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Hospitalization for ischemic stroke in Brazil: an ecological study on the possible impact of Hiperdia

Hospitalização por acidente vascular encefálico isquêmico no Brasil: estudo ecológico sobre possível impacto do Hiperdia

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ABSTRACT: ***Objective:*** The study evaluated the trend of hospitalization for ischemic stroke (HIS) and its hospital mortality in Brazil over the last 15 years as well as the impact of the Hiperdia program in this scenario. ***Methods:*** An ecological study was designed with analytical approach and data collected in the Hospital Admission System on episodes of stroke, over the years 1998 to 2012. All data were stratified by sex and age, creating an indicator for HIS and proportion of hospital mortality. To estimate the trend of the data a polynomial curve fitting was created; and the Generalized Linear Model was applied to investigate the impact of Hiperdia on the endpoint HIS and hospital mortality. We adopted a 5% significance level to minimize an error type I. ***Results:*** We observed a reduction of HIS from $37.57/10^5$ inhabitants in 1998 to 2001 to $10.33/10^5$ inhabitants in 2002 to 2005, declining 73.64%. The reduction occurred in both sexes and for all age groups. The mortality rate of ischemic stroke also declined in Brazil since 2002, in both men and women, therefore in less than 3%; and only in the groups aged between 0 and 14 and above 80 years, we did not detect trend. ***Conclusion:*** Therefore, the decline of HIS temporally coincided with the implementation of Hiperdia in 2002 and this trend continues today.

Keywords: Stroke. Hospitalization. Hospital mortality. Epidemiology. Brazil. Primary health care.

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RESUMO: ***Objetivo:*** O estudo avaliou a tendência de hospitalização por acidente vascular encefálico isquêmico (HAVEI) e a sua mortalidade hospitalar no Brasil nos últimos 15 anos, assim como o impacto do programa Hiperdia nesse cenário. ***Métodos:*** Delineou-se um estudo ecológico com abordagem analítica e dados coletados no Sistema de Internação Hospitalar sobre episódios de AVEI, referentes aos anos de 1998 a 2012. Todos os dados foram estratificados por sexo e faixa etária, criando-se um indicador para HAVEI e proporção de mortalidade hospitalar. A fim de estimar a tendência dos dados criou-se uma curva polinomial de melhor aderência e para a averiguar o impacto do Hiperdia aplicou-se o Modelo Linear Generalizado tomados como desfecho a HAVEI e a mortalidade hospitalar. Adotou-se um nível de significância de 5% para minimizar um erro tipo I. ***Resultados:*** Foi evidenciada redução das HAVEI de 37,57/10^5 habitantes em 1998 a 2001 para 10,33/10^5 habitantes em 2002 a 2005, declinando 73,64%. A redução aconteceu em ambos os sexos, assim como para todas as faixas etárias. A mortalidade hospitalar por AVEI também declinou no Brasil a partir de 2002, tanto em homens como em mulheres, porém em menos de 3% e apenas nas faixas entre 0 e 14 anos e acima de 80 anos não detectamos tendência. ***Conclusão:*** Portanto, o declínio das HAVEI coincidiu temporalmente com a implementação do Hiperdia no ano de 2002 e essa tendência se mantém até hoje.

Palavras-chave: Acidente vascular cerebral. Hospitalização. Mortalidade hospitalar. Epidemiologia. Brasil. Atenção primária à saúde.

INTRODUCTION

The stroke occurs by dysfunctions in the cerebral blood flow[1], being classified as hemorrhage or as ischemic. The ischemic stroke (IS) is the most frequent and morbid one, occurring in 80% of the cases, whereas the hemorrhagic stroke is more rare, resulting, however, in greater mortality[2,3].

Most individuals survive the IS[2], but the resulting sequelae have repercussions on the functional capacity and in the quality of life, resulting in a great impact on the health systems and social security. In Argentina and Brazil, in 2011, approximately US$ 900 million were spent with hospital care to patients hospitalized with stroke[4].

In developed countries, it is estimated that 1 in every 20 adults will be a victim of stroke, exceeding the incidence of acute coronary diseases in the near future[5-7]. In the recent 4 decades, there was a decrease of 42% in the incidence of stroke in high-income countries and an increase in the medium-income countries[8]. Within these last ones, it is observed higher post-stroke mortality[8], suggesting influence of the primary services of urgency/emergency and intensive care[9-11]. However, in general, the incidence and mortality rates related to stroke have decreased worldwide[10].

