

## Evolution of Cardiovascular Diseases Mortality in the Counties of the State of Rio de Janeiro from 1979 to 2010

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### Abstract

**Background:** Cardiovascular Diseases (CVD) are the leading cause of death in Brazil.

**Objective:** To estimate total CVD, cerebrovascular disease (CBVD), and ischemic heart disease (IHD) mortality rates in adults in the counties of the state of Rio de Janeiro (SRJ), from 1979 to 2010.

**Methods:** The counties of the SRJ were analysed according to their denominations established by the geopolitical structure of 1950. Each new county that have since been created, splitting from their original county, was grouped according to their former origin. Population Data were obtained from the Brazilian Institute of Geography and Statistics (IBGE), and data on deaths were obtained from DataSus/MS. Mean CVD, CBVD, and IHD mortality rates were estimated, compensated for deaths from ill-defined causes, and adjusted for age and sex using the direct method for three periods: 1979–1989, 1990–1999, and 2000–2010. Such results were spatially represented in maps. Tables were also constructed showing the mortality rates for each disease and year period.

**Results:** There was a significant reduction in mortality rates across the three disease groups over the the three defined periods in all the county clusters analysed. Despite an initial mortality rate variation among the counties, it was observed a homogenization of such rates at the final period (2000–2010). The drop in CBVD mortality was greater than that in IHD mortality.

**Conclusion:** Mortality due to CVD has steadily decreased in the SRJ in the last three decades. This reduction cannot be explained by greater access to high technology procedures or better control of cardiovascular risk factors as these facts have not occurred or happened in low proportion of cases with the exception of smoking which has decreased significantly. Therefore, it is necessary to seek explanations for this decrease, which may be related to improvements in the socioeconomic conditions of the population. (Arq Bras Cardiol. 2015; 104(5):356-365)

**Keywords:** Cardiovascular Diseases/mortality; Demographic Data; Data Interpretation, Statistical; Local Government.

### Introduction

Cardiovascular diseases (CVD) are the primary cause of death worldwide, irrespective of the per capita income of a country. According to the World Health Organization (WHO), cardiovascular diseases were responsible for 17 million deaths in 2011, which represents three out of every ten deaths. Of these, seven million people died from ischemic heart diseases (IHD) and 6.2 million from stroke<sup>1</sup>.

In Brazil, CVD also represent the main cause of deaths, corresponding to 28.6% of all causes of mortality in 2011. This is also the case in the state of Rio de Janeiro (SRJ), where CVD were responsible for 29.1% of all deaths. The two main

groups of deaths from CVD are IHD and cerebrovascular diseases (CBVD), which respectively comprised 30.8% and 30% of CVD deaths in Brazil and 31.6% and 27.6% of CVD deaths in the SRJ<sup>2</sup>.

Though it is still the major cause of mortality worldwide, mortality due to CVD began to decline in industrialized countries after the 1950s. In Brazil, this downturn began to be noted in the late 1970s<sup>3,4</sup>, with a significant reduction in CVD mortality rates, despite some significant regional differences<sup>5</sup>.

There are no studies assessing the evolution of mortality due to CVD and their two main groups, IHD and CBVD, by county units, which prompted us to conduct this study in the counties of the SRJ.

According to the 2010 census, the SRJ had 15,989,929 inhabitants, or 8.4% of the country's population; it is divided into 92 counties, with a population density of 365.23 inhabitants/km<sup>2</sup> according to IBGE<sup>6</sup>. The state's gross domestic product (GDP) corresponds to 11.3% of the national GDP. These counties of the state have a very heterogeneous socioeconomic structure<sup>7</sup>.

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The aim of this study was to estimate mortality rates due to CVD, CBVD, and IHD in adults from the counties of the state of Rio de Janeiro, from 1979 to 2010.

## Methods

A descriptive study of historical series of adults, i.e., people aged 20 years or over, in the counties of the SRJ, from 1979 to 2010.

The counties of SRJ were analyzed according to their denomination established by the geopolitical structure of the year 1950. Each new county that has since been created, splitting from their original county, was grouped according to their former origin. This grouping led to a reduction in the total number of counties in existence in 2010 in SRJ, from 92 to 56 clusters for purposes of analysis in this study. These groupings were created with a view to future analyses that will consider information on county clusters available since 1950. Eight new counties were created in SRJ between 1950 and 1980, 28 new counties were subsequently added. These new counties, in general still have small population sizes which also justified to group the data according to the original county cluster.

