Epidemiological profile of stroke deaths in Brazil between 2007 and 2016: a national database study

Perfil epidemiológico dos óbitos por acidente vascular encefálico no Brasil entre 2007 e 2016: um estudo de base de dados nacional

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ABSTRACT: *Objective:* To describe the epidemiological profile of patients with stroke death in Brazil and to analyze the temporal trend of stroke mortality according to geographic region. *Methods:* A descriptive observational time series study with secondary data obtained from the Department of Informatics of the Unified Health System (*DATASUS*), referring to the period between 2007 and 2016. Categories I60-I69 of the International Classification of Diseases, 10th edition, (ICD-10) were used. It was not necessary to submit the project to a Research Ethics Committee. *Results:* There were 998,529 stroke deaths in Brazil in the analyzed period, of which 50.3% were male, 51.2% white, 35.9% aged 80 years or older, 37.2% married and 46.8% with education equal to or less than 3 years of schooling. There was a tendency of mortality reduction in the country (β = -0.262), being strongly associated with time (r = 0.861) and statistically significant (p = 0.001). The southeastern and southern regions showed the highest mortality reduction trends (β = -0.519 and -0.461, respectively). *Conclusions:* Deaths from stroke predominantly occurred in males, white, older adults, married and with low education. The reduction in mortality from stroke occurred unevenly in the country, so that the regions with the best socioeconomic conditions, southeast and south, had the greatest downward trends.

Keywords: Stroke; Epidemiology; Mortality; Brazil/epidemiology.

RESUMO: *Objetivo:* Descrever o perfil epidemiológico dos pacientes com óbito por Acidente Vascular Encefálico (AVE) no Brasil e analisar a tendência temporal da mortalidade por AVE segundo a região geográfica. *Métodos:* Estudo observacional descritivo de série temporal com dados secundários obtidos a partir do Departamento de Informática do Sistema Único de Saúde (DATASUS), referentes ao período entre 2007 e 2016. As categorias da Classificação Internacional das Doenças, 10ª edição, (CID-10) utilizadas foram I60-I69. Não foi necessária a submissão do projeto a um Comitê de Ética em Pesquisa. *Resultados:* No período analisado, ocorreram 998.529 óbitos por AVE no Brasil, dos quais 50,3% eram do sexo masculino, 51,2% brancos, 35,9% com idade igual ou superior a 80 anos, 37,2% casados e 46,8% com escolaridade igual ou inferior a 3 anos de estudo. Houve tendência de redução da mortalidade no país, (β=-0,262), estando fortemente associado ao tempo (r=0,861) e estatisticamente significante (p=0,001). As regiões sudeste e sul apresentaram as maiores tendências de redução da mortalidade (β=-0,519 e -0,461, respectivamente). *Conclusões:* Os óbitos por AVE ocorreram predominantemente em indivíduos do sexo masculino, brancos, idosos, casados e com baixa escolaridade. A redução da mortalidade por AVE aconteceu de forma desigual no país, de modo que as regiões com melhores condições socioeconômicas, sudeste e sul, tiveram as maiores tendências de queda.

Palavras-chave: Acidente vascular encefálico; Perfil epidemiológico; Taxa de mortalidade; Brasil/epidemiologia.

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INTRODUCTION

Cerebrovascular accident (CVA) is one of the main causes of death and disability in the world[1]. According to the Global Burden of Disease, it is estimated that 5.5 million deaths and 116.4 million years of life were lost due to incapacity resulting from the CVA in 2016[2]. Such an impact is also present in Brazil, therefore being a major public health problem. However, for many scholars on the subject, such as Paulo Lotufo, stroke is still considered a neglected disease in Brazil[3], as the country has one of the highest mortality rates when compared to other Latin American countries[3,4].

Given the epidemiological relevance of cerebrovascular diseases, the description of stroke mortality rates will serve as an instrument for analyzing the impact of public policies to combat the disease. In addition, it will enable a comparison between different Brazilian regions in order to infer possible socioeconomic issues associated with higher mortality, as well as helping to guide strategic changes in public health management so that the principles of the Unified Health System (*SUS*) of equity and universality can be respected.

