Analysis of the Mortality Trend due to Cerebrovascular Accident in Brazil in the XXI Century

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Abstract

Background: **Although it is the second leading cause of deaths worldwide, the cerebrovascular accident (CVA) has shown a significant reduction in mortality rates in recent decades.**

Objective: **To evaluate the trend of CVA mortality rate in Brazil, in both sexes, older than 30 years old, between 2000 and 2009.**

Methods: **Population data were obtained from the database of the Brazilian Institute of Geography and Statistics (IBGE) and deaths through the Mortality Information System of the Health Surveillance Secretariat of the Ministry of Health, and included codes I60 to I69 according to 10th International Classification of Diseases. We calculated the incidence of deaths/1,000 inhabitants, gross and standardized mortality rates /100,000 inhabitants. The modeling of the trend of rates was performed using regression models.**

Results: **There was an increase in mortality until 2006, followed by a decline until 2009, when the incidence was the lowest. Comparing the years 2000 and 2009, there is a downward trend in standardized mortality rate in both sexes (male = -14.69% and female = -17%) and total (-14.99%), with fluctuations during the period. Between 30 and 49 years in both sexes, there was a trend of continuous and linear decrease in mortality rate, while the other age groups showed a curvilinear function, leading to an effective decrease in values.**

Conclusion: **There was a downward trend in mortality in all age groups and both sexes. The reduction in gross mortality rate was more pronounced in males, while the standardized mortality rate showed a greater reduction in females. (Arq Bras Cardiol 2012;98(6):519-527)**

Keywords: **Stroke/mortality; epidemiology; Brazil.**

Introduction

The number of individuals aged > 60 years has significantly increased in recent decades in the world, with projections indicating that by 2050 this group will have approximately 1,900 million people[1]. In Brazil, this segment of the population grew by 33.65% over the period 2000 to 2009[2], and with it, the chronic noncommunicable diseases (NCDs) have become predominant[3,4], especially cardiovascular disease (CVD), which became the leading cause of death in both sexes in Brazil[5,6]. Within the CVD group, cerebrovascular accident (CVA) has become a major cause of death and disability and is considered the second leading cause of death in world[7-10]. Among all Latin American countries, Brazil is the one with the highest rates of CVA mortality and the main cause of death among women[11]. Even though there has been a decrease in mortality in recent decades, these rates remain very high[7,8,12-15].

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The aim of this study is to analyze the trend of CVA mortality rates in Brazil (BR) between 2000 and 2009 in both sexes and in different age ranges.

Methods

Data collection

Population data were obtained from the 2000 census and intercensal projections from 2001 to 2009 of the population living in Brazil, carried out by the Brazilian Institute of Geography and Statistics (IBGE)[16], and stratified by sex and age range at ten-year intervals, starting at 30 to 39 years to 80 years or older.

The causes of death were selected according to the International Classification of Diseases (ICD 10) and codes I60 to I69 were included. The number of deaths was obtained through the Mortality Information System (SIM) of the Health Surveillance Secretariat of the Ministry of Health (Datasus)[17].

The incidence of deaths was calculated in relation to gender and in total/1,000 inhabitants. The gross mortality rate was calculated according to gender and age range, having as reference the estimated population for each age group and sex in the corresponding year[16]. To calculate the adjusted mortality, the direct method was used, having as the standard population

the one described by the World Health Organization (WHO) in 2000[18]. All calculations were performed with annual data between 2000 and 2009.

Statistical Methods

For all estimated epidemiological measures, data concerning the incidence of deaths were plotted and the scatter plot showed that a linear or quadratic function should be adjusted. The coefficient of determination (R^2) and the maximum point were determined in each quadratic function, and the years 2000 to 2009 were replaced by 0-9, respectively. The level of significance was set at 5% of probability ($\alpha = 0.05$).

The graphical presentation of the trend of gross and standardized mortality rates by CVA/100,000 inhabitants was determined by scatter plot.