In the United States, 795 thousand people are affected by strokes each year[5]. In Latin America, the disease is the main cause of morbidity and mortality, especially in Brazil[11,12]. By 2020, it is estimated that the stroke and the coronary arterial disease will be, together, the main causes of lost of years of life[13]. Interestingly, Feigin et al.[8] and Heuschmann et al.[14] observed regional differences in Europe as for the incidence of stroke, being lower

in Eastern European countries, a fact probably related to the implementation of fight and control measures of risk factors such as hypertension, diabetes mellitus (DM), atrial fibrilation, physical inactivity, and smoking[8,9,15].

In 2002, it was implemented in Brazil the national assistance program for people with high blood pressure (hypertension) and DM, called Hiperdia, which consists in the continuous monitoring of such patients, with the basic health units of the Unified Health System (*Sistema Único de Saúde* – SUS), with the supply of drugs and the promotion of healthy life habits[16,17].

Despite its existence for more than a decade, there are still no studies estimating the effects of the implementation of Hiperdia nationwide about the most common outcome of cerebrovascular events, which is hospitalization by IS. The estimation of this event sets in the main indicator of result that evaluates directly the effects of preventive assistance to this morbidity. On the other hand, the proportion of hospital deaths by IS after medical care is an indicator of health-care quality of emergency/pre- and intra-hospital emergency services.

Thus, there are two guiding questions for this research: do hospitalization by IS and its hospital mortality have any trends between 1998 and 2012? If so, did the Hiperdia change this trend? Considering that, the IS is a potentially preventable event, unlike the hemorrhagic one, it will be used in the estimates of incidence and hospital mortality indicators. Therefore, the objective of the present study was to measure the historical trends of hospitalizations by IS and their hospital mortality in Brazil between 1998 and 2012, under the hypothesis of a possible impact of Hiperdia in this time period.

METHODS

It was made an ecological study of the time period and an analytical approach between the years of 1998 and 2012. The information covers all the federal units (FU) in Brazil. For the study of hospitalization by IS, the Hospital Admission Authorizations due to this disease were observed. As it is a study made with secondary and aggregate data from the information systems, without personal identification, open to public consultation, not leading to the identification of those who used the hospital services of SUS, it is unnecessary the evaluation by the Ethics Committee.

The diagnosis of IS was established according to Chapter VI of nervous diseases in the tenth version of the International Classification of Diseases, whose identification code is G45.9 and grouped as follows: the vertebrobasilar artery syndrome, carotid artery syndrome (hemispheric), multiple and bilateral precerebral artery syndromes, amaurosis fugax, spasm of cerebral artery, and transient cerebral ischemia.

The data were collected in the Hospitalization System of the Unified Health System (*Sistema de Internação Hospitalar* of the *Sistema Único de Saúde* – SIH-SUS) of the Computer Department of the Unified Health System (*Departamento de Informática* of the Sistema Único de Saúde – DATASUS). To obtain the number of cases of hospitalization by IS (HIS) and its proportion of hospital mortality, it was used the functions of epidemiological information

and overall hospital morbidity by place of residence. The demographic data of populational estimates were collected in the function of demographic and socioeconomic information of the same database.

There was stratification of the data, according to the FU, gender (male and female) and age (0 to 14; 15 to 19; 20 to 29; 30 to 39; 40 to 49; 50 to 59; 60 to 69; 70 to 79; and older than 80 years old). Thus, it was determined the HIS rate in relation to the estimated population for the year of the study, simplifying them by a power of 10^5 inhabitants. The proportion of hospital mortality was defined between the number of deaths by HIS in the hospitals affiliated to SUS and the total of HIS, also stratified by gender, age range, and FU.

For the analysis of the data trends, it was used a model of polynomial regressions, due to its high statistical power and greater ease of interpretation[18]. These models have the objective of finding the best curve to adjust the data, relating the outcome variable, HIS rate, and mortality (Y), with the independent variable year of study (X). We considered the following models of polynomial regression:

- linear (1st order): $Y = \beta 0 + \beta 1X + \varepsilon$;
- quadratic (2nd order): $Y = \beta 0 + \beta 1X + \beta 2X + \varepsilon$;
- cubic (3rd order): $Y = \beta 0 + \beta 1X + \beta 2\,X + \beta 3X + \varepsilon$.