The population data were obtained from the website of the Brazilian Institute of Geography and Statistics (IBGE)<sup>6</sup>, for the years of the 1980, 1991, 2000 and 2010 censuses years, and the 1996 population count. Population fractions corresponding to sex and age bracket were obtained, for each 10-year interval. To estimate the intercensal interpolations and the extrapolations for the year 1979, the arithmetic progression method was used for each fraction of sex and age. The intercensal estimates provided by IBGE were not used, due to the change of method adopted in 2007, which caused abrupt and improbable inflections in all age brackets. These inflections alone could cause disruptions in the estimations of the mortality rates.

The data relating to deaths were obtained from the DataSus website<sup>2</sup> and itemized by the fractions that were our primary interest of the study: CVD, corresponding to those recorded in chapters VII of ICD-9<sup>8</sup> or IX of ICD-10<sup>9</sup>; IHD, corresponding to codes 410-414 of ICD-9 or I20-I25 of ICD-10; and CBVD, corresponding to codes 430-438 of ICD-9 or I60-I69 of ICD-10. Deaths due to ill-defined causes, covered in chapter XVI of ICD-9 and XVIII of ICD-10, and total deaths due to all causes were also used for compensation. ICD-9 remained in effect until 1995, while ICD-10 took effect from 1996.

As the rates of mortality due to ill-defined causes in SRJ increased significantly after 1990<sup>10</sup>, the decision was made to compensate this increase by proportionally allocating the deaths from ill-defined causes to the deaths resulting from CVD, IHD, and CBVD, in the same proportion that these deaths occurred i.e., excluding ill-defined deaths. After adding the deaths due to CVD, IHD and CBVD with the corresponding proportion of deaths from ill-defined causes, the mortality rates of the study participants, adjusted for sex and age, were estimated using the direct method<sup>11,12</sup>. The standard population used for

the adjustments was from the 2000 census in the SRJ, stratified into seven age groups (20–29 years; 30–39 years; 40–49 years; 50–59 years; 60–69 years; 70–79 years; and 80 years or over) for each sex. These rates were considered compensated and adjusted.

The compensated and adjusted mean CVD, IHD, and CBVD mortality rates were calculated in three periods: 1979–1989; 1990–1999; and 2000–2010. The decision was made to construct rates for these periods rather than annual rates, which fluctuate substantially for a high percentage of the counties, due to their small populations, even considering the clustering described previously. Each of these periods was represented spatially on maps<sup>13</sup> with the geopolitical division of the counties of SRJ of 1950. A colour scale was attributed to CVD according to the variation of the mortality rates in the periods, starting from 200 deaths per 100,000 and thereafter at intervals of 100 deaths per 100,000 inhabitants. For IHD and CBVD, the scale starts at 50 deaths per 100,000 inhabitants and continues at intervals of 50 deaths per 100,000 inhabitants.

Tables were constructed with the compensated and adjusted mean CVD, CBVD, and IHD mortality rates, in the same three periods, grouping the counties by SRJ healthcare regions. In this study, the regional division used by the Rio de Janeiro State Department of Health (SES RJ) was modified in the Metropolitan Region, which henceforth constituted the Metropolitan Belt, encompassing all the counties of the region except for the counties of Rio de Janeiro and Niterói, which became two independent regions. The other regions, Middle Paraíba, Mountain, North, Coastal Lowlands, Northwest, Mid-South, and Ilha Grande Bay, are those defined by the SES RJ. The standard deviations between the mean mortality rates of the counties of each region, and between all the counties in the three periods for the CVD, CBVD, and IHD mortality rates, were also estimated.

The quantitative procedures were conducted using the Excel-Microsoft<sup>14</sup> and STATA<sup>15</sup> programs. Maps were created using the cartographic base of IBGE<sup>16</sup> and drawn using the Microsoft Paint<sup>17</sup> program.