Statistical analysis was performed using the software Statistical Package for Social Sciences V13.0 (SPSS Inc. Chicago, Illinois, USA) and StatDisk V 8.4 (Addison Wesley Longman Inc).

Results

Table 1 (a, b, c) shows the number of deaths from CVA, the population and the incidence of deaths per 1,000 inhabitants in Brazil in the years 2000 to 2009, regarding gender and total numbers.

The tables show an increased incidence of deaths up to a certain year, followed by a decline until 2009, when it reaches the minimum value, suggesting the adjustment of data as a second-degree function, which provided that the functions shown in table 2.

The analysis of Table 2 shows that, statistically ($p < 0.05$), the data indicate a quadratic function, where the peak incidence of deaths of the male and female sex is close to that of the year 2003, as well as in both sexes.

Considering the absolute number of total deaths, there is a predominance of males (50.61%) over females (49.39%), but when comparing the years 2009 and 2000 there is a greater increase in the number of deaths among women (19.11 +%) when compared to men (+14.92%). Associating age and gender, the number of deaths among women showed a continuous rise with increasing age, whereas among men, the number of deaths in the group aged > 80 years was lower than that in the group aged 70-79 years.

The Gross mortality rate from CVA/100,000 inhabitants, comparing 2009 with 2000, showed a decline of 7.34%, with a greater reduction in males (-8.46%) than in females (- 6.13%). However, fluctuations occurred throughout the period, with the year 2006 showing the highest rates, especially in males. When analyzed by age, it is observed that these oscillations were more pronounced in the group aged > 70 years or older, being more marked in males and that the decrease was continuous only in the range of 30-39 years among men and 30 - 49 and 60-69 years among women (data not shown). Chart 1 shows the curve of the regression trend of the gross mortality rate from CVA /100,000 inhabitants from 2000 to 2009 in both sexes and in total.

The standardized mortality rate from stroke also showed a decrease when comparing the year 2009 with 2000, being in total -14.99%, -14.69% for the male sex and -17% for the female sex (Table 3) .

Table 1 – Incidence of deaths by CVA/1,000 inhabitants from 2000 to 2009

1a – In both sexes

Year	Population	Deaths	Incidence
2000	71.602.053	83.402	1.16
2001	72.648.950	85.180	1.17
2002	73.566.264	86.112	1.17
2003	74.477.701	87.842	1.18
2004	75.384.475	89.860	1.19
2005	77.446.810	88.898	1.15
2006	78.497.290	95.339	1.21
2007	86.610.023	95.629	1.10
2008	88.114.872	97.814	1.11
2009	90.390.875	97.557	1.08

1b – Male sex

Year	Population	Deaths	Incidence
2000	34.187.421	42.569	1.25
2001	34.691.239	43.673	1.26
2002	35.131.298	43.780	1.25
2003	35.569.204	44.934	1.26
2004	36.004.920	45.636	1.27
2005	36.996.001	44.577	1.20
2006	37.500.676	47.864	1.28
2007	41.148.050	48.124	1.17
2008	41.847.966	49.249	1.18
2009	42.918.691	48.921	1.14

1c – Female sex

Year	Population	Deaths	Incidence
2000	37.414.632	40.833	1.09
2001	37.957.711	41.507	1.09
2002	38.434.966	42.332	1.10
2003	38.908.497	42.908	1.10
2004	39.379.555	44.224	1.12
2005	40.450.809	44.321	1.10
2006	40.996.614	47.475	1.16
2007	45.461.973	47.505	1.04
2008	46.266.906	48.565	1.05
2009	47.472.184	48.636	1.02

Data analysis of mortality rates between 2000 and 2009 in both sexes and in total showed a fluctuation of values, suggesting again the adjustment of data to a second degree function, shown in Table 4.