It was characterized as $\beta 0$ is the mean outcome observed in the period regardless of the year, and $\beta 1$, $\beta 2$, and $\beta 3$ are the regression coefficients, which inform the annual mean evolution. Its signal determines the growing trend (+) or decreasing trend (-) of the outcome. The term ε represents the residue not explained by the equation. The choice of the model depended on the analysis of the residues in the scatter diagram and the adjusted determination coefficient (R^2). As there are two similar models, it was chosen to use the simplest one, the one of lower order.

To avoid the serial correlation between the terms of the regression equation, it was chosen not to use the gross values of the years, but instead the difference between the year and the midpoint of the historical series. Therefore, for the period between 1998 and 2012, the term (X - 2004) represented the independent variable. For example, for the linear model:

$YT = \beta 0 + \beta 1\,(X - 2004)$, where: YT = incidence rate/mortality; X = year; $\beta 0$ = HIS/mean mortality in the period; and $\beta 1$ = annual evolution average.

After establishing the best model for the outcomes, it was performed that the comparison of the proportional evolution results (%) between the initial 4 years of the series (1998 to 2001), after the implementation of the Hiperdia (2002 to 2005) and the end of the time series (2009 to 2012).

The Generalized Linear Model (GLM) was used to verify the impact of the Hiperdia program on the trend of hospitalizations and hospital mortality by IS in Brazil, by considering the best curves of adjustment are linear equations, as well as the data residue, have average distribution and do not reveal seasonality in their distribution. This way, it was created an independent variable called Hiperdia contact with the levels before 2002 and after 2002. When adding it to the model through the linear connection function, it would be possible to reveal the existence of Hiperdia impact in the trends of the data and the observation of the sign g regression coefficient, which would allow the identification of the effect of

the program. Which would have a statistically significant difference between the equation generated and the intercept through the method of maximum likelihood, as well as the significance of the regression coefficients by the - [2] Wald test.

We used the SPSS® (version 20.0; IBM®, Inc.) for the adjustment of the polynomial curves and for the construction of the GLM. A significance level of 5% was observed to minimize a type I error in the processes of adherence to the modeling curves.

RESULTS

A decline in the HIS was observed from 2002 onward. The average incidence of HIS in the time period was estimated at $12.6/10^5$ inhabitants (Table 1), with mean decrease of $1.03/10^5$ inhabitants a year ($p < 0.01$). In the period from 1998 to 2001, hospitalizations corresponded to a mean of $37.87/10^5$ inhabitants and in the period from 2002 to 2005 it was reduced to $9.98/10^5$ inhabitants, a reduction of 73.64%.

When stratified by gender, the HIS among women represented a mean of $11.48/10^5$ inhabitants ($p < 0.01$) in the whole period. When comparing the periods 1998 to 2001 and 2002 to 2005, a reduction of 73.89% is noticeable. Among men, a mean of $12.72/10^5$ inhabitants was observed, with annual mean reduction of hospitalization around $1.76/10^5$ inhabitants ($p < 0.01$), which corresponds to 72.95% of the decline between 1998 to 2001 and 2002 to 2005 (Table 1).

Table 1. Modeling of hospital trends by ischemic stroke in Brazil between 1998 and 2012.

	Model	R^2	p-value	Trend	Proportion 2001 – 2005	Proportion 2009 – 2012
Total	$Y = 12.6 - 1.03x + 0.37x^2 - 0.22x^3$	0.77	< 0.01	Decreasing	-73.64%	-64.35%
Gender						
Female	$Y = 11.48 - 1.75x - 0.36x^2$	0.73	< 0.01	Decreasing	-73.89%	-68.80%
Male	$Y = 12.72 - 1.76x + 0.37x^2$	0.74	< 0.01	Decreasing	-72.95%	-63.05%
Age range (years)						
0 to 14	$Y = 0.12 - 0.13x + 0.004x^2$	0.60	< 0.01	Decreasing	-98.80%	-97.09
15 to 19	$Y = 0.37 - 0.69x + 0.01x^2$	0.80	< 0.01	Decreasing	-82.10%	-77.25%
20 to 29	$Y = 0.78 - 0.14x + 0.38x^2$	0.83	< 0.01	Decreasing	-79.13%	-69.52%
30 to 39	$Y = 2.44 - 0.50x + 0.10x^2$	0.81	< 0.01	Decreasing	-76.48%	-71.94%
40 to 49	$Y = 9.83 - 1.82x + 0.30x^2$	0.60	< 0.01	Decreasing	-76.67%	-75.77%
50 to 59	$Y = 19.52 + 1.22x^2 - 0.14x^3$	0.93	< 0.01	Decreasing	-76.05%	-75.97%
60 to 69	$Y = 57.44 - 10.98x + 1.92x^2$	0.81	< 0.01	Decreasing	-75.54%	-74.23%
70 to 79	$Y = 117.73 - 21.83x + 3.84x^2$	0.82	< 0.01	Decreasing	-73.70%	-73.32%
Above 80	$Y = 195.41 - 34.33x + 5.97x^2$	0.82	< 0.01	Decreasing	-72.82%	-71.43%