## Results

We noted that the mean CVD mortality rates (Figure 1 and Table 1) decreased gradually over the three periods analysed. In the first period, from 1979 to 1989, all but three of the county clusters had mean CVD mortality rates above 500 deaths per 100,000 inhabitants, while 13 had rates of more than 700 deaths per 100,000 inhabitants. These rates decreased gradually until the last period, when all the county clusters had rates of between 200 and 500 deaths per 100,000 inhabitants due to CVD. The mean CVD mortality rate in the state was 347.1 deaths per 100,000 inhabitants in the most recent period, compared to 656.8 deaths per 100,000 inhabitants in the earliest period. Besides the gradual decrease in cardiovascular mortality, we also noted a tendency towards homogenization of mortality rates among the county clusters and regions over time, which can be observed

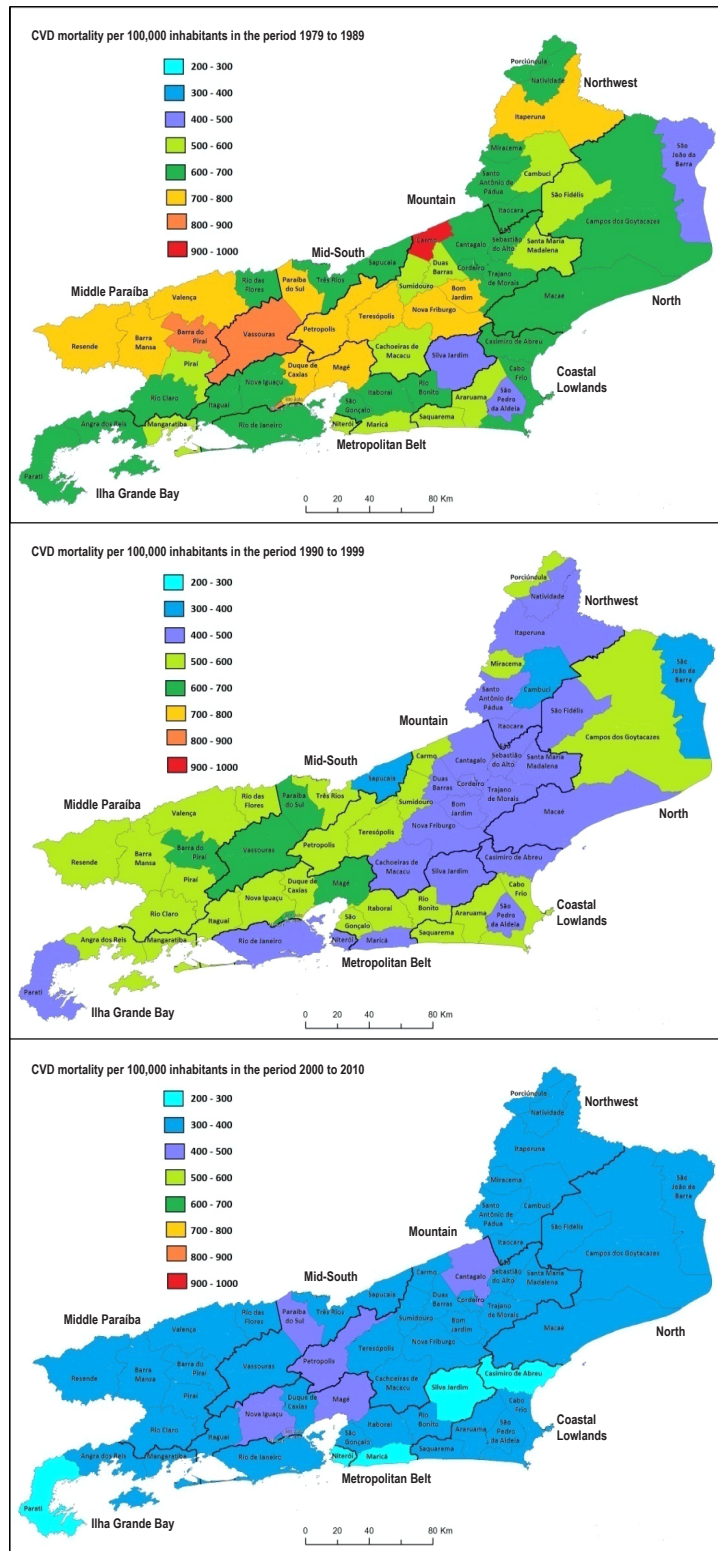


Figure 1 – Mean CVD mortality rates per 100,000 inhabitants, compensated and adjusted by sex and age, in the counties of the state of Rio de Janeiro in three periods, from 1979 to 2010.

