associated with an increase in the incidence of cerebrovascular diseases².

Cerebrovascular accidents can be classified into two main types: ischemic, caused by the obstruction of blood flow to the brain, and hemorrhagic, which occurs due to the rupture of a blood vessel, resulting in cerebral hemorrhage and increased intracranial pressure^{3,4}.

The hemorrhagic type accounts for around 20% of cases and is often associated with a more severe course of the disease, since the increase in intracranial pressure accelerates neurological damage, significantly compromising the patient's recovery⁵.

In states like Rio Grande do Norte and Paraíba, the health infrastructure suffers from precariousness and difficulties in access to health services for the population. According to data provided by the Ministry of Health, in the state of Rio Grande do Norte, the capital has only one hospital specialized in treating suspected and confirmed cases of stroke⁶.

While in the interior there are only two specialized units for a population of 3,302,406 inhabitants, Rio Grande do Norte has only one hospital specialized in stroke care, and Paraíba has one in its capital and one in the interior regions, reducing the response capacity of the health system^{7,8}.

Compared to states with greater infrastructure, such as São Paulo, which has 22 public hospitals specializing in the care of patients with cerebrovascular diseases, with 11,451,999 inhabitants in the state⁹.

Between 2013 and 2023, 502,836 cases of stroke were recorded in Brazil, without distinguishing between ischemic or hemorrhagic. This figure represents a significant increase compared to the period from 1996 to 2021, when 305,426 cases were reported, indicating an exponential growth in disease over decades¹⁰.

While the state of Paraíba has socio-economic inequality, quantified by the Gini Index, as the highest income inequality index in the country, with a coefficient of 0.558 in per capita household income, and only one public hospital specializing in care for cardiovascular diseases¹¹.

Stroke is therefore a serious public health problem, with deaths potentially avoidable through preventive measures. The aim of this study is to evaluate the temporal trends in the mortality coefficient and proportional mortality due to stroke in the populations of the states of Rio Grande do Norte and Paraíba, in the Northeast region of Brazil.

METHODS

Study design

This is a descriptive, ecological, time-series study based on secondary data taken from the database of the Department of Informatics of the Unified Health System - DATASUS¹². This database provides public information that can be used for epidemiological analysis, including data on deaths from strokes. In addition, DATASUS contains detailed records on vital statistics, mortality and live births, covering all Brazilian states and municipalities.

Study location and period

The states of Paraíba and Rio Grande do Norte, located in the Northeast region of Brazil, were analyzed from 2004 to 2023. Paraíba, with a population of 3,974,687 and a population density of approximately 70.39 inhabitants per km², is characterized by significant social vulnerability, evidenced by disparities in human development compared to other regions of the country.

The state has a Human Development Index (HDI) of 0.698, ranking 23rd in the state. In contrast, Rio Grande

do Norte, with a population of 3,302,729 inhabitants and a population density of 62.54 inhabitants per km², ranks 16th, with an HDI of 0.728^{2,13}.

Study population and eligibility criteria

The inclusion criteria were cases of death with a diagnosis of stroke in residents of the state of Paraíba and the state of Rio Grande do Norte, with data from 2004 to 2023¹³. The exclusion criteria were data recorded as unknown for sex and age.

Study variable

The stroke variable was composed of the grouping of deaths recorded as subarachnoid hemorrhage (I60), intracerebral hemorrhage (I61), cerebral infarction (I63) and stroke not specified as hemorrhagic or ischemic (I64), according to the coding presented in the International Classification of Diseases, version 10¹⁴.

Data collection

The data was extracted by two trained researchers and in cases where there were discrepancies, corrections were made by consensus between them. For each year from 2004 to 2023, the stroke variable was extracted by place of residence of the population of adults aged 20 and over. Data was also extracted stratified by male and female sex and by age group (20 to 44 years; 45 to 64 years; and 65 years or older).

Once the data had been collected, spreadsheets were generated in comma-separated value (CSV) file format. Trained researchers extracted the data.

Data analysis

The analysis of stroke mortality from 2004 to 2023 was calculated using the mortality coefficient (deaths per 100,000 inhabitants) and proportional mortality (proportion of stroke deaths in relation to total deaths).

The percentage difference was calculated by subtracting the mortality coefficient (or proportional mortality) of the state of Paraíba from the mortality coefficient (or proportional mortality) of the state of Rio Grande do Norte. The resulting difference was divided by the mortality coefficient or proportional mortality of the state of Rio Grande do Norte.

The quotient of the division was multiplied by 100. All calculations of the mortality coefficient, proportional mortality and percentage difference were made using the Microsoft Excel spreadsheet, version 2016.

To identify trends and points of change over time, joinpoint regression models (version 5.3, 2024)¹⁵ were applied, selected based on the weighted Bayesian Information Criterion. A maximum of 3 segments were estimated. The direction and magnitude of trends were estimated by annual percentage change (APC) and average annual percentage change (AAPC) with 95% confidence intervals estimated by the parametric method. 95% confidence intervals were estimated using the parametric method. Models with $p \leq 0.05$ were considered statistically significant.