Thus, this study aims to describe the epidemiological profile of patients with stroke death in Brazil and analyze the temporal trend of stroke mortality according to geographic region.

MATERIAL AND METHODS

This is a descriptive observational time series study with secondary data. The Mortality Information System (*SIM*) was used as a data source, available through the *SUS* Informatics Department platform (*DATASUS*) of the Brazilian Ministry of Health. Information about the resident population in the years analyzed in each region was obtained from of the "Projection of the population of federation units by sex and age groups: 2000-2030", which was carried out by *IBGE* and is available on *DATASUS* through the website TabNet Win32 3.0: Population Projection of Federation Units by sex and groups of age: 2000-2030 (datasus.gov.br).

All patients who died from cerebrovascular disease (categories I60 to I69, according to the International Classification of Diseases in its 10th version) between 2007 and 2016 in Brazil, registered in *DATASUS*, whose access is available via TabNet Win32 3.0: Mortality - Brazil (datasus.

gov.br) were included. The study variables were year of death, region (by place of residence), sex, age group, skin color, marital status and education.

Mortality was calculated by the ratio between the number of deaths due to stroke per year and the resident population estimated for the same period in each Brazilian region by the Brazilian Institute of Geography and Statistics (*IBGE*), multiplied by 100,000 (10^5). The Statistical Package for Social Sciences (SPSS) version 14 was used to perform the linear regression, as well as to calculate the coefficient of determination (R^2), correlation coefficient (r), β and p-value. The r value is used to assess the association between the variables: mortality coefficient and the year of death in the time series, which suggests a strong association when > 0.75. On the other hand, β enabled identifying the temporal trend of the mortality coefficients, indicating a tendency to fall when negative[5]. The chi-squared test (X^2) was applied to assess whether there was a statistical difference between stroke deaths according to sex. Values of p<0.05 were considered statistically significant.

As this is a secondary database study, submission to a Research Ethics Committee (*CEP*) was waived under the guidelines of resolution 466/12 of the National Health Council.

RESULTS

There were 998,529 deaths from stroke in Brazil in the period analyzed in the study (2007 to 2016), corresponding to 8.5% of all deaths registered in *DATASUS* in the period. The year 2007 had the lowest number of deaths due to stroke in absolute values (96,804 deaths), while the year 2016 had the highest occurrence (102,965 deaths). When analyzing the deaths in the entire time series according to gender, 50.3% were represented by males, with no statistically significant difference (p = 0.232) in relation to the number of deaths in females (Table 1).

White-skin individuals constituted the majority of stroke deaths (51.2%). Brown-skin individuals were responsible for the second largest portion (33.2%). On the other hand, indigenous people constituted the smallest percentage affected (0.2%) (Graph 1).

It was noted that there is an increase in the proportion of deaths as the age group increases regarding the distribution of deaths. In this sense, individuals aged 80 years or more accounted for 35.9% of deaths from stroke in the study period, being the most affected group proportionally. On the other hand, individuals aged < 30 years had the lowest percentage, 1.0% (Graph 2).

Table 1 - Number and proportional distribution of stroke deaths according to sex. Brazil, 2007 to 2016

Year	Male		Female		Ignored		Total	
	N	%	N	%	N	%	N	%
2007	48770	50.4	48024	49.6	10	0.0	96804	100.0
2008	49875	50.4	49082	49.6	5	0.0	98962	100.0
2009	49814	50.2	49442	49.8	6	0.0	99262	100.0
2010	50536	50.7	49190	49.3	6	0.0	99732	100.0
2011	50877	50.5	49863	49.5	11	0.0	100751	100.0
2012	50530	50.4	49652	49.6	12	0.0	100194	100.0
2013	50333	50.3	49705	49.7	12	0.0	100050	100.0
2014	49830	50.2	49436	49.8	23	0.0	99289	100.0
2015	50251	50.0	50252	50.0	17	0.0	100520	100.0
2016	51753	50.3	51198	49.7	14	0.0	102965	100.0
Total	**502.569**	**50.3**	**495.844**	**49.7**	**116**	**0.0**	**998.529**	**100.0**

Source: MS/SVS/CGIAE – SIM. Accessed in: April, 2019. Data expressed in absolute (N) and percentage (%) values.