**Table 1** – Mean CVD mortality rates per 100,000 inhabitants of the counties, compensated and adjusted by sex and age, according to the healthcare regions of the State of Rio de Janeiro, in three periods, from 1979 to 2010

Healthcare region	mean (79-89)	sd* (79-89)	mean (90-99)	sd* (90-99)	mean (00-10)	sd* (00-10)	Nº. of counties
Rio de Janeiro	601,8		461,2		309,6		1
Metropolitan Belt	669,9	111,3	550,8	80,0	364,4	43,1	11
Mid-South	691,4	77,6	549,9	46,4	359,7	25,1	7
Mountain	687,9	105,3	483,4	62,3	350,8	37,7	13
North	604,1	96,2	444,5	48,9	319,2	17,2	4
Coastal Lowlands	578,0	72,2	472,0	47,6	322,6	34,3	5
Niterói	550,1		425,6		259,4		1
Northwest	643,4	47,5	487,5	56,2	347,7	14,4	7
Middle Paraíba	718,2	75,5	539,3	107,5	377,3	35,7	4
Ilha Grande Bay	598,6	43,3	511,6	25,0	315,8	28,5	3
<b>Total</b>	<b>656,8</b>	<b>93,6</b>	<b>505,8</b>	<b>70,5</b>	<b>347,1</b>	<b>37,7</b>	<b>56</b>

\*sd: standard deviation of the means of the counties of the region.

in the maps, and in the reduction of standard deviations (Figure 1 and Table 1).

The highest CVD mortality rates from 1979 to 1989 occurred in the region of Middle Paraíba; from 1990 to 1999, the highest rates were in the Metropolitan Belt Region; and from 2000 to 2010, the highest values again occurred in Middle Paraíba. The lowest CVD mortality rates for the three periods were recorded in the county of Niterói.

CBVD (Figure 2 and Table 2) and IHD (Figure 3 and Table 3) mortality rates exhibited a behavior that closely resembled that of the CVD mortality rates, with a gradual reduction in rates over the periods, and a tendency towards homogenization of the rates for the SRJ, regions, and county clusters in the last period. In the SRJ, in the most remote and intermediate periods, there were higher mortality rates due to CBVD than due to IHD; however, in the last period, the figures were very similar, with a slight predominance of deaths due to IHD. This did not mean there was an increase in IHD mortality rates, as these also decreased over time, but only that there was a greater reduction in mortality rates due to CBVD than those resulting from IHD.

## Discussion

Based on the data submitted, it can be seen that the mortality rates due to CVD, CBVD, and IHD gradually decreased in all the county clusters and regions of the SRJ over the study periods analysed, similar to the global tendency towards a reduction in cardiovascular mortality in recent decades<sup>18,19</sup>. The mean cardiovascular mortality rates in SRJ occupy intermediate values when compared with those of several countries. In the last period of the study, from 2000 to 2010, the mean CVD mortality rate was 347.1, the mean CBVD mortality rate was 105.9, and the mean IHD

mortality rate was 109.6 deaths per 100,000 inhabitants. We can compare these with the mortality rates from the same causes in other regions worldwide in a similar period. In the decade of 2000–2010, the lowest CVD mortality rates were observed in Japan, with about 100 deaths per 100,000 inhabitants. As for IHD, the lowest rates occurred in Japan and Korea, with 38 and 37 deaths per 100,000 inhabitants, respectively; the lowest CBVD mortality rates are those of Israel and Switzerland, with 28 and 29 deaths per 100,000 inhabitants, respectively. The highest IHD and CBVD mortality rates are reported for the Russian Federation, with 524 and 313 deaths per 100,000 inhabitants, respectively. Evidence allows us to assume that the CVD mortality rate in the Russian Federation is higher than 1000 deaths per 100,000 inhabitants. With such high rates, Russia leads the ranking of 35 countries in terms of mortality by cardiovascular disease, well ahead of the country occupying the second place, Slovakia, which had IHD and CBVD mortality rates of 324 and 112 deaths per 100,000 inhabitants, respectively. If we were to include SRJ in this ranking, it would occupy fourth place in CBVD mortality, only coming behind Russia, Slovakia, and Hungary. As for IHD mortality, SRJ is in 18<sup>th</sup> place, with lower mortality than countries like the United States, the United Kingdom, and Canada, but above Latin American countries like Chile and Mexico<sup>20</sup>.