The paired comparison of the mortality coefficient and standardized mortality from stroke between the

states of Paraíba and Rio Grande do Norte was assessed using the parallelism and coincidence tests, with the aid of the Joinpoint Regression Program (version 5.3, 2024). Specifically, the parallelism test compared whether both average joinpoint regression functions are parallel¹⁵.

While the coincidence test compared whether both joinpoint regression functions are identical¹⁵ p -values ≤ 0.05 rejected the hypothesis of parallelism or coincidence. In addition, the absolute difference with its 95% confidence interval of the average annual percentage change between the states was calculated. A p -value ≤ 0.05 accepted the hypothesis of a statistically significant difference in the average annual percentage change between the states.

Ethical and legal aspects of the research

This study was submitted for evaluation by the Research Ethics Committee (CEP), in accordance with the requirements established by Resolutions N^o. 466/12, No. 510/2016 and N^o. 580/2018, obtaining approval under opinion number 7.415.291.

RESULTS

In adults, between 2004 and 2023, there were 29,645 deaths from strokes in the state of Paraíba and 18,618 in the state of Rio Grande do Norte.

In the state of Paraíba, the highest number of deaths occurred in females, with 15,206 deaths (51.3%) and in the age group 65 years or older, with 22,238 deaths (75.0%). In the state of Rio Grande do Norte, the majority of deaths were registered among females, with 9,558 deaths (51.2%) and in the over-65 age group, with 14,092 (75.4%). In 2008 (1,848 deaths) and 2022 (1,039 deaths) there were the highest numbers of deaths in the states of Paraíba and Rio Grande do Norte, respectively (Figure 1).

In 2004, the stroke mortality coefficient in Paraíba was 61.53/100,000 inhabitants, falling to 40.78/100,000 in 2023. In Rio Grande do Norte, it went from 43.55/100,000 in 2004 to 37.66/100,000 in 2023. In both years and states, men had higher coefficients than women, and the 65+ age group had the highest values. The percentage difference between the states was 41.29% in 2004, reducing to 8.28% in 2023.

Proportional mortality in Paraíba fell from 7.31% (2004) to 4.36% (2023), and in Rio Grande do Norte, from 6.01% to 4.61%. Women had higher proportional mortality than men, and those aged 65+ had the highest rates (Table 1).

In table 2, the trend from 2004 to 2023 showed a decline in Paraíba (-2.59%; $p < 0.001$) and Rio Grande do Norte (-1.10%; $p = 0.001$). The biggest falls occurred among 45-64 year olds in Paraíba (-3.92%; $p < 0.001$) and 65-year-olds and over in Rio Grande do Norte (-2.14%; $p < 0.001$). In Rio Grande do Norte, male mortality remained stable (-0.74%; $p = 0.592$).

Paraíba had a greater decline overall (-1.48%; $p = 0.039$) and among 45-64 year olds (-2.05%; $p = 0.001$) than Rio Grande do Norte. The parallelism test indicated variations between the states ($p < 0.05$), except in the 20-44 age group, and the coincidence test showed dissimilarity in mortality trends ($p < 0.05$).