The data also revealed a decline in the HIS in all age groups ($p < 0.01$). However, it is highlighted the higher rate of hospitalization within the older age groups, especially from the fourth decade of life, presenting an annual mean of 9.83 (40 to 49 years), 19.52 (50 to 59 years), 57.44 (60 to 69 years), 117.73 (70 to 79 years), and 195.41/10^5 inhabitants (above 80 years), showing a geometric trend of doubling the occurrence of HIS every decade of life (Table 1).

Table 2 exposes the hospital mortality trend by IS in Brazil, showing a downward trend, with mean in the time period of approximately 13.38% of the HIS and a decrease of 0.18% a year ($p < 0.01$). Among women, the mean mortality was 13.54% and the mean decrease was 0.13% a year ($p < 0.01$), with a reduction of 2.83% between the periods from 1998 to 2001 and 2002 to 2005. Among men, the hospital mortality in HIS was characterized by a mean annual decrease of 0.22% ($p < 0.01$), with a reduction of 2% between the periods from 1998 to 2001 and 2002 to 2005.

As for the age ranges, it was observed stability between 0 and 14 years of age and from 80 years of age onward ($p > 0.05$). Within the other ranges, there was a statistically significant decrease in mortality ($p < 0.05$) and the mean hospital deaths proportion by IS varied from 8% to 14% with the increasing age (Table 2).

Table 3 contains the equations for the trends of HIS and the hospital mortality proportion for IS in the FU in Brazil. The FU of Goiás, Roraima, and Ceará has a stable HIS rate ($p > 0.05$), while the remaining FU revealed a decrease ($p < 0.05$). The trend of hospital

Table 2. Modeling of hospital mortality trend by ischemic stroke in Brazil between 1998 and 2012.

	Model	R^2	p-value	Trend	Proportion 2001 – 2005	Proportion 2009 – 2012
Total	$Y = 13.38 - 0.18x$	0.66	< 0.01	Decreasing	-2.92%	+0.13%
Gender						
Female	$Y = 13.54 - 0.13x$	0.53	< 0.01	Decreasing	-2.83%	-2.04%
Male	$Y = 464.86 - 0.22x$	0.68	< 0.01	Decreasing	-2.00%	-2.75%
Age range (years)						
0 to 14	$Y = 35.15 + 10.15x + 25.02x^2$	0.28	0.13	Stable	-3.41%	-4.69%
15 to 19	$Y = 9.11 - 0.41x + 0.08x^2$	0.45	0.02	Decreasing	+1.30%	-3.44%
20 to 29	$Y = 8.29 - 0.27x$	0.31	0.03	Decreasing	-5.11%	-4.23%
30 to 39	$Y = 10.06 - 0.43x$	0.75	< 0.01	Decreasing	-4.38%	-4.06%
40 to 49	$Y = 10.72 - 0.33x$	0.79	< 0.01	Decreasing	-2.69%	-5.15%
50 to 59	$Y = 10.01 - 0.28x + 0.03x^2$	0.37	0.02	Decreasing	-1.20%	-3.67%
60 to 69	$Y = 11.79 - 0.23x$	0.75	< 0.01	Decreasing	-1.67%	-3.43%
70 to 79	$Y = 14.04 - 0.14x$	0.40	0.01	Decreasing	-1.44%	-0.14%
Above 80	$Y = 18.73 - 0.87x$	0.20	0.09	Stable	-3.39%	-1.10%

Table 3. Modeling of hospitalization trends by ischemic stroke and hospital mortality by ischemic stroke in Brazilian Federal Units between 1998 and 2012.