Original Article

Table 2 – Quadratic functions related to the adjustment of incidence of death/1,000 inhabitants in relation to years 2000 to 2009, considering the genders and the total

Gender	Model	Coefficient of determination	p	Maximum point
Male	$Y_i=1.2273 + 0.0192\ x_i - 0.0028\ x_i^2$	0.74	0.009	3.42
Female	$Y_i=1.0799 + 0.0216\ x_i - 0.0031\ x_i^2$	0.61	0.038	3.48
Both	$Y_i=1.1581 + 0.0179\ x_i - 0.0030\ x_i^2$	0.64	0.018	2.98

x = year.

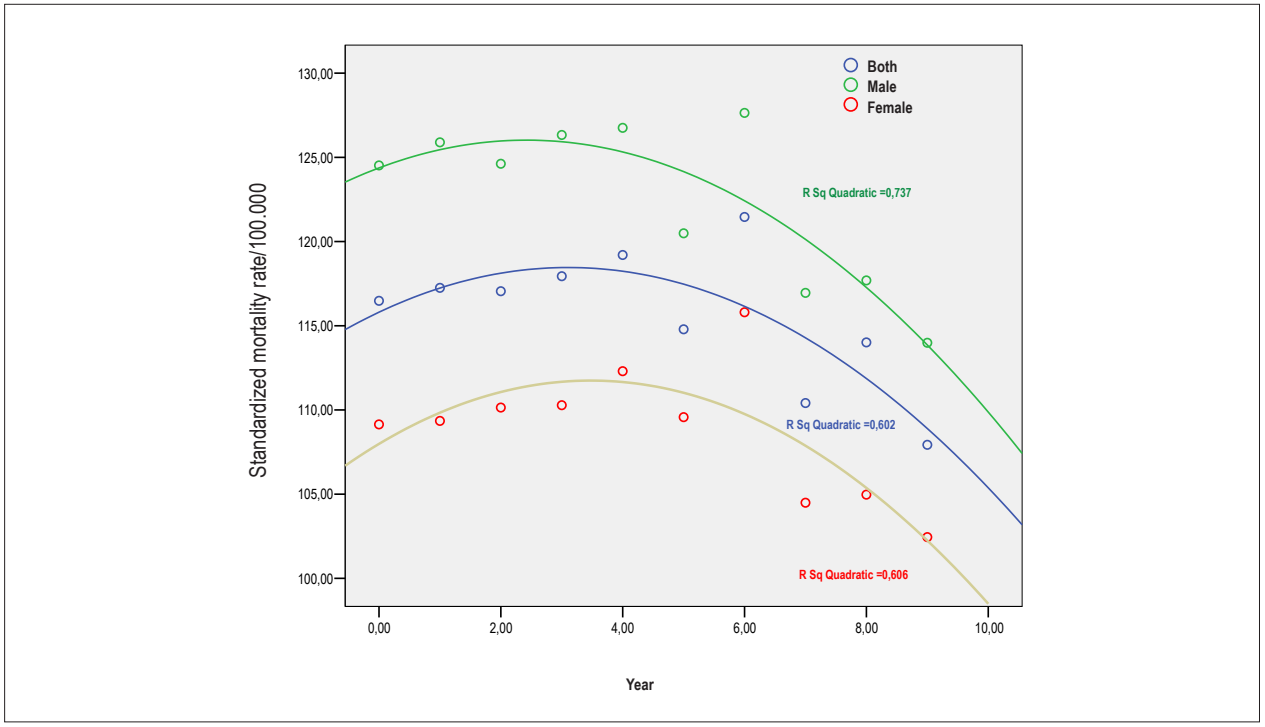

Chart 1 – *Curve of the regression trend of the gross mortality rate/100,000, between 2000 and 2009, according to gender.*

Table 3 – Rate of mortality standardized by CVA /100,000 inhabitants, according to gender, from 2000 ato 2009

	Male	Female	Both
2000	155.54	119.33	135.88
2001	157.96	119.78	137.13
2002	157.24	120.83	137.35
2003	159.69	121.08	138.57
2004	160.8	123.55	140.38
2005	153.8	120.8	135.83
2006	164.05	127.96	144.26
2007	139.13	106.52	121.11
2008	138	105.33	119.97
2009	132.69	99.04	115.51
V%	-14.69%	-17.00%	-14.99%

By analyzing Table 4 it can be stated statistically ($p < 0.05$) than the data indicate a quadratic function where the peak incidence of the standardized mortality among men occurred around the year 2002, while among women and in both sexes, it happened in 2003.