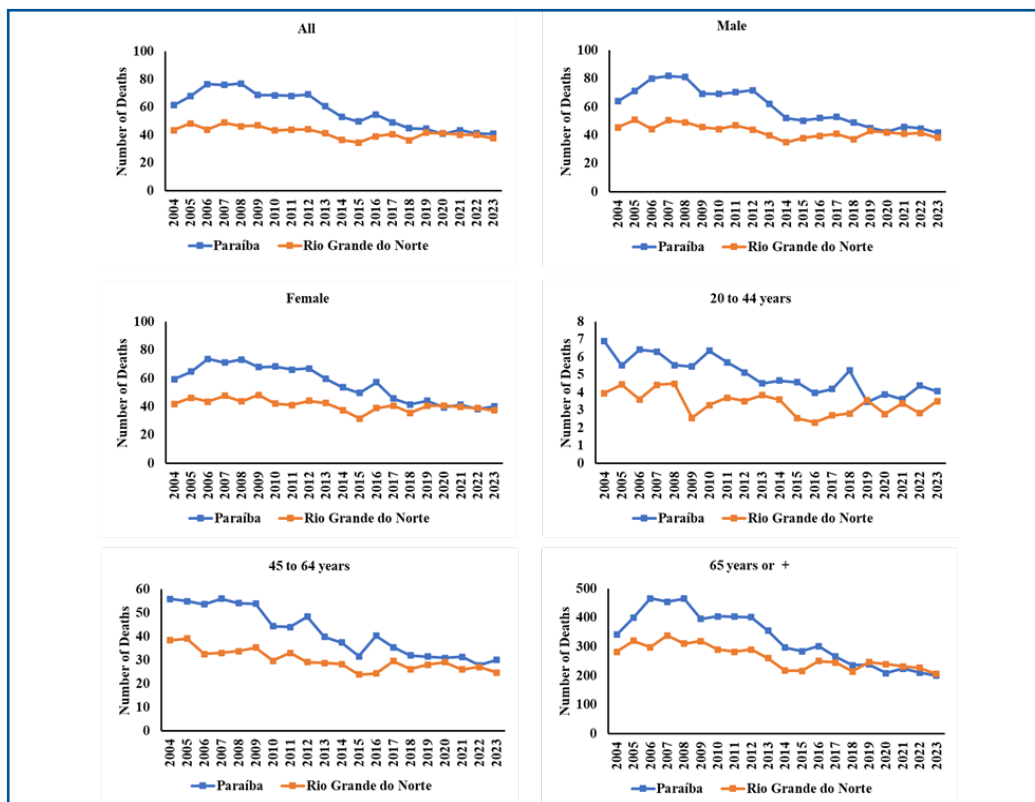


Figure 1: Deaths from stroke in adults in the states of Paraíba and Rio Grande do Norte, Brazil

Table 1: Mortality coefficient, proportional mortality and percentage difference between stroke states by sex and age group in adults

	2004			2023		
	Paraíba	Rio Grande do Norte	% Difference	Paraíba	Rio Grande do Norte	% Difference
Mortality rate						
All	61.53	43.55	41.29	40.78	37.66	8.28
Sex						
Male	63.89	45.41	40.70	41.66	38.09	9.37
Female	59.42	41.84	42.02	40.00	37.28	7.30
Age group						
20 to 44 years	6.89	3.95	74.43	4.07	3.51	15.95
45 to 64 years	55.84	38.30	45.80	29.98	24.62	21.77
65 years or more	340.95	281.67	21.05	199.29	205.97	-3.24
Proportional Mortality						
All	7.31	6.01	21.63	4.36	4.61	-5.42
Sex						
Male	6.53	5.30	23.21	3.91	4.09	-4.40
Female	8.26	6.95	18.85	4.88	5.24	-6.87
Age group						
20 to 44 years	3.59	2.29	56.77	2.04	2.04	0.00
45 to 64 years	7.72	6.04	27.81	4.33	4.07	6.39
65 years or more	7.98	6.91	15.48	4.79	5.26	-8.94

From 2004 to 2023, proportional mortality from stroke in Paraíba decreased, except among men, who remained stable. The greatest reduction occurred in the 45-64 age group (-4.44%; $p < 0.001$). In Rio Grande do Norte, the rate remained stable ($p = 0.056$), as did the male sex and the 20-44 age group.

On the other hand, the female sex and the 45-64

and 65+ age groups fell, with the greatest reduction in the female sex (-2.95%; $p < 0.001$). There was a statistical difference in the annual variation between 45-64 years ($p = 0.001$) between the states. Apart from the 20-44 age group, the parallelism and coincidence tests showed variations and dissimilarity between the states ($p < 0.05$) (table 3).

Table 2: average annual percentage change and paired comparison of the stroke mortality coefficient by sex and age group in adults in the states of Paraíba and Rio Grande do Norte

	State	AAPC	Pairwise comparison		
			AAPC Diference	Parallelism (p)	Coincidence (p)
All	PB	-2.59*	-1.48*	<0.001	<0.001
	RN	-1.10*			
Sex					
Male	PB	-2.41*	-1.67	<0.001	<0.001
	RN	-0.74			
Female	PB	-2.54*	-1.50	<0.001	<0.001
	RN	-1.03*			
Age group					
20 to 44 years	PB	-2.92*	-1.16	0.145	<0.001
	RN	-1.75			
45 to 64 years	PB	-3.92*	-2.05*	<0.001	<0.001
	RN	-1.86*			
65 years or more	PB	-2.88*	-0.73	<0.001	<0.001
	RN	-2.14*			

*: p≤0.05; PB: Paraíba; RN: Rio Grande do Norte; AAPC: average annual percentage change.

Table 3: Average annual percentage change and paired comparison of proportional mortality from stroke by sex and age group in adults in the states of Paraíba and Rio Grande do Norte, from 2004 to 2023

	State	AAPC	Pairwise comparison		
			AAPC Diference	Parallelism (p)	Coincidence (p)
All	PB	-2.76*	-0.97	<0.001	<0.001
	RN	-1.78			
Sex					
Male	PB	-2.67	-0.90	<0.001	<0.001
	RN	-1.77			
Female	PB	-3.56*	-0.60	<0.001	<0.001
	RN	-2.95*			
Age Group					
20 to 44 years	PB	-3.36*	-1.27	0.439	<0.001
	RN	-2.08			
45 to 64 years	PB	-4.44*	-1.70*	<0.001	<0.001
	RN	-2.73*			
65 years or more	PB	-3.45*	-1.69	0.001	<0.001
	RN	-1.75*			

*: p≤0.05; PB: Paraíba; RN: Rio Grande do Norte; AAPC: average annual percentage change.