Graph 1 – Percentage distribution of deaths from cerebrovascular accident according to skin color. Brazil, 2007 to 2016
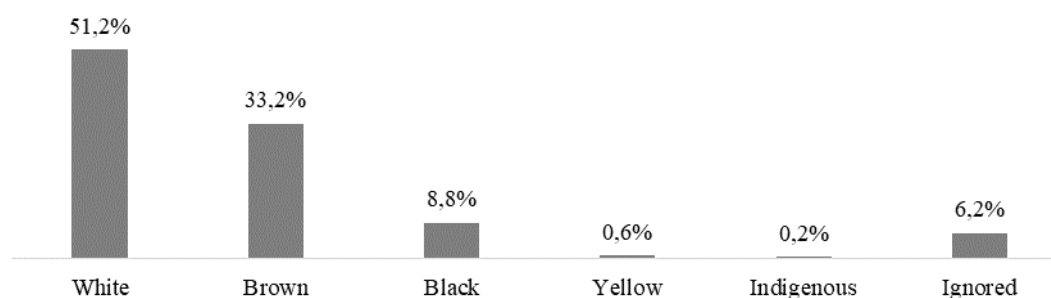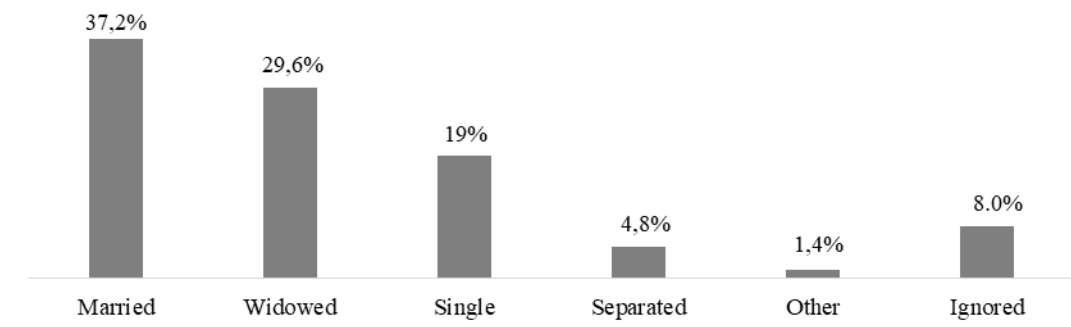

Source: *MS/SVS/CGIAE – SIM*. Accessed in: April, 2019. Data expressed in percentage (%).

Graph 2 – Percentage distribution of deaths from cerebrovascular accident according to age group. Brazil, 2007 to 2016
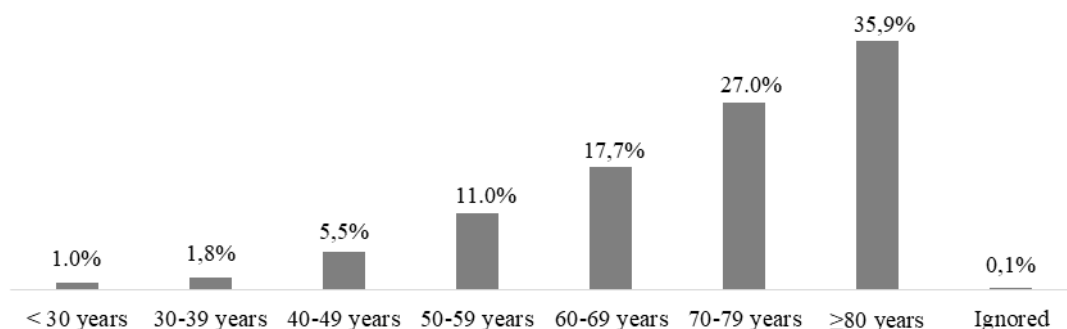
Source: MS/SVS/CGIAE – SIM. Accessed in: April, 2019. Data expressed in percentage (%).