Chart 2 shows the curve of the regression trend of the standardized mortality rate from CVA/100,000 inhabitants in both sexes, according to gender in the studied period.

Considering age range and gender, and comparing the year 2009 with 2000, the standardized mortality rate for women showed a greater decline in the age groups of 30-39 years (-33.92%), 70-79 (-13.71 %) and > 80 years (-8.95%) compared to men, who showed respectively -33.10% -10.04% and -0.85%. In other groups there was a slight predominance of decrease in the mortality rate in the male sex (40-49 years = -32.38%, 50-59 years = -29.70%, 60-69 = -21.54%) compared to females (respectively -32.06% -26.77% and -21.51%).

Except for he age groups 30-39 years and 40-49 years, the other age groups showed a fluctuation in the standardized mortality rates, also suggesting the adjustment of data to a second degree function (Table 5).

Chart 3 shows the curve of the regression trend for both sexes according to age range. It can be observed that between 30 and 49 years there was a continuous and linear downward trend of the standardized mortality rate /100,000 in the evaluated period, contrary to the other groups, which showed variations during the study period, but culminating in an effective decrease of the values from the maximum point.

Discussion

CVA is a leading cause of death and disability worldwide, and it has been reported as the cause of approximately 5.7 million deaths in 2005, of which 87% occurred in middle and

Table 4 – Quadratic functions related to the adjustment of the standardized mortality rate/100,000, from 2000 to 2009, considering the genders and the total

Gender	Model	Coefficient of determination (R^2)	p	Maximum point
Male	$Y_i=154.309 + 4.373\ x_i - 0.775\ x_i^2$	0.78	0.004*	2.82
Female	$Y_i=111.717 + 5.931\ x_i - 0.725\ x_i^2$	0.79	0.004*	4.09
Both	$Y_i=129.233 + 5.630\ x_i - 0.717\ x_i^2$	0.79	0.005*	3.92

x = year.

