

Serial Temporal Analysis of Ischemic Heart Disease and Stroke Death Risk in 5 Regions of Brazil from 1981 to 2001

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Objective: The aim of this study was to evaluate the trends of ischemic and cerebrovascular death risk in the five regions - Midwest, Northeast, North, Southeast and South - of Brazil from 1981 to 2001.

Methods: Data on mortality due to cerebrovascular and coronary heart diseases in the five regions of Brazil were obtained from the Brazilian Ministry of Health. The data source was the SIM - Sistema de Informações sobre Mortalidade (System of Information on Mortality), from the Department of Health Information Analysis. The population estimates were obtained from the IBGE (Brazilian Institute of Geography and Statistics) census of 1991 and 2000, and population estimates of 1996, all from DATASUS. The codes used in this study were International Classification Disease ICD-9 430-438 and ICD-10 I60-I69 for cerebrovascular diseases and ICD-9 410-414 and ICD-10 I21-I25 for ischemic disease. Statistical analysis was carried out by adjusted linear models.

Results: There was a decline trend in death rates due to cerebrovascular disease at all age ranges and in both sexes in the South, Southwest, and Midwest regions. Additionally, death rates due to ischemic heart disease declined in the South and Southwest regions. There was a stabilization of the death risk in the Midwest and an increase in the Northeast region.

Conclusion: The risk of death due to cerebrovascular and ischemic heart diseases declined in the Southwest and South, which are the more developed regions of Brazil, whereas the risk increased in the less developed ones, mainly in the Northeast region.

Key words: Cardiovascular disease, ischemic heart disease, stroke, mortality, epidemiology, Brazil.

Mortality trends in Brazil have changed throughout the last decades^{1,2}. In 1980, the circulatory diseases were the main cause of death, which persisted in the year 2000. Neoplasias were the fifth cause of death in 1980, and became the third cause in the year 2000. Another important change was the increase of deaths due to respiratory system diseases and the decrease in infectious and parasitic diseases. The temporal series analysis aims at evaluating the mortality trend in each region of Brazil along the last twenty years, comparing the regions regarding death risk trend by the analyzed causes and estimating the annual risk variation for each region, gender and age range analyzed.

Methods

A temporal series analysis of mortality due to ischemic heart disease and cerebrovascular disease was carried out in a twenty-year series, according to gender, age range and regions of Brazil. The data source was the System of Information on Mortality (SIM) of the Department of Health Information Analysis – Health Surveillance Secretary of the Ministry of Health. The data source on the population of the

regions and states was the Brazilian Institute of Geography and Statistics (IBGE), census of 1991 and 2000, population calculation of 1996 and population estimates, all made available by DATASUS. SIM data referred to the following causes of death: cerebrovascular disease (International Classification of Diseases ICD-9 430-438, ICD-10 I60-I69) and ischemic heart disease (ICD-9 410-414, ICD-10 I21-I25).

Statistical analysis - In order to assess the mortality trend in each region of Brazil, descriptive and inferential analyses were performed. For the description of temporal trends, the data were graphically represented by a simple scatter plot and a smoother line with the Lowess technique (SPSS-10). For the inferential analysis, generalized linear models were adjusted^{3,4}. The response variable was the number of deaths or mortality coefficient. We took into account that the mortality trends might not be similar in both sexes and among the several age ranges and regions. Thus, the explicative variables of mortality were time (in years), gender (male or female), age range (30-49, 50-64 and ≥ 65 yrs), and regions of Brazil (North, Northeast, Middle East, Southeast and South).

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For each combination of gender, age range and region, we modeled the mortality trend along time. The class of generalized linear models comprises the models of conventional multiple linear regression, as well as the Poisson regression models, negative binomial models and logistics, among others. Of these, the best known and easier to interpret is the conventional multiple linear regression. However, when the response variable is a calculation (as is the case with the number of deaths) the assumptions of this model about normality and the homocedasticity of the residues are not, in general, fulfilled. To overcome this problem, transformations can be used for the response variable (such as the logarithm or the square root), or models can be adjusted, in which the distribution of the response variable is Poisson or negative binomial. Another possibility is to use an estimation method of quasi-similarity. The conclusion about the most adequate model can be achieved only after a careful analysis of the residues.