Individuals whose marital status was married had the highest proportional values of deaths (37.2%). Next were widowed individuals, who represented 29.6% of deaths (Graph 3).

Graph 3 – Percentage distribution of deaths from cerebrovascular accident according to marital status. Brazil, 2007 to 2016

Source: MS/SVS/CGIAE – SIM. Accessed in: April, 2019. Data expressed in percentage (%).

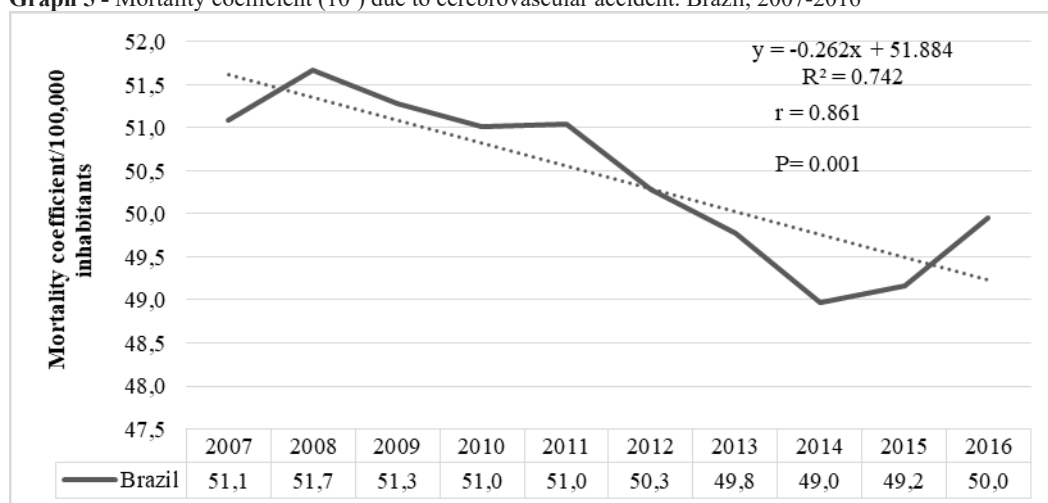It was observed that there was no record of education in 25.8% of deaths. In addition, people with no education and between 1 and 3 years of formal schooling were those with the highest proportions after the group of ignored education, with 21.6% and 25.2%, respectively. Individuals with 12 years of formal schooling or more were a minority of deaths (3.2%) (Graph 4).

Graph 4 – Percentage distribution of deaths from cerebrovascular accident according to education. Brazil, 2007 to 2016
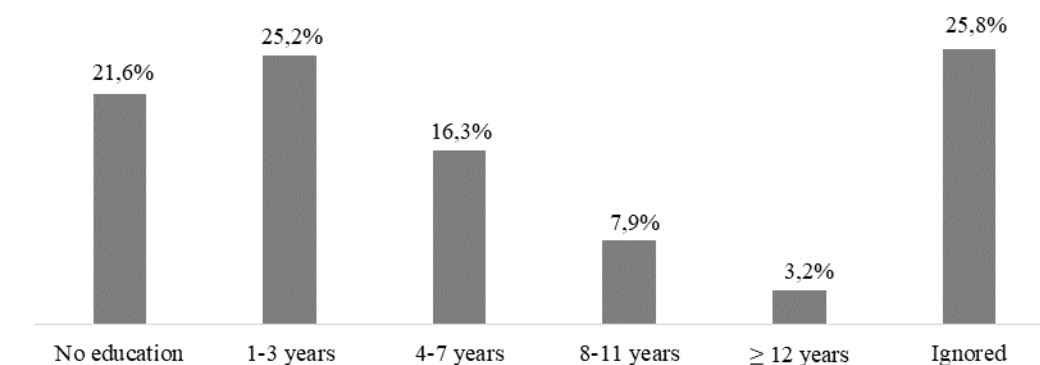
Source: MS/SVS/CGIAE – SIM. Accessed in: April, 2019. Data expressed in percentage (%).