A similar reduction in CVD, IHD, and CBVD mortality rates in the county clusters of SRJ was also observed in Brazil, in the Metropolitan Region of São Paulo<sup>21</sup>, but with a shorter analysis period, from 1990 to 2009. The trend towards a reduction of cardiovascular mortality was the same as in SRJ, which had a drop in IHD mortality, but the most accentuated reduction occurred in CBVD. All the SRJ regions showed a drop in IHD and CBVD mortality rates. However, in the comparison between CBVD and IHD, presented variable mortality rates behaviours among the healthcare regions.

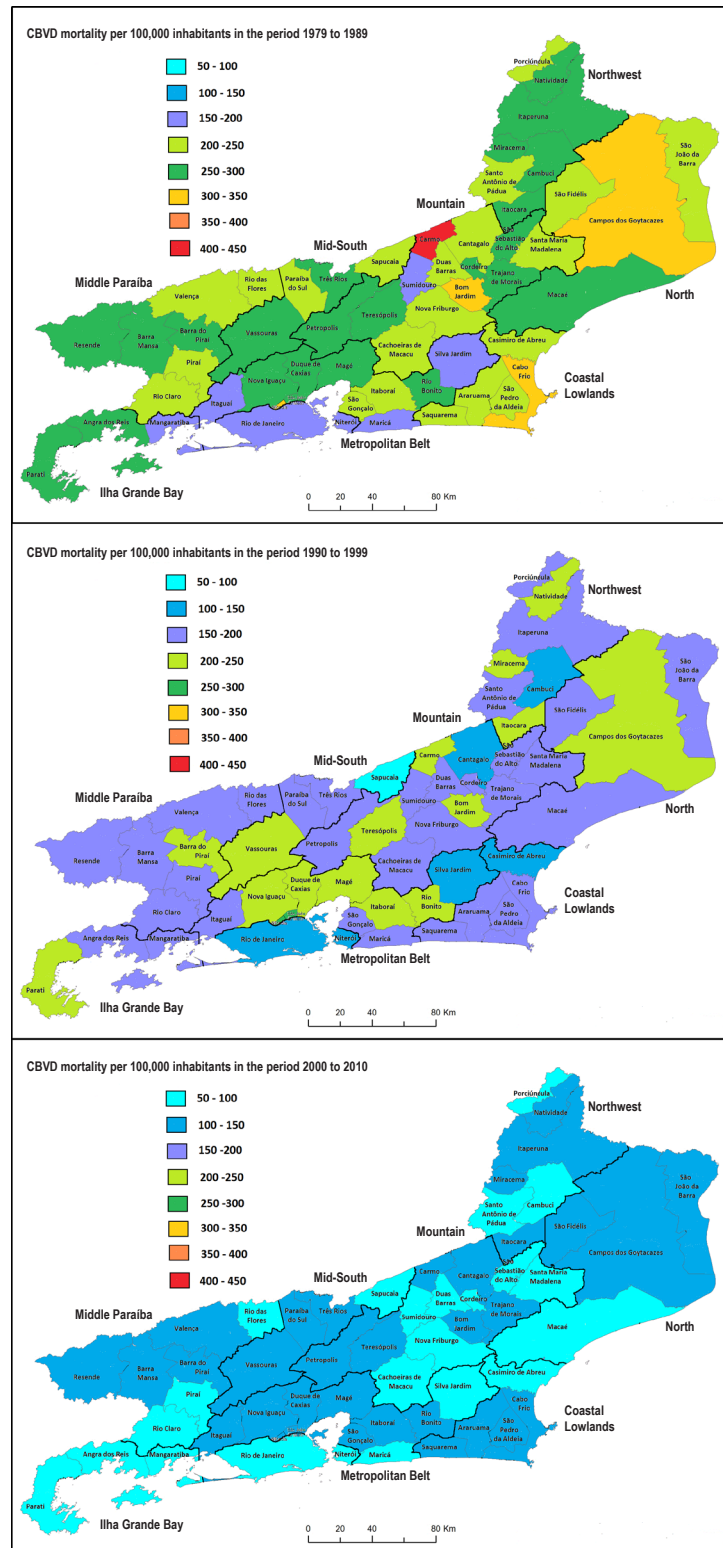


Figure 2 – Mean CBVD mortality rates per 100,000 inhabitants, compensated and adjusted by sex and age, in the counties of the state of Rio de Janeiro in three periods, from 1979 to 2010.

**Table 2** – Mean CBVD mortality rates per 100,000 inhabitants of the counties, compensated and adjusted by sex and age, according to the healthcare regions of the State of Rio de Janeiro in three periods, from 1979 to 2010

Healthcare region	mean (79-89)	sd* (79-89)	mean (90-99)	sd* (90-99)	mean (00-10)	sd* (00-10)	Nº. of counties
Rio de Janeiro	190,4		146,2		95,3		1
Metropolitan Belt	247,9	46,7	208,5	35,0	121,2	16,7	11
Mid-South	242,4	31,9	182,4	19,8	102,9	10,7	7
Mountain	264,5	58,8	181,2	28,4	97,8	14,7	13
North	261,4	49,8	191,7	35,8	113,0	18,3	4
Coastal Lowlands	248,1	36,4	171,0	18,6	105,7	17,2	5
Niterói	178,9		146,4		95,1		1
Northwest	263,7	36,8	186,8	30,0	100,0	10,6	7
Middle Paraíba	244,0	22,6	161,4	50,3	103,9	14,9	4
Ilha Grande Bay	241,0	49,6	188,3	24,9	95,2	2,3	3
<b>Total</b>	<b>253,5</b>	<b>44,5</b>	<b>186,8</b>	<b>32,8</b>	<b>105,9</b>	<b>16,3</b>	<b>56</b>

\*sd: standard deviation of the means of the counties of the region.