Hence, the analysis strategy for the mortality variable involved the following steps:

1) We initially adjusted six models:

- Gaussian regression, in which the response variable was the coefficient of mortality.
- Gaussian regression, in which the response variable was the logarithm of the coefficient of mortality.
- Gaussian regression, in which the response variable was the square root of the coefficient of mortality.
- Poisson regression, in which the response variable was the number of deaths, controlled for the number of inhabitants in the population.
- Negative binomial regression, in which the response variable was the number of deaths, controlled for the number of inhabitants in the population.
- A quasi-similarity model, in which the response variable was the number of deaths, controlled for the number of inhabitants in the population, using a quasi-similarity method of estimation.

2) Subsequently, we performed an analysis of residues for each model through an envelope graph, in order to determine the "most appropriate" model.

3) We then tested the hypotheses of interest (whether the coefficients of mortality were similar for each region, gender or age range).

4) We then grouped the data in situations when the coefficients were similar, achieving the final model.

5) From the final model, we calculated the adjusted values against the model for the coefficient of mortality for each year, gender, region and age range.

6) Based on the information in the previous item, we constructed tables and charts.

It is worth mentioning that the interpretation of the coefficients was similar for the chosen models. For instance, consider that the coefficient of each explicative variable is represented by $bvar$. For the time variable, it can be said that each passing year, the coefficient of mortality is multiplied by $\exp(btime)$. For the gender variable, it can be said that the

coefficient of mortality in the male sex is equal to $\exp(bgender)$ times that of the female sex. For the region variable, it can be said that the coefficient of mortality in the northeast region is equal to $\exp(bnortheast)$ times that of the North region; the coefficient of mortality in the Midwest region is $\exp(bmidwest)$ times that of the North region and so forth. From the $\exp(btime)$, the annual percentage variations can be obtained. To make the interpretation easier, the tables contain three basic information types: the adjusted value for the coefficient of mortality in the first year, its percentage variation for each year and the adjusted value for the coefficient of mortality in the last year.

Results

Mortality due to circulatory diseases - The analysis of mortality data of 2001 showed that the main causes of death in all regions of Brazil and for both sexes were the circulatory system diseases. From 45 years of age on, circulatory system diseases were the main cause of death, followed by neoplasias and external causes. When the cause of death groups were disassembled into main component units, it was observed that cerebrovascular disease was the main cause of death, with 86,424 occurrences in 2001, followed by ischemic heart disease with 79,375 and other cardiac diseases with 58,745.

Trend of death risk due to cerebrovascular disease - The trend of death risk due to cerebrovascular disease showed a decline in most regions, for both sexes and all age ranges (Figs. 1 to 3; Table 1). The northeast region showed stabilization in the risk at the youngest age range for men and women and increase in the risk for the older age ranges.

The decline in the South region was similar to that of the Southeast region, with exception of the age range 65 yrs and older, when it was at least two-fold lower. The risk in the South region in this age range was higher than the one in the Southeast region in 2001 (Fig. 3 Table 1). It is important to stress that the death risk among women was lower than that among men at the younger age ranges. Among the oldest ranges (≥ 65 yrs) the death risks are very close (Table 1), probably reflecting the higher longevity of women, resulting in an accumulation of elderly females, giving the impression of similar risks for men and women at this age range.

Trend of death risk due to ischemic heart disease - For the women, the coefficient of mortality due to ischemic heart disease remained stable in the North and Midwest regions. It decreased in the Southeast and South regions, and increased in the Northeast region for all age ranges. The annual variation was higher than 2% per year in the Northeast region, and the decline of death risk in the South region was always lower than that of the Southeast region (Figs. 4 to 6; Table 2). For men, a decline trend was observed in the Southeast and South regions. The Midwest region showed stabilization in the mortality trend at the 30-49 yr and ≥ 65 yrs age ranges. The 50-64 yr age range showed an increase in the death risk. It is worth mentioning that the death risk among women was lower than among men at the 30-64 yr age range and at the ≥ 65 yr age range, the