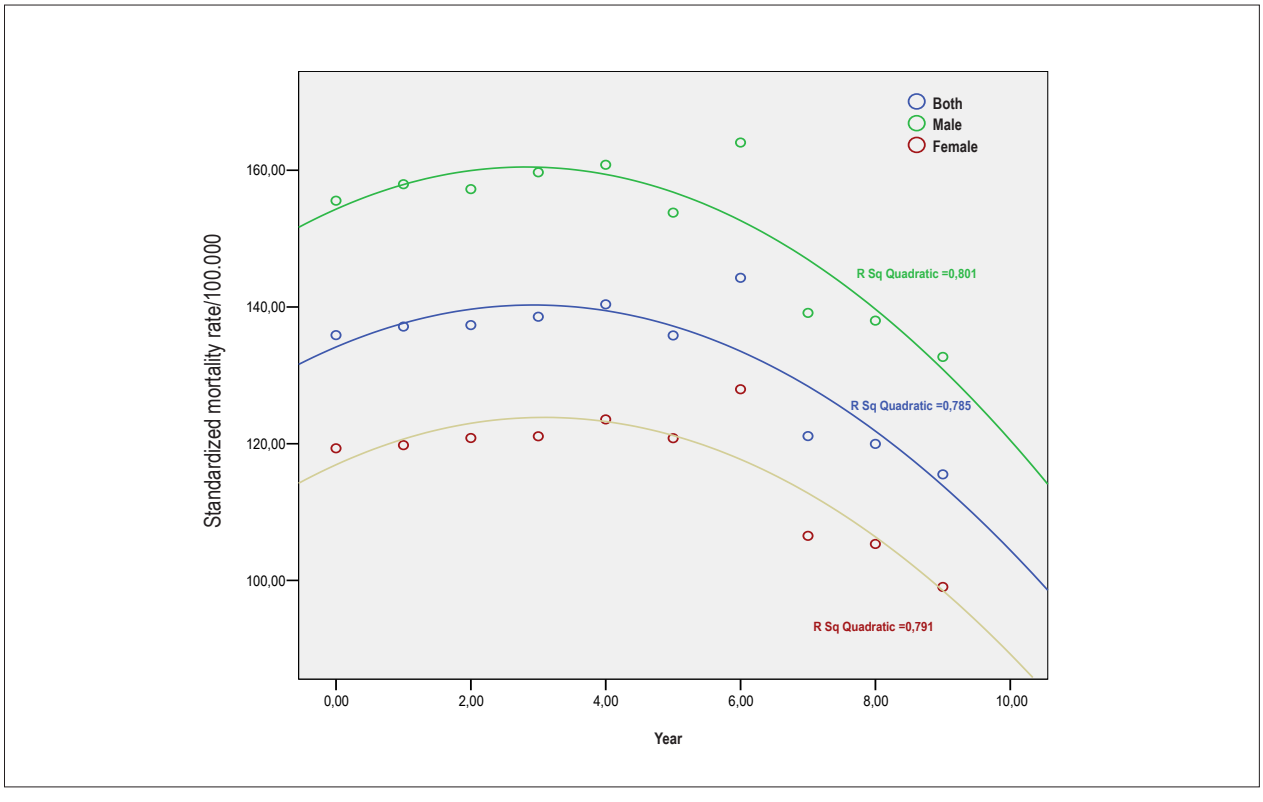

Chart 2 – *Curve of the regression trend of the mortality rate standardized by CVA/100,000, according to gender (2000-09).*

Table 5 – Linear and quadratic functions related to adjustment of standardized mortality rate/100,000 in relation to years 2000 to 2009, considering genders and age ranges

Gender	Age range	Model	Coefficient of determination (R^2)	p	Maximum point
Male	30-39 years	$Y_i=2.859 - 0.103\ x_i$	0.96	0.000	
	40-49 years	$Y_i=9.719 - 0.361\ x_i$	0.91	0.000	
	50-59 years	$Y_i=20.941 + 0.257\ x_i - 0.089\ x_i^2$	0.92	0.000	1.44
	60-69 years	$Y_i=34.906 + 0.213\ x_i - 0.096\ x_i^2$	0.93	0.000	1.10
	70-79 years	$Y_i=45.098 + 1.544\ x_i - 0.194\ x_i^2$	0.78	0.005	3.97
	> 80 years	$Y_i=35.502 + 4.213\ x_i - 0.383\ x_i^2$	0.61	0.003	5.5
Female	30-39 years	$Y_i=2.797 - 0.111\ x_i$	0.96	0.000	
	40-49 years	$Y_i=8.841 - 0.305\ x_i$	0.91	0.000	
	50-59 years	$Y_i=13.989 + 0.429\ x_i - 0.079\ x_i^2$	0.86	0.001	2.71
	60-69 years	$Y_i=21.785 + 0.208x_i - 0.066\ x_i^2$	0.94	0.000	1.57
	70-79 years	$Y_i=30.857 + 1.647\ x_i - 0.193\ x_i^2$	0.74	0.009	4.26
	> 80 years	$Y_i=33.494 + 3.833\ x_i - 0.366\ x_i^2$	0.61	0.036	5.23
Both sexes	30-39 years	$Y_i=2.827 - 0.107\ x_i$	0.98	0.000	
	40-49 years	$Y_i=9.267 - 0.332\ x_i$	0.92	0.000	
	50-59 years	$Y_i=17.339 + 0.341\ x_i - 0.083\ x_i^2$	0.90	0.000	2.05
	60-69 years	$Y_i=27.864 + 0.214x_i - 0.080\ x_i^2$	0.94	0.000	4.33
	70-79 years	$Y_i=37.156 + 1.624\ x_i - 0.197\ x_i^2$	0.77	0.006	4.12
	> 80 years	$Y_i=34,746 + 3,691\ x_i - 0,338\ x_i^2$	0.56	0.005	5.46

x = year.