FU	HIS	R2	p-Value	Trend	Hospital mortality	R2	p-Value	Trend
GO	$Y = 16.27 - 0.7x + 0.30x^2$	0.29	0.12	Stable	$Y = 9.98 - 2.15x + 0.27x^2$	0.88	< 0.01	Decreasing
MA	$Y = 15.92 - 2.4x + 0.45x^2$	0.85	< 0.01	Decreasing	$Y = 6.70 + 0.28x$	0.46	< 0.01	Increasing
MG	$Y = 12.71 - 2.24x + 0.25x^2$	0.85	< 0.01	Decreasing	$Y = 12.88 - 0.26x$	0.50	0.01	Decreasing
MS	$Y = 13.69 - 1.50x + 0.23x^2$	0.63	< 0.01	Decreasing	$Y = 15.15 - 0.27x$	0.30	0.11	Stable
MT	$Y = 9.33 - 1.74x + 0.19x^2$	0.74	< 0.01	Decreasing	$Y = 11.46 + 0.15x$	0.03	0.54	Stable
PA	$Y = 7.57 - 1.33x$	0.60	< 0.01	Decreasing	$Y = 13.26 - 0.60x + 0.14x^2$	0.52	0.01	Decreasing
PB	$Y = 7.38 + 1.5x - 0.04x^2$	0.62	0.01	Decreasing	$Y = 9.55 + 3.12x - 0.05x^2$	0.71	< 0.01	Decreasing
PE	$Y = 1.54 + 0.55x + 0.23x^2$	0.77	< 0.01	Decreasing	$Y = 15.93 + 0.49x$	0.22	0.07	Decreasing
PI	$Y = 22.66 + 1.03x$	0.52	< 0.01	Decreasing	$Y = 6.34 + 0.02x$	≤0.01	0.78	Stable
PR	$Y = 20.03 - 2.76x$	0.65	< 0.01	Decreasing	$Y = 12.16 - 0.04x$	0.02	0.60	Stable
AC	$Y = 15.85 - 2.73x$	0.68	< 0.01	Decreasing	$Y = 16.60 - 1.94x$	0.65	< 0.01	Decreasing
RJ	$Y = 12.05 - 0.98x + 0.20x^2$	0.54	< 0.01	Decreasing	$Y = 14.81 - 0.12x$	0.11	0.22	Stable
RN	$Y = 14.00 - 2.72x + 0.86x^2$	0.71	< 0.01	Decreasing	$Y = 0.59 + 1.27x + 0.20x^2 - 0.03x^3$	0.76	< 0.01	Decreasing
RO	$Y = 4.16 - 2.42x + 0.47x^2$	0.85	≤ 0.01	Decreasing	$Y = 11.52 + 0.11x$	0.01	0.70	Stable
RR	$Y = 0.42 + 0.05x$	0.11	0.21	Stable	$Y = 8.20 - 1.01x$	0.03	0.53	Stable
RS	$Y = 17.29 - 8.24x + 1.99x^2$	0.86	< 0.01	Decreasing	$Y = 13.44 + 0.01x$	≤0.01	0.87	Stable
SC	$Y = 31.05 - 5.23x + 0.88x^2$	0.75	< 0.01	Decreasing	$Y = 12.33 - 0.32x$	0.78	< 0.01	Decreasing
SE	$Y = 6.62 - 4.20x + 0.28x^2$	0.80	< 0.01	Decreasing	$Y = 30.91 - 0.31x$	0.33	0.08	Decreasing
SP	$Y = 8.60 + 0.19x - 0.30x^2$	0.79	< 0.01	Decreasing	$Y = 13.03 - 0.44x + 0.03x^2$	0.88	< 0.01	Decreasing
TO	$Y = 26.34 - 4.8x$	0.42	< 0.01	Decreasing	$Y = 16.82 - 0.20x$	0.27	0.15	Decreasing
AL	$Y = 13.87 - 4.35x + 0.54x^2$	0.71	< 0.01	Decreasing	$Y = 11.82 - 2.36x + 0.23x^2 + 0.03x^3$	0.81	< 0.01	Decreasing
AM	$Y = 6.49 + 1.88x + 0.36x^2$	0.77	< 0.01	Decreasing	$Y = 8.30 + 0.23x$	0.51	0.01	Decreasing
AP	$Y = 10.35 - 2.4x$	0.46	< 0.01	Decreasing	$Y = 15.92 + 0.53x$	0.02	0.55	Stable
BA	$Y = 11.01 - 1.10x + 0.23x^2$	0.53	0.01	Decreasing	$Y = 12.35 - 0.04x$	<0.01	0.75	Stable
CE	$Y = 8.45 - 0.17x$	0.10	0.23	Stable	$Y = 22.00 + 0.61x - 0.24x^2$	0.58	< 0.01	Decreasing
DF	$Y = 12.62 - 1.19x$	0.35	0.07	Decreasing	$Y = 14.52 - 0.62x$	0.64	< 0.01	Decreasing
ES	$Y = 17.60 - 0.10x$	0.70	< 0.01	Decreasing	$Y = 19.59 - 0.62x - 0.14x^2$	0.74	< 0.01	Decreasing