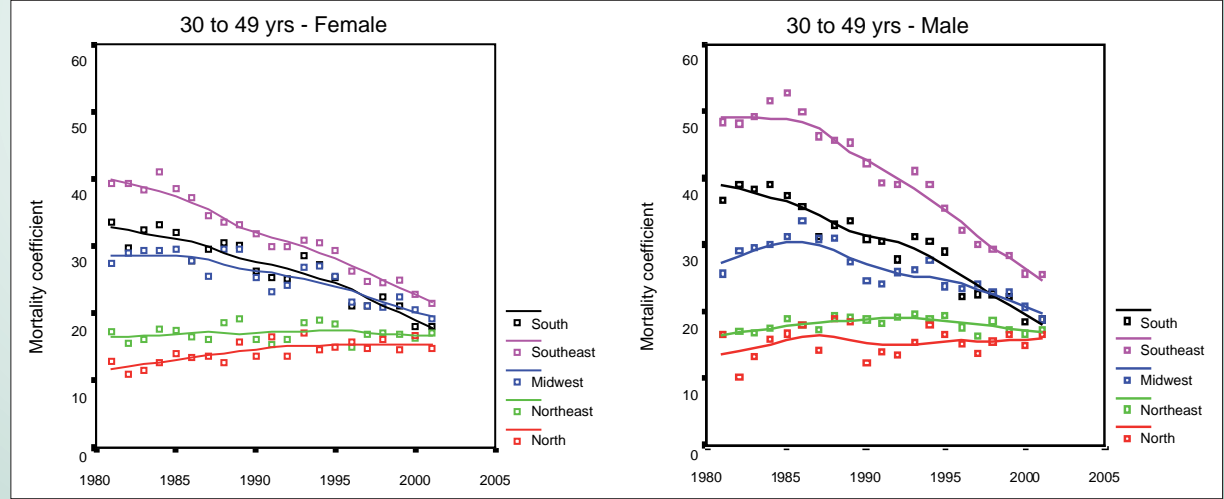


Fig. 1 - Mortality trend due to cerebrovascular disease, age range 30-49 yrs, distributed according to the regions of Brazil, 1981-2001.

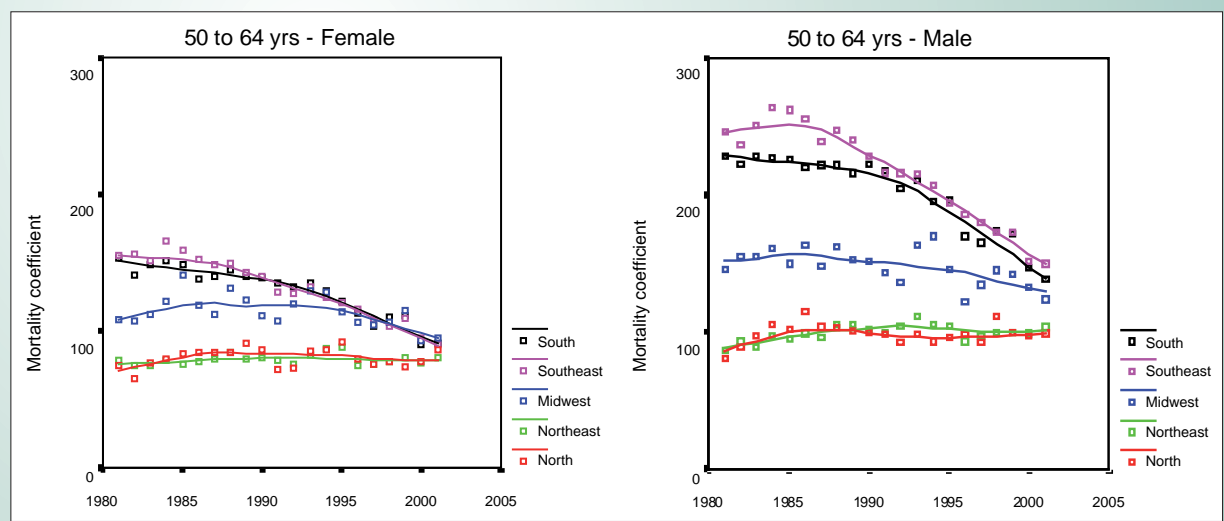


Fig. 2 - Mortality trend due to cerebrovascular disease, age range 50-64 yrs, distributed according to the regions of Brazil, 1981-2001.