low-income countries[19]. This study shows a significant increase in deaths from CVA when comparing the year 2009 with 2000, especially in females, although the absolute numbers of deaths among men was higher than among women. Lotufo[12] reported a high rate of mortality from CVA in Brazil in the late 1980s, even higher than those found in developed countries. The author also reports that, considering all causes of death in Brazil, CVA has become the main one, bypassing coronary heart disease. This study, when comparing the year 2009 and 2000 and taking into account all causes of death, shows that CVA was responsible for 10.70% of the deaths in 2000 and 10.18% in 2009. Women had higher values in 2000 (F = 12.07%, M = 9.65%) and 2009 (F = 11.38%, M = 9.21%) (data not shown), data similar to those reported by the Pan American Health Organization (Opas)[20].

The reduction in CVA mortality began in the mid-1960s and was stabilized at the end of the twentieth century[21-24]. This decline was more pronounced in the United States, Canada, Australia, the Western Europe countries and Japan[23-26], whereas the rates are higher in South America and Eastern Europe and still increasing in Eastern Europe countries[23-27]. Brazil is included in the context of decrease in the rates of CVA mortality with values that are similar to those of developing countries[11,12,28], showing the highest rates when compared to countries in Latin America[12] and South America[29].

In this study, we observed that this trend of reduction in CVA mortality in the twentieth century continued into the first decade of this century. The gross mortality rate showed a slight decrease, which was more evident in males, similar to that found by Smith et al[30], while the standardized mortality rate showed a greater reduction, especially among women, corroborating the results of other studies[6,28,30-32].

This decline in CVA mortality is well observed when comparing 2009 with 2000, as the values of these rates varied during this period. We observe that the year 2006 showed the highest values of the incidence of deaths and mortality rates. In fact, when comparing the years 2006 and 2005, we observe that the increase in the number of deaths was much higher (men = 7.12%, females = 7.37%, both = 7.25%) than the increase in population growth during the same period (men = 1.36%, females = 1.35%, both = 1.36%), which did not happen in other years.

Even as the present study confirmed this trend of decrease in CVA mortality in Brazil, the numbers remain high, being higher than those of developed countries and of countries in South America, being considered the four-highest rate among all Latin American countries, which was also reported in other studies[8,20,32].

The reasons to explain the reduction in CVA mortality are closely related to the incidence and mortality of the disease. The incidence is related to risk factors such as hypertension, diabetes, obesity, smoking, human development index (HDI), among others, while the mortality rate evaluates the effectiveness of the treatment. The control of risk factors, the primary and