Table 4 shows the annual variation in stroke mortality in Paraíba. From 2006 to 2023, there was a reduction among men (-4.17%; $p < 0.001$) and those aged 65+ (-5.37%; $p < 0.001$). In the 20-44 and 45-64 age groups, the drop occurred between 2004-2023 ($p < 0,05$).

Proportional mortality fell from 2006 to 2021 for adults (-6.02%; $p < 0.001$) and men (-5.88%; $p < 0.001$). From 2006 to 2023, women (-5.77%; $p < 0.001$) and those aged 65+ (-6.15%; $p < 0.001$) also saw a decline. In the 20-44 and 45-64 age groups, there was a reduction from 2004 to 2023 ($p < 0.05$).

Table 5 shows the annual variation in stroke mortality in Rio Grande do Norte. We observed a downward trend in the analysis by age, with -3.24% ($p < 0.001$) in the 2004-2015 segment. In the 2006-2021 segment, there was a downward trend in proportional mortality for all adults (APC: -5.59%; $p < 0.001$).

In males, the downward trend occurred in the 2007-2014 segment (APC: -6.15%; $p = 0.001$). Females and the 45-64 age group had a downward trend in the 2004-2023 segment of -2.95% ($p < 0.001$) and -2.73% ($p < 0.001$), respectively. The 65 and over age group showed a downward trend in proportional mortality in the 2007-2015 segment (APC: -5.82; $p < 0.001$).

Table 4: Annual percentage variation in the mortality coefficient and proportional mortality from stroke by sex and age group in adults in the state of Paraíba

	Mortality Coefficient			Proportional mortality		
	Segment	APC	p	Segmento	APC	p
All	2004-2007	7.64	0.085	2004-2006	17.60	0.153
	2007-2023	-4.40	<0.001	2006-2021	-6.02	<0.001
				2021-2023	3.84	0.639
Sex						
Male	2004-2006	13.95	0.195	2004-2006	16.15	0.153
	2006-2023	-4.17	<0.001	2006-2021	-5.88	<0.001
				2021-2023	4.83	0.639
Female	2004-2007	8.32	0.093	2004-2006	17.47	0.146
	2007-2023	-4.45	<0.001	2006-2023	-5.77	<0.001
Age group						
20 to 44 years	2004-2023	-2.92	0.001	2004-2023	-3.36	<0.001
45 to 64 years	2004-2023	-3.92	<0.001	2004-2023	-4.44	<0.001
65 years or more	2004-2006	21.07	0.045	2004-2006	22.93	0.063
	2006-2023	-5.37	<0.001	2006-2023	-6.15	<0.001

APC: annual percent change.

Table 5: Annual percentage variation in the mortality coefficient and proportional mortality from stroke by sex and age group in adults in the state of Rio Grande do Norte, from 2004 to 2023

	Mortality Coefficient			Proportional mortality		
	Segment	APC	p	Segmento	APC	p
All	2004-2023	-1.10	<0.001	2004-2006	5.03	0.287
				2006-2021	-5.59	<0.001
				2021-2023	-0.36	0.708
Sex						
Male	2004-2011	-0.42	0.702	2004-2007	4.35	0.373
	2011-2014	-6.84	0.401	2007-2014	-6.15	0.001
	2014-2023	1.12	0.157	2014-2023	-0.26	0.759
Female	2004-2023	-1.03	0.003	2004-2023	-2.95	<0.001
Age group						
20 to 44 years	2004-2023	-1.75	0.017	2004-2017	-5.86	<0.001
				2017-2023	6.62	0.171
45 to 64 years	2004-2015	-3.24	<0.001	2004-2023	-2.73	<0.001
	2015-2023	0.04	0.963			
65 years or more				2004-2007	7.62	0.099
	2004-2023	-2.14	<0.001	2007-2015	-5.82	<0.001
				2015-2023	-0.96	0.301

APC: annual percent change.

DISCUSSION

Between 2004 and 2023, Paraíba recorded 29,645 deaths from strokes, while Rio Grande do Norte recorded 18,618 deaths from the same cause. The year 2004 showed the highest stroke mortality rates in adults in both states, with Paraíba recording 61.53 deaths per 100,000 inhabitants and Rio Grande do Norte 45.55 deaths. Regarding proportional mortality, the greatest disparities between the states occurred in the 20-44 age group in 2004 and in the 45-64 age group in 2023.

Considering that factors such as age and gender are directly related to cerebrovascular diseases, the data analyzed reveals a high magnitude of proportional mortality in females. Paraíba stands out as the state with the highest female mortality, with 8.26% of deaths, especially with advancing age (7.98%)¹⁶. These data are in line with studies that associate higher mortality among women with their higher life expectancy than men, which results in an accumulation of female deaths as the female population, for the most part, becomes more numerous over the years¹⁷.