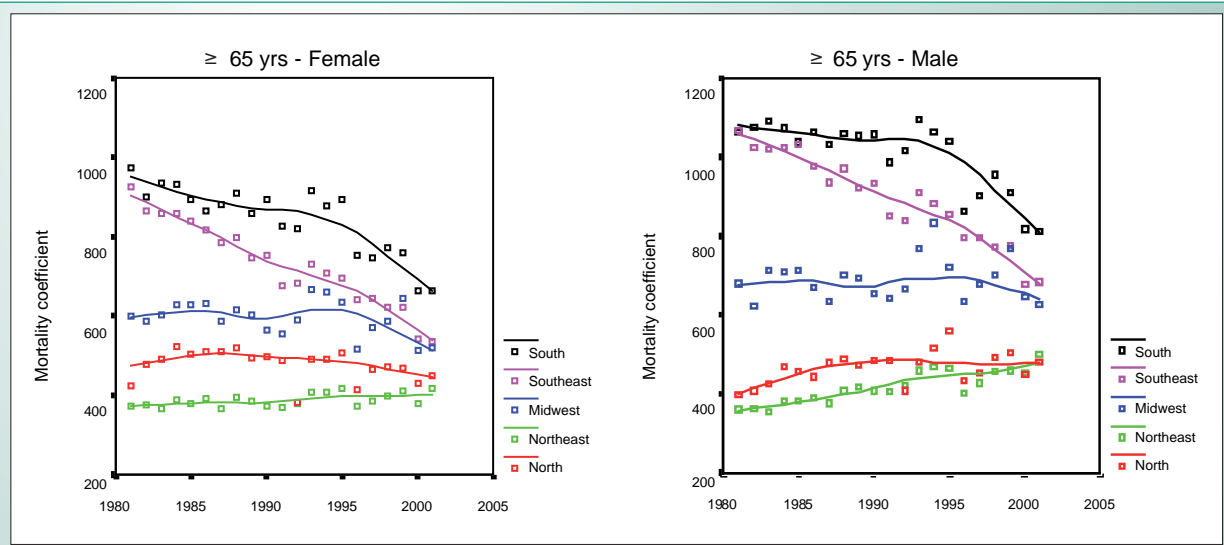


Fig. 3 - Mortality trend due to cerebrovascular disease, age range > 65 years, distributed according to the regions of Brazil, 1981-2001.

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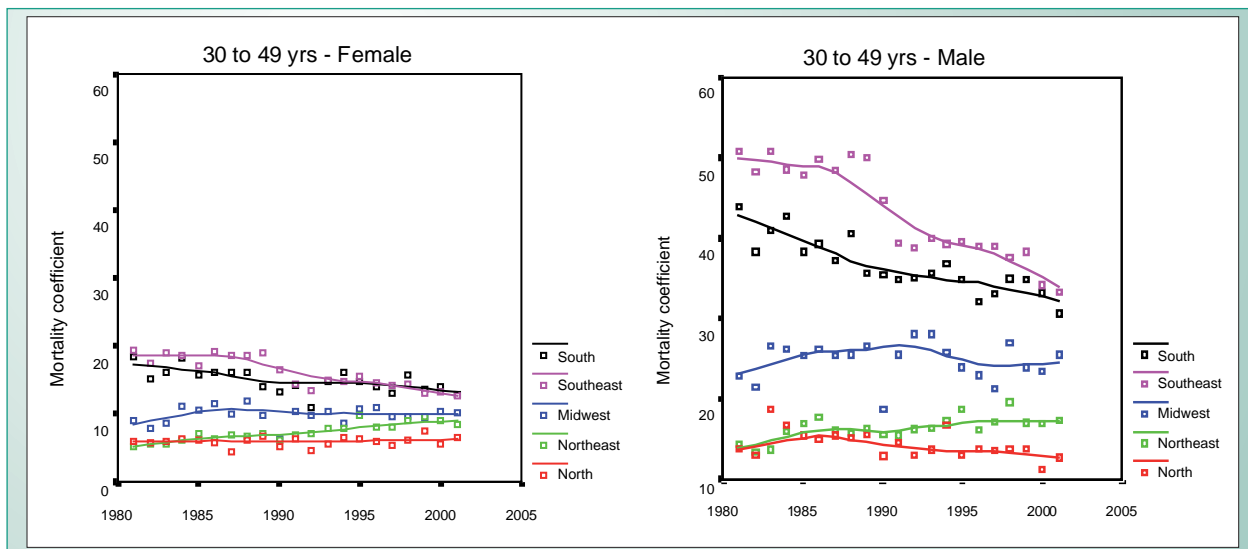


Fig. 4 - Mortality trend due to ischemic heart disease, age range 30-49 yrs, distributed according to the regions of Brazil, 1981-2001.