When analyzing the coefficient of mortality from stroke in Brazil, it was noticed that in 2007 it was 51.1 deaths/100,000 inhabitants, going to 50.0 deaths/100,000 inhabitants in 2016, a reduction of 2.1%. In this sense, a decreasing trend (β=-0.262) was evidenced when calculating the temporal trend of the stroke mortality coefficient at the national level, being strongly correlated with time (r=0.861) and statistically significant (p=0.001) (Graph 5).

**Graph 5 -** Mortality coefficient (10^5) due to cerebrovascular accident. Brazil, 2007-2016

$$y = -0.262x + 51.884$$
$$R^2 = 0.742$$
$$r = 0.861$$
$$P = 0.001$$

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Brazil	51,1	51,7	51,3	51,0	51,0	50,3	49,8	49,0	49,2	50,0

Source: MS/SVS/CGIAE – SIM. Accessed in: April, 2019.

When comparing the mortality coefficients of the geographic regions with each other and with the national values, it was noticed that the South and Southeast regions had the highest rates over most of the time series, while the North and Midwest regions showed the lowest coefficients. In addition, from the calculation of temporal trends of regional mortality coefficients, it was noted that the South and Southeast regions showed a decreasing trend associated with time and with statistical significance (β= -0.461, r= 0.768 and p= 0.009, values corresponding to the Southern region; β= -0.519, r= 0.911, and p< 0.0001, values referring to the Southeast region). The Northeast and Midwest regions showed a slight downward trend in mortality coefficients (β= -0.016 and -0.009, respectively) in the analyzed period, but these findings were not statistically significant. On the other hand, the North region showed an increasing temporal trend (β= 0.495) in the mortality coefficient due to stroke, being strongly associated with time (r= 0.873) and with statistical significance (p= 0.001) (Graph 6).

Graph 6 – Mortality coefficient (10^5) for stroke. Brazil and geographic regions, 2007-2016
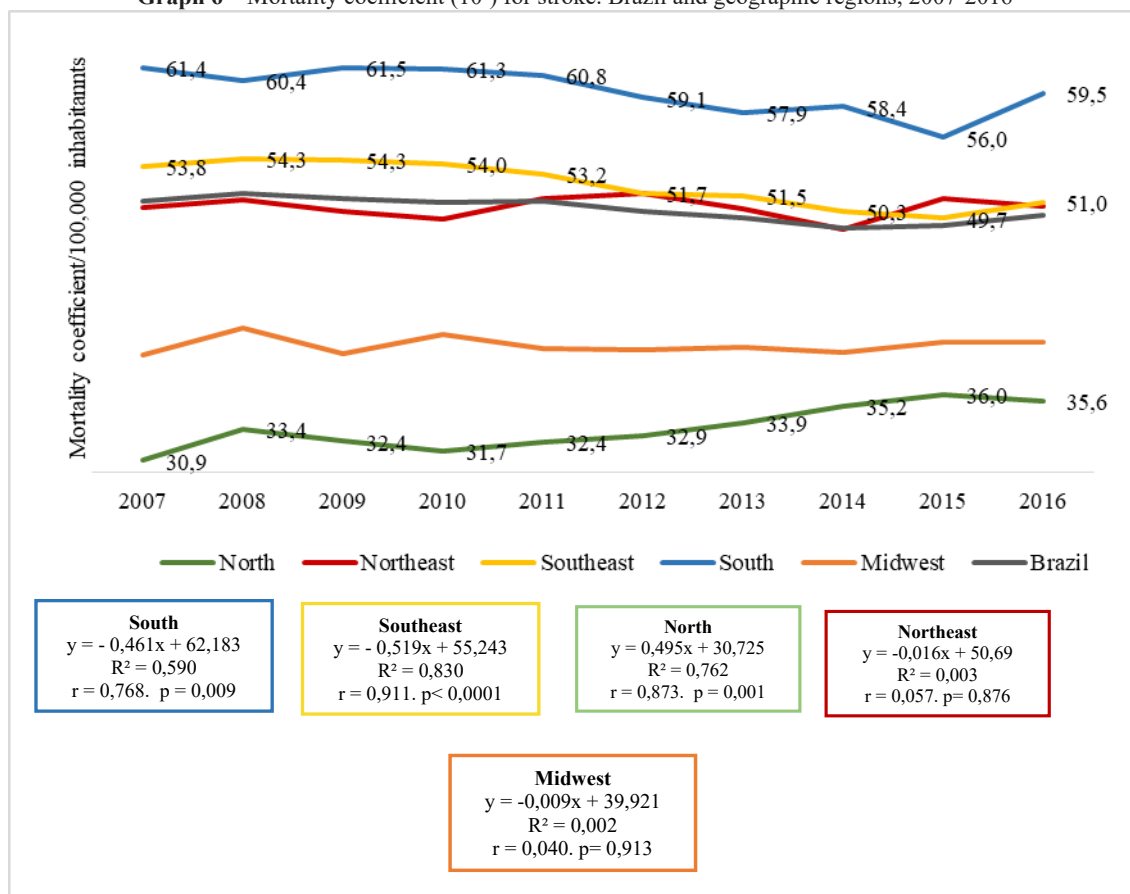
Source: MS/SVS/CGIAE – SIM. Accessed in: April, 2019.