In young age groups, studies highlight factors related to pregnancy and the onset of menopause as constituting an increased risk of stroke, especially when this occurs early, indicating a decline in mortality in young groups according to the data analyzed (-2.92 in the 20-44 age group and -3.92 in the 45-64 age group)¹⁸⁻²⁰.

However, this trend is refuted by the study by Dawson and MacDonald²¹, which indicates that women have a higher prevalence of stroke deaths before the age of 30, with a reduction in deaths as they age. When men start to present a higher risk of death, particularly in the over 65 age group¹⁸.

Analysis of the annual variation in both states showed a downward trend for adults and females (table 4). This confirms the findings that even with the low risk associated with young groups, residual mortality is mainly due to accumulated lifestyle habits^{22,23}, especially when associated with family history and genetic predisposition.

In the cohort study²⁴, the genomic association mapped through temporal follow-up resulted in healthy patients having the same risk of stroke as patients with pre-existing diseases. And contrary to the risk, a 2023 cohort indicated a 55% lower risk when applying a metric of eight healthy behaviors even in the presence of a family predisposition²⁵.

Making stroke a preventable cause of death through primary and secondary prevention strategies implemented by public health policies²⁶. Focusing on primary prevention to avoid the development of chronic diseases, many of which are associated with an inadequate diet^{27,28}.

Between 2004 and 2006, an outlier was identified in the over 65 age group (21.07%, table 4), possibly related to the fifth Brazilian Hypertension Guideline, which highlighted excess weight as a risk factor for stroke, especially in countries with a low Human Development Index (HDI), the consumption of foods with no nutritional value such as ultra-processed foods are the dietary basis due to the low financial cost, making it difficult to adopt a diet rich in essential nutrients^{27,29,30}.

The relationship between HDI and other risk factors such as smoking and alcohol consumption has been

outlined in several studies due to its strong relationship with cerebrovascular diseases³¹. Smoking contributes to the formation of blood clots, while excessive alcohol consumption is associated with hemorrhagic stroke, due to the relaxation of blood vessels and impairment of the vascular epithelium^{27,32}.

In similar temporal studies, Paiva³² related factors such as alcoholism being predominant in the 55-64 age group and, above the age of 65, the occurrence of cardiovascular diseases. In addition, 56% of post-stroke patients reported a history of smoking, as observed by Filho *et al.* (2023)^{30,32}.

Given the socio-economic characteristics of the Northeast region, promoting physical activity is an effective primary prevention strategy³³ physical inactive can be associated with an increase in depressive symptoms, which reinforces habits that are harmful to health^{34,35}.

The accumulation of harmful habits results in the inefficiency of primary prevention, making interventions aimed at preventing permanent damage necessary³⁶. Although trends in Rio Grande do Norte and Paraíba, especially in the mortality coefficient (-1.10%, table 5), show a steady decline, technological advances have been fundamental in reducing the number of deaths³⁷.

When it comes to treatment, rapid care is decisive for the extent of brain damage, an essential factor in post-stroke recovery, especially in respiratory and motor functions. The lack of specialized care drastically reduces the chances of recovery³⁸. As outlined in the cross-sectional study³⁹, only 1% of patients followed up in the post-stroke period had full access to treatment through the Unified Health System (SUS).

Although the downward trend in proportional mortality during the period analyzed suggests an improvement in the current scenario of stroke mortality, there are still challenges to be faced. Regions in the Northeast, such as Rio Grande do Norte and Paraíba, continue to have a deficit in the supply of health facilities and specialized care, which is reflected in the high overall mortality rates in both states⁴⁰.

In addition, some limitations should be considered. The cultural particularities of the states analyzed make it difficult to make direct comparisons with other regions of Brazil, making the extrapolation of data less precise. Furthermore, the use of secondary data prevents in-depth analysis of the specific socio-economic variables of the states studied.

CONCLUSION

In the period analyzed, we concluded that the state of Paraíba maintained the highest mortality coefficients compared to Rio Grande do Norte. However, when considering proportional mortality, in 2023 there was a reversal, with Rio Grande do Norte excelling, especially in the 65 and over age group.

In the analysis of percentage difference, it can be seen that, in 2023, this disparity had been significantly reduced to the point where there was a reversal in the difference between the two states. This is evidenced by the continuous decline in all age groups and between both genders.

Author Contributions

All authors contributed to the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

Funding

This research received no external funding.