FU: Federal unit; GO: Goiás; MA: Maranhão; MG: Minas Gerais; MS: Mato Grosso do Sul; MT: Mato Grosso; PA: Pará; PB: Paraíba; PE: Pernambuco; PI: Piauí; PR: Paraná; AC: Acre; RJ: Rio de Janeiro; RN: Rio Grande do Norte; RO: Rondônia; RR: Roraima; RS: Rio Grande do Sul; SC: Santa Catarina; SE: Sergipe; SP: São Paulo; TO: Tocantins; AL: Alagoas; AM: Amazonas; AP: Amapá; BA: Bahia; CE: Ceara; DF: Distrito Federal; ES: Espirito Santo; HIS: hospitalization by ischemic stroke.

mortality by IS was stable in the FU of Mato Grosso do Sul, Mato Grosso, Piauí, Paraná, Rio de Janeiro, Rondônia, Roraima, Rio Grande do Sul, Amapá, and Bahia ($p > 0.05$), while Maranhão showed a rising trend of 0.28% a year ($p < 0.01$). On the other hand, Goiás, Minas Gerais, Pará, Paraíba, Pernambuco, Acre, Rio Grande do Norte, Santa Catarina, Sergipe, São Paulo, Tocantins, Alagoas, Amazonas, Ceará, Distrito Federal, and Espírito Santo showed a decreasing trend across the 15 years analyzed.

Table 4 presents the GLM to estimate the Hiperdia impact on the trend of the data, where a decline in the HIS ($B = -28.71$; $p < 0.001$) was identified with the inclusion of the variable Hiperdia impact in the model. It is also highlighted that the model without the inclusion of the Hiperdia explained only 44.0% ($R^2 = 0.44$) of the trend and after its inclusion it showed explanatory power of 98% ($R^2 = 0.98$) in the reduction of HIS, a difference of 54%. On the other hand, hospital mortality seems not to be influenced by the program ($B = -0.62$; $p = 0.19$). The variance explained by the model with only the temporal independent variable was 66.0% ($R^2 = 0.66$) and after the inclusion of the variable Hiperdia impact it only explained 70% ($R^2 = 0.70$), which equals to an increase of 4% (Table 4).

Table 4. General Linear Model of Hiperdia impact on trend of hospitalization by ischemic stroke and hospitalar mortality in Brasil between 1998-2012.

Variables	β	Wald 95%CI	Hypothesis test		
			Wald χ^2	lg	p-value
HIS					
Likehood ratio				1	< 0.001
Intercept	40.15	37.87 – 42.43	1192.11	1	< 0.001
Hiperdia					
After	-28.71	-31.61 – -25.81	376.71	1	< 0.001
Before	0				
Years in the period	0.49	0.20 – 0.79	10.80	1	0.001
Hospital mortality					
Likehood ratio				1	< 0.001
Intercept	283.035	89.23 – 476.83	8.19	1	< 0.01
Hiperdia					
After	-0.62	-1.56 – 0.32	1.65	1	0.19
Before	0				
Years in the period	-0.134	-0.231 – -0.03	7.37	1	< 0.01

95%CI: confidence interval of 95%; lg: liberty degree; HIS: hospitalization by ischemic stroke.

DISCUSSION

Large scale studies on the occurrence of IS and its hospital mortality are incipient in Brazil. For the most part of them, they are restricted to local populational epidemiological studies. The present study covers the entire national territory and uses an information system of relevance for the monitoring of the studies outcomes, allowing to evidence pronounced reductions in the HIS from 2002 onward, year of implementations of the Hiperdia program. On the other hand, hospital mortality, despite its significant decreasing trend, reveals trivial value in epidemiological application and health management.