DISCUSSION

In the analyzed period, it was observed that 50.3% of deaths from stroke occurred in males, although there was no statistical relevance (p = 0.232). This finding is in line with other Brazilian studies, such as those developed by Ladeia et al.[6] in 2014, and Garritano et al.[4] in 2012, and can be explained by the greater exposure to risk factors for the development of cerebrovascular diseases such as alcoholism and smoking[7]. However, in the international literature, there are sources which show numerical superiority of deaths from stroke in females, which would be elucidated by the higher life expectancy of women[8].

Research indicates higher mortality from stroke in blacks, which would be a consequence of the high prevalence of arterial hypertension in this group, greater lethality from cerebrovascular disease, as well as the interference of socioeconomic issues[9]. However, the results found in this study show that white-skinned individuals made up the majority of deaths (51.2%), followed by brown individuals (33.2%), which is in line with what was described by Deolinda[10] in 2017 These findings may have been influenced by the great miscegenation that exists in Brazil with a significant proportion of brown individuals. Added to this there is the heterogeneity of criteria for identifying skin color which can be made by

self-declaration, provided for by law No. 12,711/2012, or by information from third parties[9].

The higher occurrence of deaths from stroke in older adults is supported by the literature[7,10-13]. Some of the possible explanations for this are the neuropathological changes which occur in the central nervous system with aging and make the individual more susceptible to stroke, such as: weight and brain volume loss, neuronal atrophy, white matter degeneration (leukoaraiosis), expansion of the ventricular system, decreased cerebral blood flow, increased vulnerability of the axons to ischemia and degeneration of the cerebral vascular structure, which can suffer ruptures[14]. Associated with this, there is a higher prevalence of hypertension and diabetes with increasing age, which are important risk factors for the occurrence of stroke[11].

Systematic reviews have already demonstrated the influence of marital status on the incidence of cardiovascular diseases, such that not being married (including widowed and divorced people) is associated with higher mortality from stroke compared to married individuals. In this sense, theories seek to explain this possible protective effect which emphasize the benefits of marital support, a tendency to faster recognition of warning signs and symptoms, less time to seek medical help and better adherence to treatment[15]. Despite this, the highest proportion of deaths in this study was represented by married individuals (37.2%), followed by widowers (29.6%), which was also demonstrated in other studies[6,10].

Only from 2003 onwards did death certificates contain information about years of formal schooling, which is a possible explanation for the persistence of high rates of lack of this record. Furthermore, there is still a deficit in the training provided by faculties to professionals in training with regard to filling out such a document[12]. From this perspective, education was not informed in 25.8% of deaths from stroke, which corresponds to the group with the highest proportion among those analyzed.