REFERENCES

1. Kobayashi A, Czlonkowska A, Ford GA, Fonseca AC, Luijckx GJ, Korv J, et al. European Academy of Neurology and European Stroke Organization consensus statement and practical guidance for pre-hospital management of stroke. *Eur J Neurol* [Internet]. 2018 Mar;25(3):425–33. Available from: <http://dx.doi.org/10.1111/ene.1353>
2. Antza C, Gallo A, Boutari C, Ershova A, Gurses KM, Lewek J, et al. Prevention of cardiovascular disease in young adults: Focus on gender differences. A collaborative review from the EAS Young Fellows. *Atherosclerosis*. 2023 Nov;384:117272. Available from: [10.1016/j.atherosclerosis.2023.117272](https://doi.org/10.1016/j.atherosclerosis.2023.117272)
3. Lima ABR, Cavalcante Carvalho CV, Costa Martins LG, Guareschi DE, Sensi Santhiago G, Garcia K, et al. PERFIL DE INCIDÊNCIA DE INFARTO AGUDO DO MIOCÁRDIO E ACIDENTE VASCULAR CEREBRAL EM ADULTOS JOVENS: ANÁLISE DE UMA DÉCADA. *Braz J Implantol Health Sci*. 2024 Aug 23;6(8):3985–98. Available from: <https://bjih.emnuvens.com.br/bjih/article/view/3093/3302>
4. Dam-Nolen DHKV, Truijman MTB, Van Der Kolk AG, Liem MI, Schreuder FHBM, Boersma E, et al. Carotid Plaque Characteristics Predict Recurrent Ischemic Stroke and TIA. *JACC: Cardiovascular Imaging*. 2022 Oct;15(10):1715–26. Available from: [10.1016/j.jcmg.2022.04.003](https://doi.org/10.1016/j.jcmg.2022.04.003)
5. Rangel DM, Feitosa AKN, Araújo FM, Pinheiro MC da S, Cidrão AA de L. The effects of the healthcare line in a stroke unit: three years' experience of a center in the Northeast of Brazil. *Arq Neuropsiquiatr* [Internet]. 2023 Aug;81(8):707–11. Available from: <http://dx.doi.org/10.1055/s-0043-177035>
6. Sociedade Brasileira de AVC. Fatores de Risco para o AVC [Internet]. SBDCV. 2021. Available from: <https://avc.org.br/pacientes/fatores-de-risco-para-o-avc/>
7. Sociedade Brasileira de AVC. Hospitais para Atendimento ao AVC no Brasil - SBAVC [Internet]. SBAVC. 2024. Available from: <https://avc.org.br/pacientes/hospitais-referencia-avc-brasil/>
8. Tsoo CW, Aday AW, Almarzooq ZI, Alonso A, Beaton AZ, Bittencourt MS, et al. Heart Disease and Stroke Statistics—2022 Update: A Report From the American Heart Association. *Circulation* [Internet]. 2022 Jan 26;145(8). Available from: <https://www.ahajournals.org/doi/10.1161/CIR.0000000000001052>
9. Feigin VL, Stark BA, Johnson CO, Roth GA, Bisignano C, Abady GG, et al. Global, regional, and national burden of stroke and its risk factors, 1990–2019: A systematic analysis for the global burden of disease study 2019. *The Lancet Neurology* [Internet]. 2021 Sep 3;20(10):795–820. Available from: [10.1016/S1474-4422\(21\)00252-0](https://doi.org/10.1016/S1474-4422(21)00252-0)
10. Lima LCDO, Santos AVF, Cunha Júnior VCD, Menezes MCL, Martins SSA, Feitosa FRS. Perfil epidemiológico do acidente vascular cerebral isquêmico transitório (AVC) e síndromes relacionadas em adultos e idosos no Nordeste brasileiro de 2018 a 2023. *Revista JRG*. 2025 Feb 11;8(18):e081820. Available from: <https://bjih.emnuvens.com.br/bjih/article/view/3093/3302>
11. Boden-Albala B. Roadmap for Health Equity: Understanding the Importance of Community-Engaged Research. *Stroke*. 2024 Nov 21; Available from: [10.1161/strokeaha.124.046958](https://doi.org/10.1161/strokeaha.124.046958)
12. Ministério da Saúde. Informações de Saúde (TABNET) – DATASUS [Internet]. Saude.gov.br. 2024. Available from: <https://datasus.saude.gov.br/informacoes-de-saude-tabnet/>
13. IBGE. Paraíba | Cidades e Estados | IBGE [Internet]. [cited 2025 Feb 20]. Available from: <https://www.ibge.gov.br/cidades-e-estados/pb.html>
14. World Health Organization. *World Health Statistics 2015*. Geneva: World Health Organization; 2015. 162 p.
15. Kim, Hyune-Ju, et al. "Permutation Tests for Joinpoint Regression with Applications to Cancer Rates." *Statistics in Medicine*, vol. 19, no. 3, Feb. 2000, pp. 335–51.
16. Ferreira SRG, Moura ECD, Malta DC, Sarno F. Frequência de hipertensão arterial e fatores associados: Brasil, 2006. *Rev Saúde Pública*. 2009 Nov;43(suppl 2):98–106. Available from: [10.1590/s0034-89102009000900013](https://doi.org/10.1590/s0034-89102009000900013)
17. Blomstrand A, Blomstrand C, Hakeberg M, Sundh V, Lissner L, Björkelund C. Forty-four-year longitudinal study of stroke incidence and risk factors – the Prospective Population Study of Women in Gothenburg. *Scandinavian Journal of Primary Health Care*. 2022 Jan 2;40(1):139–47. Available from: [10.1080/02813432.2022.2057040](https://doi.org/10.1080/02813432.2022.2057040)