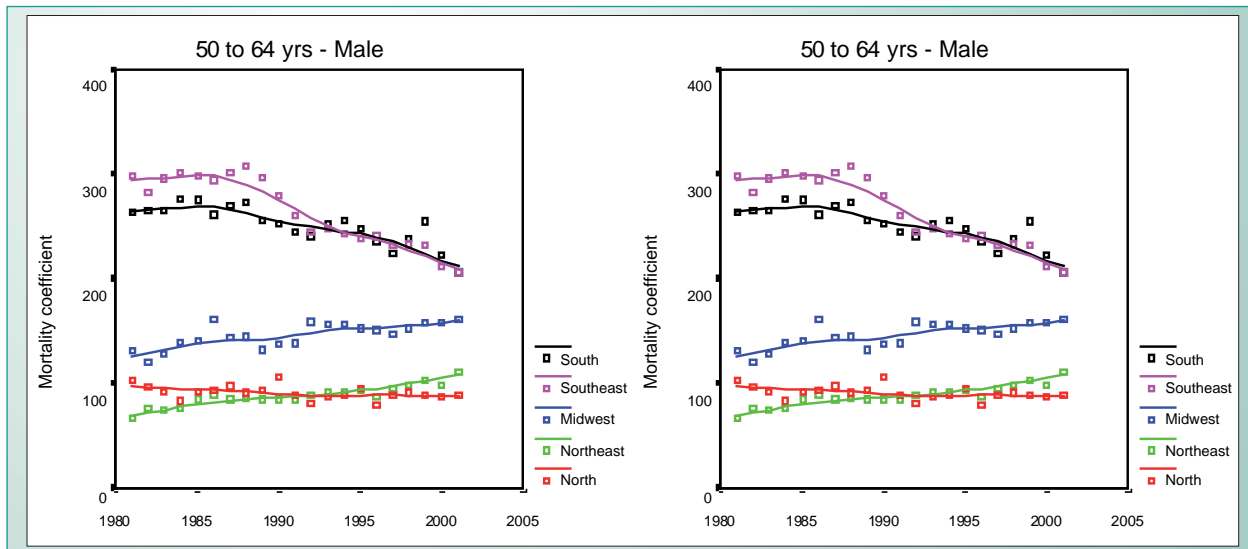


Fig. 5 - Mortality trend due to ischemic heart disease, age range 50-64 yrs, distributed according to the regions of Brazil, 1981-2001.

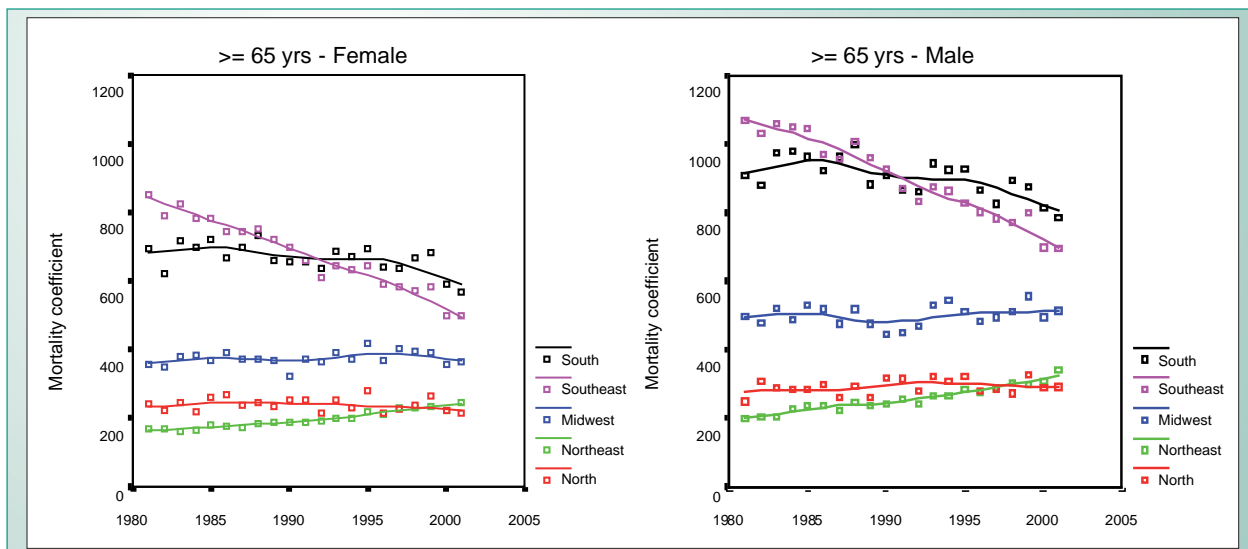


Fig. 6 - Mortality trend due to ischemic heart disease, age range ≥ 65 yrs, distributed according to the regions of Brazil, 1981-2001.