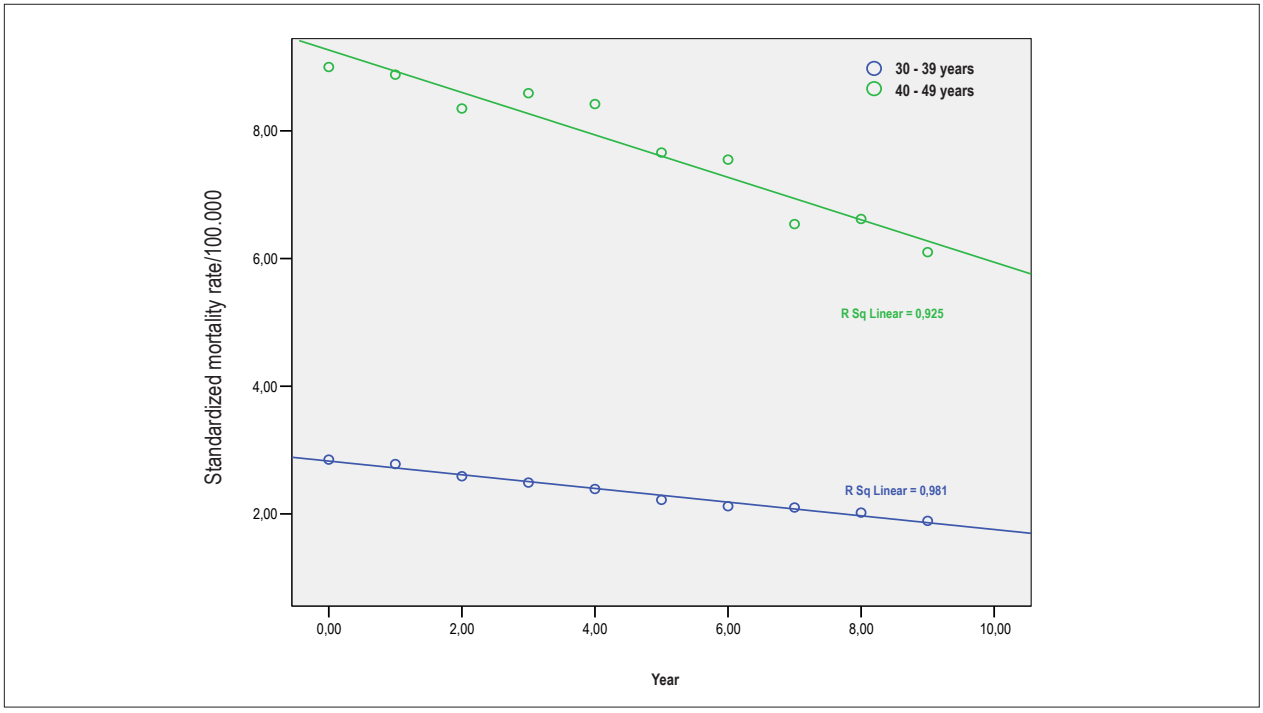

Chart 3a – *Regression trend of the mortality rate standardized by CVA/100,000, both sexes (2000-09): Trend line of regression of the mortality rate standardized by CVA/100,000, both sexes, from 30 - 49 years (2000-09).*