18. Poon LC, Nguyen Hoang L, Smith GN, Bergman L, O'Brien P, Hod M, et al. Hypertensive disorders of pregnancy and long-term cardiovascular health: FIGO Best Practice Advice. *Intl J Gynecology & Obste*. 2023 Jan;160(S1):22–34. Available from: 10.1002/ijgo.14540.
19. Bromfield SG, Ma Q, DeVries A, Inglis T, Gordon AS. The association between hypertensive disorders during pregnancy and maternal and neonatal outcomes: a retrospective claims analysis. *BMC Pregnancy Childbirth*. 2023 Jul 14;23(1):514. Available from: 10.1186/s12884-023-05818-9.
20. Katsafanas C, Bushnell C. Pregnancy and stroke risk in women. *Neurobiology of Disease*. 2022 Jul;169:105735. Available from: 10.1016/j.nbd.2022.105735.
21. Dawson J, MacDonald A. Sex and hypertensive organ damage: stroke. *J Hum Hypertens*. 2023 Apr 14;37(8):644–8. Available from: 10.1038/s41371-023-00830-0.
22. Kapral MK, Bushnell C. Stroke in Women. *Stroke [Internet]*. 2021 ;52(2):726–8. Available from :https://www.ahajournals.org/doi/10.1161/STROKEAHA.120.033233.
23. Orlandi IS, Braz Carlini Pestana A, Lage Pereira De Aguiar B, Bergamini Effgen Sena A, Stein Messetti PA, Cardoso Leitão FN, et al. Time series of mortality from stroke in the adult population residents of the State of Amazonas from 2000 to 2021. *Journal of Human Growth and Development*. 2024 Jul 31;34(2):308–16. Available from: 10.36311/jhgd.v34.16304
24. Wu S, Liu M. Global burden of stroke: dynamic estimates to inform action. *The Lancet Neurology*. 2024 Oct;23(10):952–3. Available from: 10.1016/S1474-4422(24)00363-6.
25. Sur NB, Kozberg M, Desvigne-Nickens P, Silversides C, Bushnell C, Goldstein LB, et al. Improving Stroke Risk Factor Management Focusing on Health Disparities and Knowledge Gaps. *Stroke*. 2024 Jan;55(1):248–58. Available from: 10.1161/strokeaha.122.040449.
26. Li X, Ma H, Wang X, Feng H, Qi L. Life's Essential 8, Genetic Susceptibility, and Incident Cardiovascular Disease: A Prospective Study. *ATVB*. 2023 Jul;43(7):1324–33. Available from: 10.1161/ATVBAHA.123.319290.
27. Silva RPF, Pellense MCDS. AVALIAÇÃO DA QUALIDADE DO ACESSO NA ATENÇÃO BÁSICA EM UMA REGIÃO DE SAÚDE DO RIO GRANDE DO NORTE. *REV CIÊNC PLURAL*. 2024 Apr 29;10(1):1–16. Available from: 10.21680/2446-7286.2024v10n1ID34861.
28. Yang L, Chen X, Cheng H, Zhang L. Dietary Copper Intake and Risk of Stroke in Adults: A Case-Control Study Based on National Health and Nutrition Examination Survey 2013–2018. *Nutrients*. 2022 Jan 18;14(3):409. Available from: 10.3390/nu14030409.
29. Paiva LDS, De Alcantara Sousa LV, Oliveira FR, De Carvalho LEW, Raimundo RD, Correa JA, et al. Temporal Trend of the Prevalence of Modifiable Risk Factors of Stroke: An Ecological Study of Brazilians between 2006 and 2012. *IJERPH*. 2022 May 6;19(9):5651. Available from: 10.3390/ijerph19095651.
30. Baden MY, Shan Z, Wang F, Li Y, Manson JE, Rimm EB, et al. Quality of Plant-Based Diet and Risk of Total, Ischemic, and Hemorrhagic Stroke. *Neurology [Internet]*. 2021 Apr 13; 96(15). Available from: 10.1212/WNL.00000000000011713.
31. Djaló ACN, Souza OF, Maud H, Cavalcanti MPE, Pereira GAV, Campos MF, et al. Mortality from cerebral stroke in the State of Pernambuco, Brazil: an ecological study. *Journal of Human Growth and Development*. 2024 Apr 11;34(1):53–67. Available from: https://revistas.marilia.unesp.br/index.php/jhgd/article/view/15781/16334
32. Filler J, Georgakis MK, Dichgans M. Risk factors for cognitive impairment and dementia after stroke: a systematic review and meta-analysis. *The Lancet Healthy Longevity*. 2024 Jan;5(1):e31–44. Available from: 10.1016/s2666-7568(23)00217-9.
33. Beck Filho JA, Pitta AMF, Bonfim CB, Christovam BP, Machado AC, Guimarães LF, et al. Associação entre sintomas depressivos e inatividade física em trabalhadores técnico-administrativos de uma universidade pública do Nordeste do Brasil: estudo transversal. *Rev bras saúde ocup*. 2023;48:edepi6. Available from: https://doi.org/10.1590/2317-6369/34222pt2023v48edepi6.
34. McLellan HL, Dawson EA, Eijsvogels TMH, Thijssen DHJ, Bakker EA. Impact of Hypertension on the Dose-Response Association Between Physical Activity and Stroke: A Cohort Study. *Stroke [Internet]*. 2024 Aug 8; Available from: 10.1161/strokeaha.123.045870.
35. Goncalves S, Bourvellec ML, Mandigout S, Duclos NC. Impact of Active Physiotherapy on Physical Activity Level in Stroke Survivors: A Systematic Review and Meta-Analysis. *Stroke [Internet]*. 2023 Dec 1;54(12):3097–106. Available from: 10.1161/strokeaha.123.043629.
36. Silva JLFRD, Ribeiro BB, Bassi-Dibai D, Almeida De Oliveira Baggio J. QUALIDADE DE VIDA EM PACIENTES HIPERTENSOS EM UM MUNICÍPIO DO INTERIOR DO NORDESTE BRASILEIRO. *Rev Portal: Saúde e Sociedade*. 2022 Apr 29;7. Available from: 10.28998/rpss.e02207008.