In the Metropolitan Belt, the North, and Ilha Grande Bay, the predominance of CBVD was maintained from the most remote to the most recent period, for the county of Rio de Janeiro the opposite was seen with predominance of IHD mortality over CRVD throughout the entire period. The Mid-South, Mountain, Northwest, and Middle Paraíba CRVD mortality rates predominate over IHD for the period of 1979-1989 and IHD mortality rates predominate over CRVD for the period of 2000-2010. In Ilha Grande Bay, the highest rate in the period of 1979-1989 was for CBVD, while in the last period, the rates of CBVD and IHD were similar (Tables 2 and 3).

Niterói, which had a clearly higher rate of mortality from IHD than CBVD in the most remote period, began to have similar rates of IHD and CBVD in the last period. It should be emphasized that a less notable decline in the CBVD mortality rate was to be expected in Niterói, as this was the county with the lowest mortality rate for this cause in the initial period of the study. If we observe the relative reduction mortality rates for the total period [(1979–1989) – (2000–2010) / (1979–1989)] for CVD, we see that Niterói had the greatest relative reduction (53%), and the Middle Paraíba region had the smallest reduction (44%). The county of Niterói, in our study, was separated from the Metropolitan Region because its socioeconomic pattern differs considerably from that of the other counties of this region. Niterói has the third highest human development index in Brazil and the highest in SRJ<sup>6</sup>. Moreover, according to a survey by Fundação Getúlio Vargas (FGV), Niterói has the largest number of people from Brazil's highest socioeconomic class (30.7%), based on data from the Demographic Census of 2010<sup>22</sup>. The county clusters of the Middle Paraíba region, in turn, are those that underwent early industrialization due to the establishment of the first steel plant in Brazil, in Volta Redonda. The steel industry is admittedly one which causes great environmental pollution and unhealthy working conditions.