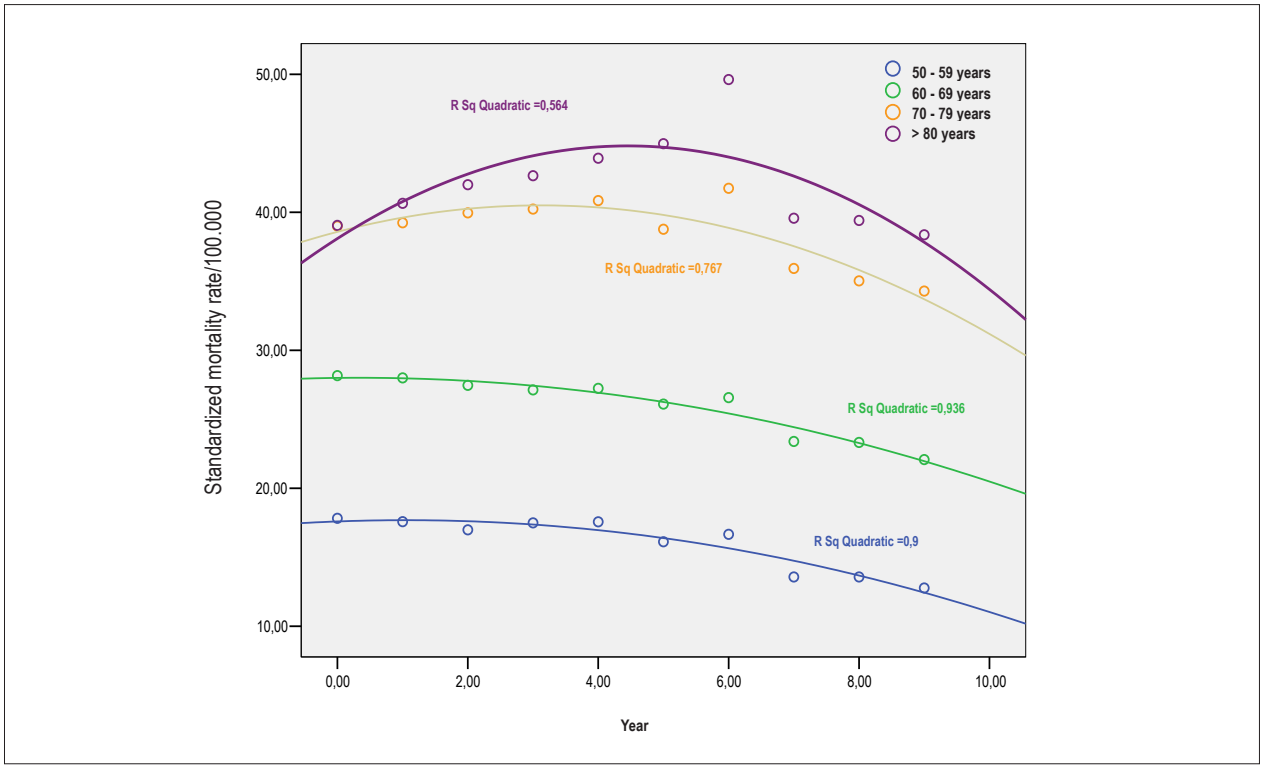

Chart 3b – *Regression trend of the mortality rate standardized by CVA/100,000, both sexes (2000-09): Curve of the regression trend of the mortality rate standardized by CVA/100,000, both sexes, from 50 - > 80 years (2000-09).*

secondary prevention of circulatory diseases and improving the socioeconomic conditions of the population may lead to a decrease in mortality. In addition, the high-tech procedures (angioplasty), a larger number of equipment in hospitals for more accurate diagnosis (CT, MRI) and faster care also help to reduce mortality. However, due to its dimensions, Brazil shows great regional inequality, and healthcare resources are scarce; thus the population of some areas might not be treated with these procedures.

One should also reflect on the death and population data, which may not always correspond to reality. There is no doubt that population studies show results closer to reality than those based on secondary data. However, it should be noted that the secondary data are official and originate from the Ministry of Health, and even though they might contain flaws, they are used for the creation of public policies, and thus should be considered. It is possible that the underreporting or deaths due to ill-defined causes are most often observed among the elderly, especially due to the coexistence of multiple chronic diseases.

According to Jorge et al[4], there was a significant decrease in the proportion of deaths due to ill-defined causes between 1996 and 2005; however, values higher than 20% were recorded in the North and Northeast Brazil. Using the Datasus[17] database, we extended this evaluation to 2009 and observed that the North remains with a high percentage (15%), while other regions have values below 10%, although they are still considered significant. We agree with Jorge et al[4] about the inappropriate use of terms such as "cardiac arrest", "multiple organ failure", "cachexia" and others, when filling out death certificates, often in cases with diagnosis that have been already defined, which compromise a more specific evaluation of the causes of deaths.

Thus, it becomes necessary to raise awareness among health professionals for the correct filling out of forms, certificates or other documents, which are important in the development of scientific research and implementation of government programs designed to improve the quality of life of the population.

Conclusion

The results of this study show that there was a downward trend in mortality due to CVA when comparing the years 2009 and 2000 and that between 30 and 49 years of age this reduction was linear, while in the others there were fluctuations during the period, culminating in a decrease from a certain point.

The findings showed that the reduction in CVA mortality during the study period was more pronounced in females.

CVA is a public health problem that could worsen if there is no continuity in the improvement of socioeconomic conditions, education, quality of hospital care, primary and secondary control of risk factors.

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Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

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