37. Bernal HDM, Abreu LCD, Bezerra IMP, Adami F, Takasu JM, Ji Young Suh JV, et al. Incidence of hospitalization and mortality due to stroke in young adults, residents of developed regions in Brazil, 2008-2018. Gall S, editor. PLoS ONE. 2020 Nov 16;15(11):e0242248. Available from: 10.1371/journal.pone.0242248.
38. Carmo SHD, Paiva LS, Adami F, Leitão F.N, Maria De Paula Rebouças C, Engracia Valenti V, et al. Relationship between motor-cognitive functions and hemodynamic response of individuals with chronic stroke during and after an acute bout of aerobic exercise. Journal of Human Growth and Development. 2021 Aug 3;31(2):267–82. Available from: 10.36311/jhgd.v31.12223.
39. Silva LKC, Sousa CDDD, Viana RT, Jucá RVBDM, Lopes JM, Faria CDCDM, et al. Stroke in Brazil: prevalence, activity limitations, access to healthcare, and physiotherapeutic treatment. Arq Neuropsiquiatr. 2024 Dec;82(12):001–11. Available from: 10.1055/s-0044-1792094.
40. Roni G, Castelo Branco AA, Maud H, Noll M, Macedo HS, Ferraz MC, et al. Mortality from Stroke in Pará, Brazilian Amazon: a Joinpoint Analysis. Journal of Human Growth and Development. 2024 Apr 11;34(1):68–78. Available from: 10.36311/jhgd.v34.15794.

Resumo

Introdução: dentre as principais causas de morte, o acidente vascular cerebral representa um problema de saúde pública de difícil controle, com altas taxas de mortalidade. A análise dos padrões de mortalidade revela fatores de risco e condições preexistentes que aumentam o risco de doenças cerebrovasculares, destacando a importância de traçar o perfil epidemiológico regional.

Objetivo: avaliar as tendências temporais do coeficiente de mortalidade e da mortalidade proporcional por acidente vascular cerebral nas populações dos estados do Rio Grande do Norte e da Paraíba, na região Nordeste do Brasil.

Método: estudo de séries temporais, com análise de dados secundários sobre óbitos por acidente vascular cerebral em adultos nos estados da Paraíba e do Rio Grande do Norte, no período de 2004 a 2023. Os dados foram extraídos do banco de dados do Sistema Único de Saúde. Foram utilizadas regressão Joinpoint, variações percentuais anuais e médias anuais com intervalos de confiança de 95%.

Resultado: no estado da Paraíba, o maior número de óbitos ocorreu no sexo feminino com 1.5206 óbitos (51,3%) e na faixa etária de 65 anos ou mais com 22.238 óbitos (75,0%). No estado do Rio Grande do Norte, a maioria dos óbitos foi registrada no sexo feminino com 9.558 óbitos (51,2%) e na faixa etária de 65 anos ou mais com 14.092 (75,4%).

Conclusão: no período analisado de 2004 a 2023 o estado da Paraíba manteve os maiores coeficientes de mortalidade em comparação ao Rio Grande do Norte. No entanto, a mortalidade proporcional, apresentou uma inversão em 2023, com o Rio Grande do Norte se sobressaindo, especialmente na faixa etária de 65 anos ou mais.

Palavras-chave: mortalidade, incidência, acidente vascular cerebral. acidente vascular cerebral isquêmico, acidente vascular cerebral hemorrágico.

©The authors (2025), this article is distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The Creative Commons Public Domain Dedication waiver (<http://creativecommons.org/publicdomain/zero/1.0/>) applies to the data made available in this article, unless otherwise stated.