The inverse relationship between the education level and the prevalence of stroke has already been described in the literature, which would be attributed to the lack of information on prevention among individuals with a lower educational level, making them more likely to have a stroke[13]. In agreement with this evidence, this research observed that people with fewer years of formal schooling accounted for a large proportion of deaths, while individuals with 12 years of formal schooling or more were a minority (3.2%).

Although the number of deaths from stroke has increased over the years, there is a tendency to reduce this rate in the time series in Brazil (β = -0.262; r=0.861; p=0.001) when analyzing the mortality coefficients, which takes into account the ratio of deaths by the resident population. It is noteworthy that this epidemiological scenario was also indicated by other studies which attribute this reduction in mortality to the active fight against risk factors for the disease, as well as improvement in the treatment offered to patients. However, the country has the fourth highest mortality from stroke among those located in Latin America, which reinforces the need for more significant reductions[4,16].

It is worth noting that there was a significant decline in the stroke mortality rate in the country between 2011 and 2014. This may be a consequence of the implementation of new national programs for controlling hypertension and diabetes as of 2011, with expansion of free access to medication[1]. In addition, given that the Brazilian population lacked information about CVA[17], a national campaign to combat the disease was carried out that same year, which disseminated information on prevention in 22 Brazilian states[1]. Such initiatives are essential, since 90% of stroke cases can be avoided through intervention in modifiable risk factors[18].

There were differences between the regional mortality coefficients, with the Southern region, followed by the Southeast presenting the highest values. These results were also found by other authors, with a possible explanation for this being the greater number of records carried out[10], as well as the presence of death certificates filled out correctly in these regions[19]. Furthermore, there is a high proportion of deaths in older adults from ill-defined causes in the North and Northeast regions with values above 20%[20], which may have contributed to the lower mortality rates from stroke in these regions.

Despite the low rates of stroke mortality in the Northern region compared to other Brazilian regions, an increase was observed over time (β=0.495 r=0.873 and p=0.001), which was also pointed out by Nunes[21] in 2013 when studying cardiovascular diseases in the Brazilian Amazon region. This can be partially explained by the subtle and gradual decrease in underreporting rates, although it remains among the highest in Brazil[4]. In addition, another plausible hypothesis is attributed to the demographic transition experienced by the Northern region, with progressive population aging and growth in cardiocirculatory diseases[21].

The Southeast and South regions showed the greatest temporal trends in mortality decline, with the respective values of β=-0.519 and -0.461. In this sense, the fact that these regions are among the holders of the best socioeconomic conditions in the country is highlighted, as evidenced by the Municipal Human Development Index (MHDI) published by the Institute of Applied Economic Research (*IPEA*) in 2010, which evaluates longevity, income and education, with values being: 0.766 (Southeast); 0.757 (Midwest); 0.754 (South); 0.667 (North) and 0.663 (Northeast)[22]. This greater reduction in mortality in regions with better socioeconomic conditions was also described by Lotufo[23] in 2017.

As this is a study of secondary data, limitations are the possible underreporting of deaths due to stroke as a

consequence of incorrect or incomplete filling out of death certificates[19]. In addition, as this is a descriptive study, the risk calculation was not performed, but the frequencies according to each variable.

CONCLUSIONS

The largest proportion of deaths from stroke was represented by white males, aged 80 years or over, married and with less than or equal to 3 years of formal schooling. The temporal trend of the stroke mortality rate in Brazil between 2007 and 2016 was decreasing, being strongly associated with time and statistically significant. The Southern and Southeastern regions showed the greatest trends in mortality reduction compared to other Brazilian regions.

The importance of combating risk factors is reinforced through awareness campaigns and incentives for programs to control comorbidities such as hypertension, diabetes and dyslipidemia. In addition, it is also suggested to improve the living conditions of the population in order to impact the reduction of mortality from stroke.

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