In addition to the gradual decrease in mortality rates in the periods studied, it can also be noted that the mortality rates in the county clusters across the three groups of causes studied were homogenized, as is evident in the maps for the period 2000 to 2010. This analysis can be summarized in two aspects. Mortality due to CVD has dropped in the last three decades in the SRJ; this phenomenon was not isolated, and has also been noted in other countries and in other Brazilian states. This reduction was not uniform among the counties, with a relative overall reduction (between the first and last periods studied) in CVD for the counties of Niterói (53%), the Mid-South Region (49%) and Rio de Janeiro (49%), and lesser reductions in the Middle Paraíba (44%), Ilha Grande Bay, (46%) and Northwest regions (46%). This asymmetrical or diverse reduction of cardiovascular mortality rates cannot be explained by increasing access to high technology procedures such as myocardial revascularization surgery and angioplasty because of their poor performance<sup>23-25</sup> and limited scope in Brazil, or by better control of classic cardiovascular risk factors<sup>26-34</sup>.

These findings need a search for other explanations for these reduction in cardiovascular mortality, such as improvements in the population's socioeconomic or environmental. Throughout the 20<sup>th</sup> century and particularly after the 1950s, Brazil experienced a period of progress that brought improvements in socioeconomic indicators, although social inequalities still remains high and have only begun to decrease in recent years, nevertheless preceding the drop in CVD mortality<sup>35</sup>. All over the world, social inequalities, even in so-called developed countries, are clearly associated with various diseases, including cardiovascular conditions. It is estimated that the cost of social inequality is as high as 39 billion pounds/year in the United Kingdom due to reduced life expectancy, murders, worsening of mental health, and other health problems<sup>36</sup>. In a recent study in the counties of Rio de Janeiro, we showed that the differences between CBVD