Sex	Age range	Region	Coef* 1981	Annual variation	Coef*2001
Female	30 to 49	North	12.7	1.2	16.2
		Northeast	17.0	0.0	17.0
		Midwest	31.0	-2.0	20.7
		South-east	43.1	-3.3	22.2
		South	36.3	-3.3	18.7
	50 to 64	North	80.9	0.0	80.9
		Northwest	79.3	0.0	79.3
		Midwest	125.6	-0.9	104.3
		South-east	169.5	-2.6	101.0
		South	166.2	-2.6	99.0
	≥65	North	504.2	-0.5	452.5
		Northwest	373.5	0.4	401.9
		Midwest	628.2	-0.5	563.8
		South-east	918.7	-2.4	568.9
		South	975.5	-1.5	717.6
Male	30 to 49	North	15.5	0.0	15.5
		Northwest	18.0	0.0	18.0
		Midwest	32.2	-2.0	21.5
		South-east	54.8	-3.3	28.2
		South	41.0	-3.3	21.1
	50 to 64	North	98.8	0.0	98.8
		Northwest	94.9	0.4	103.1
		Midwest	161.8	-0.9	134.2
		South-east	275.8	-2.6	164.4
		South	257.6	-2.6	153.5
	≥65	North	441.9	0.5	488.8
		Northwest	360.3	1.4	478.0
		Midwest	687.5	0.0	687.5
		South-east	1087.7	-2.1	718.7
		South	1133.7	-1.3	879.6

*Coefficient por 100 mil

Table 1 - Death risk due to cerebrovascular disease according to sex, age range and regions of Brazil

Sex	Age range	Region	Coef* 1981	Annual variation	Coef*2001
Female	30 to 49	North	5.9	0.0	5.9
		Northeast	5.6	2.6	9.4
		Midwest	9.9	0.0	9.9
		South-east	19.7	-2.1	12.9
		South	16.7	-1.1	13.3
	50 to 64	North	42.6	0.0	42.6
		Northwest	31.3	3.2	58.4
		Midwest	70.3	0.0	70.3
		South-east	129.4	-1.7	91.8
		South	117.1	-0.5	106.9
	≥65	North	238.2	0.0	238.2
		Northwest	158.1	2.1	237.6
		Midwest	373.5	0.0	373.5
		South-east	856.6	-2.4	522.4
		South	708.3	-0.6	622.5
Male	30 to 49	North	16.0	-1.1	12.8
		Northwest	14.9	0.9	18.0
		Midwest	24.9	0.0	24.9
		South-east	52.6	-2.1	34.6
		South	41.4	-1.3	31.9
	50 to 64	North	90.3	0.0	90.3
		Northwest	73.2	1.7	103.3
		Midwest	132.0	0.9	159.3
		South-east	318.3	-1.9	215.7
		South	276.7	-1.0	225.1
	≥65	North	293.8	0.0	293.8
		Northwest	201.6	2.3	320.3
		Midwest	501.0	0.0	501.0
		South-east	1104.2	-2.1	720.7
		South	969.5	-0.7	837.0

*Coefficient por 100 mil

Table 2 - Death risk due to ischemic heart disease according to sex, age range and regions of Brazil

risk rates were very close (Table 2). This outcome may be due to the higher longevity of women, and hence must be analyzed with caution.

Discussion

The mortality trend due to cerebrovascular disease showed a decline in the Southeast, South and Midwest regions, at all age ranges and in both sexes. In addition, the mortality due to ischemic heart disease also declined in the Southeast and South region, reaching stabilization of risk in the Midwest region and increasing in the Northeast

region. These decline trends in the main causes of death among the circulatory diseases probably reflect changes in behavior related to the control of the main risk factors, such as smoking, dyslipidemia, diabetes and systemic arterial hypertension.

It is known that such control, primary and secondary prevention of circulatory diseases is more adequate in the more developed regions such as the South and Southeast regions, where significant mortality reductions were observed. Therefore, the socioeconomic conditions are facilitating means for a better response in the reduction of the morbidity and mortality due to circulatory diseases. However, the resources

aimed at public health services in developing countries are known to be scarce and much lower than those suggested by the World Health Organization^{5,6}. This also occurs between regions inside a same country, as is the case of Brazil, where there are regional differences of access to health services.

The results observed in this study complement the same trends observed in previous studies, carried out before the year 2000^{7,8}. In summary, these studies have shown a reduction in the death risk only in the more developed regions, and this

decrease was late and small, when compared to that of other countries⁹⁻¹¹. However, this issue is still insufficiently studied, and remains open for discussion and investigation, reaffirming the need to establish a surveillance for these diseases.

Potential Conflict of Interest

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

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