A study carried out in Chili revealed IS incidence of approximately $47/10^5$ inhabitants a year[8]. In China[15], in 2007, the incidence of stroke varied from 259.86 to $719/10^5$ inhabitants. In Europe, the incidence of stroke suffered regional variations, and in Italy it was observed an incidence of $101.2/10^5$ inhabitants and in Lithuania, of $239.3/10^5$ inhabitants[14]. In India, the occurrences were proven lower, in the order of $74.8/10^5$ inhabitants[19]. Our findings, prior to the implementation of the Hiperdia, are similar to the findings in Chile[8]. However, after 2002, there was a reduction in the HIS in Brazil, as in Belgium[10], in the mid-1980s. The way inferior rates of HIS in Brazil in comparison to countries such as Italy portray the demographic transition that already occurred in the country, whose greater proportion of older people increases the occurrence of cerebrovascular events as will be discussed ahead. And as Belgium, Brazil started outlining preventive measures of great impact.

The differences between developed and undeveloped countries are related, probably, to the management of risk factors such as hypertension, diabetes, and smoking[20,21]. Liu et al.[15] revealed a decrease of 21.4% in the incidence of stroke in 4 years in China between 1992 and 1995. A study carried out in the city of Oxford revealed a decline of 40% in the incidence of stroke between 1981 and 2004, after the implementation of preventive and educational measures in the fight against risk factors such as hypertension[22]. In Japan, no significant changes were reported in the incidence of IS between 1988 and 2004[23], probably due to secular lifestyle that favors longevity with quality of life and low rates of cerebrovascular events in this Asian country.

In Brazil, we see a decline of more than 70% in the HIS right after the execution of the assistencial program to hypertensive and diabetics in 2002. Such health policy allowed the control of blood pressure and of glucose through the use of drugs and strategies to changing lifestyle habits[16,17]. Probably, the fall in HIS in Brazil is due to these preventive measures that mitigate the modifiable risk factors of great impact in the occurrence of the disease[24,25]. Feigin et al.[8] state the importance of the immediate launch of prevention programs, control of blood pressure, and above all tobacco control interventions, at populational and individual levels, along with improvements in the access to primary health care in low-income countries.

However, a common modifiable factor, the stress, caused by work and the daily life of people and which has a strong relation with hypertension[26] is not the strategical focus of the fight of health services, maybe due to its being a behavioral effect influenced by many determinants such as socioeconomic, educational, and cultural levels, not restricted to the biological one[27], requiring a joint action of multisectoral policies that change the life realities.

In the present study, it was observed that the HIS is similar among men and women, as well as the downward trend. Leite et al.[12] also did not find the disparity between men and

women with sequelae by stroke in a research carried out in Basic Health Units, a fact also highlighted by Heuschmann et al.[21] in London. This contributes to confirm there is no need to develop a strategy directed to the specific subpopulation of men and women regarding the measure of therapeutic adherence and behavioral change.

It is revealed in Brazil a progressive increase of the HIS after 40 years of age. Elderly aged 80 years old or older are almost 20 times more likely to have a stroke than those who are 40 to 49 years old. Heuschmann et al.[14] identified that the incidence of stroke worldwide also increases progressively each decade of life, as well as Liu et al.[15] and Palm et al.[28]. In this situation, differently from the issue raised for gender, it seems important to develop actions with a different focus for the age ranges from the fourth decade of life on as for the treatment, as well as the lifestyle.

When analyzing the Brazilian FU, there was a decrease in the incidence of HIS on most of them, being Goiás, Roraima, and Ceará are the most stable ones. Such fact may be related to the assistencial quality of the Hiperdia, to the low hospital assistance in these FU or even to problems related to the quality of SIH/SUS in these states.

There seems to be no regionalization in the reduction of hospitalizations, considering that we verified a decline in the incidence of HIS practically in all FU and the Hiperdia is a nationwide program. However, for a greater understanding of the characteristics of the program, which have greater impact in the decline of the IS, it is necessary a deeper analysis if the indicators of structure and process of this program, which was not our objective in this study. This, maybe, will potentialize the effects of the program, such as coverage and adhesion, when identifying fragility in its working.