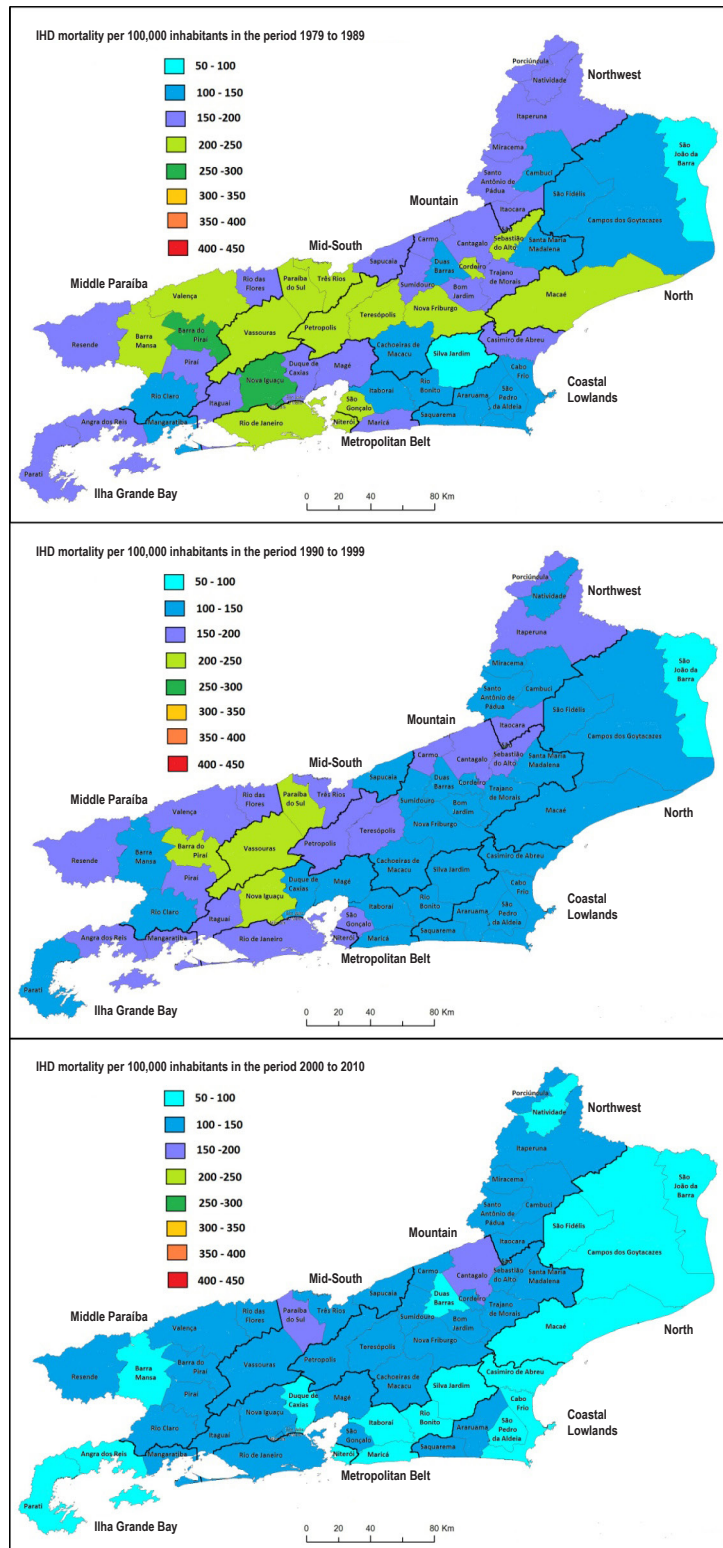


Figure 3 – Mean mortality IHD rates per 100,000 inhabitants, compensated and adjusted by sex and age, in the counties of the state of Rio de Janeiro in three periods, from 1979 to 2010.

**Table 3** – Mean IHD mortality rates per 100,000 inhabitants of the counties, compensated and adjusted by sex and age, according to the healthcare regions of the State of Rio de Janeiro in three periods, from 1979 to 2010.

Healthcare region	mean (79-89)	sd* (79-89)	mean (90-99)	sd* (90-99)	mean (00-10)	sd* (00-10)	Nº. of counties
Rio de Janeiro	217,3		160,0		106,2		1
Metropolitan Belt	186,0	56,2	151,7	38,5	102,9	12,5	11
Mid-South	199,0	41,2	164,1	31,7	112,9	13,1	7
Mountain	186,1	39,2	135,7	29,7	117,6	17,8	13
North	137,6	57,3	101,1	21,3	89,7	6,2	4
Coastal Lowlands	140,3	22,8	131,4	16,4	100,6	14,0	5
Niterói	212,4		156,2		95,3		1
Northwest	168,9	34,3	143,4	18,3	115,5	16,0	7
Middle Paraíba	203,6	25,3	183,3	43,1	132,9	18,3	4
Ilha Grande Bay	162,4	21,7	159,2	33,0	94,8	14,5	3
<b>Total</b>	<b>179,0</b>	<b>44,1</b>	<b>146,0</b>	<b>33,9</b>	<b>109,6</b>	<b>17,5</b>	<b>56</b>

\*sd: standard deviation of the means of the counties of the region.

mortality between the administrative regions of this county were ten times higher in the region with the lowest economic development index (Santa Cruz-Campo Grande) than in the region with the highest HDI (Gávea). This increase in mortality occurred 10 years earlier<sup>37</sup>.

The evaluations performed in this article depend on the quality of information recorded in the death certificates. Therefore, this might be a limitation for the interpretations made herein. We must thus reinforce the attention that should be given for the constant improvement of information provided by the physicians and other related professionals at the moment of deaths. This improvement involves continuing education of healthcare professionals and the provision of adequate working conditions by public and private institutions. Other limits relate to the scope of the data, and the methods used to estimate population and deaths according to the causes. None of the methods used guarantee certainty, but they are simple, logical, and easily reproducible.

Future studies are necessary to relate the mortality due to the CVD and all the diagnostic components of this class to socioeconomic and social inequality indicators, as well as to environmental pollution in county clusters, which include variability of indicators and mortality. These socioeconomic and environmental variables appear to have a much greater impact on cardiovascular mortality than “classic” risk factors.

## Author contributions

Conception and design of the research: Soares GP, Klein CH, Silva NAS, Oliveira GMM. Acquisition of data: Soares GP, Klein CH, Silva NAS, Oliveira GMM. Analysis and interpretation of the data: Soares GP, Klein CH, Silva NAS, Oliveira GMM. Statistical analysis: Soares GP, Klein CH, Silva NAS, Oliveira GMM. Writing of the manuscript: Soares GP, Klein CH, Silva NAS, Oliveira GMM. Critical revision of the manuscript for intellectual content: Soares GP, Klein CH, Silva NAS, Oliveira GMM.

## 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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