In relation to the findings of the proportion of hospital mortality, there was observed a statistically significant slight decrease, though trivial from the epidemiological point of view. Thus, it is a strong thought that the Hiperdia did not change the profile of hospital mortality by IS. Such scenario may occur, once that the program has the objective of acting in the prevention of the cerebrovascular events and, once occurring the IS, it would need pre- and intra-hospital assistance in time and quality for the resolution or minimization of the damage, such as death. Therefore, the reduction of hospital mortality is more related to the quality of the emergency support to the ones affected by the IS, once that immediate actions of early diagnosis and thrombolytic therapy reduce deaths and the severe sequelae.

On the other hand, overall mortality by stroke reduced, as shown by Garritano et al.[11], who identified a decline in the mortality rate by stroke between 2000 and 2009 in Brazil. Unlike the findings of the present study, overall mortality has a direct influence on the control actions of modifiable risk factors, which is a direct reflex of the reduction of new cases.

Regarding the quality of pre-hospital assistance, Machado et al.[29] highlighted the failure of Emergency Mobile Care Service (*Serviços de Atendimento Móveis de Urgência* – SAMU) in a survey carried out in Brazil. Only 20.5% of the municipalities have this service, also having inappropriate support to the detection of acute IS and a small number of vehicles. It was also observed that all the FU that have more than 80% of the population covered by the SAMU have declined HIS mortality. Luz et al.[30] showed that the coverage of the Family Health Strategy and the presence of a SAMU influenced the mortality by stroke in the FU of Minas Gerais, the first one by prevention of the occurrence and the second one by the

primary attention to new cases. Finally, Kuster et al.[31] verified that the cases of IS admitted in hospitals are from emergency services such as the SAMU with lower time of neuroimaging entry-diagnosis and also higher frequency of thrombolytic therapy.

Another relevant aspect in hospital mortality by IS is the existence of services of the radiological diagnosis. In the case of the IS, the performing of computerized tomography (CT) allows the rapid and acute diagnosis of its existence. Rolim[32] observed the importance of performing a tomography during hospital admission for the diagnosis and reduction of mortality by IS. Rolim and Martins[33] also mentioned that only 22.3% of hospitalizations by stroke in Brazil performed CT scans. Rink and Khanna[34] also considered that the practically stable mortality may be related to inadequacy of hypertensive therapies in controlling, in some situation, the blood pressure and also the lack of hospital measures to reverse the ischemic condition.

In the present study, it was observed an increase in the mortality directly related to the increasing age, in both gender, corroborating the results of Lui et al.[15]. Chen et al.[35] observed that the mortality by stroke among young people has been kept stable in both low- and high-income countries. The stability here observed among individuals between 0 and 14 years of age may be explained by the difficulty of diagnosis of stroke among children[36] and, therefore, the absence of timely clinical decision making to reverse the case. In turn the instability in mortality of elderly aged 80 years old or older, it raises the possibility that these individuals have great vascular fragility and that small cerebrovascular events already produce significant deterioration of the nervous system, which makes the containment strategies little efficient for ongoing cerebrovascular events.

Among all the Brazilian FU, Roraima stands out, which showed stable trends for the proportion of hospital mortality as in the incidence of HIS. It is suggested that the low hospital assistance of these FU may be the source of such stability or even low quality of the SIH/SUS in the state health system. In general, Fernandes et al.[37] verified the non-existence of mortality by stroke among hospitals in Northeast and Southeast Brazil.

Our study analyzed the evolution of IS in Brazil within the last 15 years through the HAA in SUS. As a result, the are some limitations, namely: despite the hospitals accredited by SUS covering around 80% of hospitalizations in the country, there is a considerable portion of the population, which is assisted by health insurance, not entering the statistics of the SIH; the indicators of structure and Hiperdia process were not analyzed, to estimate the influence of such components is more relevant to mitigate the occurrence of IS. However, these limitations do not minimize the plausibility of studies that used the SIH as a data source, as this is a mean to indirectly evaluate the assistencial quality of the services of primary care as well as hospital care, directly[38].

CONCLUSION

There was a sharp decline in the incidence of HIS in Brazil for all age ranges and gender, as well as there is no regionalization in the event of HIS, coinciding with the implementation of Hiperdia from 2002 onward. However, we did not observe a decrease in hospital mortality in the same magnitude, maybe due to its being dependent of measures to improve the system of emergency support.

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