Original Article

Urban Space and Mortality from Ischemic Heart Disease in the Elderly in Rio de Janeiro

Germana Périssé[1,3], Roberto de Andrade Medronho[1], Claudia Caminha Escosteguy[2]
Instituto de Estudos de Saúde Coletiva (IESC) da Universidade Federal do Rio de Janeiro[1]; Hospital dos Servidores do Estado - Ministério da Saúde[2]; Secretaria Municipal de Saúde e Defesa Civil do Rio de Janeiro[3], Rio de Janeiro, RJ - Brazil

Abstract

Background: **Cardiovascular diseases are the leading cause of death in Brazil, especially among the elderly. In the city of Rio de Janeiro (RJC), ischemic heart disease (IHD) is the predominant cause of mortality. Studies show an association between the process of urbanization, socioeconomic conditions and changes in lifestyle with the occurrence of IHD.**

Objective: **To describe the geographical distribution of the IHD mortality rates in the elderly of RJC in 2000 and its correlation with socioeconomic variables.**

Methods: **This was an ecological study with a spatial analysis of the distribution of the IHD mortality rates in the elderly residing in RJC in 2000, standardized by gender and age, and its correlation with socioeconomic variables from the demographic census.**

Results: **There were no strong correlations between the socioeconomic variables and IHD mortality in the elderly in the districts. Some correlations, albeit weak, showed an association between higher socioeconomic status and higher mortality. After correcting the IHD mortality rate by adding ill-defined causes (IDC) of death, an association between low socioeconomic status and higher mortality from IHD was observed. The study showed spatial dependence for socioeconomic variables, but not for mortality from IHD.**

Conclusion: **The spatial dependence observed in economic variables shows that the urban space in RJC, although heterogeneous, has a certain amount of discrimination in the districts. Some correlations between IHD and socioeconomic variables were opposite to those found in the literature, and this may be partly related to the proportion of IDC, or to the exclusive profile of this age group. (Arq Bras Cardiol 2010; 94(4):437-444)**

Key words: **Myocardial ischemia/mortality; aged; urbanization; cities; Rio de Janeiro; Brazil.**

Introduction

Cardiovascular diseases (CVD) are the leading cause of death in Brazil, especially among the elderly[1]. Cerebrovascular diseases (CBVD) and ischemic heart diseases (IHD) represent more than 60% of CVD deaths. In the state of Rio de Janeiro, CBVD still exceed IHD, although in some cities, like Rio de Janeiro, IHD are the leading cause of death[2].

In 2002, the proportion of IHD mortality was 30.5% of deaths from CVD, and, in the age group above 60 years, the mortality rate from CVD was 27.4% for females and 32.0% for males. In Rio de Janeiro, this rate was 34.9% for the general population, and 32.0% for women over 60 years, and 38.1% for men over 60 years[1].

Studies that analyzed the geographic variation of ischemic heart disease verified the involvement of environmental factors among its determinants, especially the process of urbanization, socio-economic conditions and changes in lifestyle[3-8].

In Rio de Janeiro (RJC)[9,10], studies showed an inverse relationship between social inequality and health status, with an increase in mortality rates in the less urban regions which are not well served by the public sanitary sewer system.

Some authors[3,5,8] who evaluated the access to invasive cardiovascular procedures concluded that people with low income are less likely to achieve such access. Brazilian studies[11-13] that evaluated the risk of death and cardiovascular disease concluded that the increased risk was influenced by low socioeconomic status.

Ecological studies have been used to study the behavior and distribution of diseases, and they are relatively fast and inexpensive, requiring no knowledge of the distribution of individual variables. The use of spatial analysis techniques in this type of study has increased[14,15].

The objective of this study was to describe the geographical distribution of mortality rates from IHD in the elderly in RJC, in 2000, and its correlation with socioeconomic variables.

Mailing address: Claudia Caminha Escosteguy •
Rua Sacadura Cabral, 178 - 20221-903 - Rio de Janeiro, RJ - Brazil
E-mail: cescosteguy@hse.rj.saude.gov.br
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Methods

This was an ecological study on the variation of the mortality rate from IHD in elderly people who lived in RJC in 2000. Individuals aged over 60 years were considered elderly, in accordance with the Elderly Statute[16].

Mortality data were obtained from the Information System (SIM), provided by the State Health Department of Rio de Janeiro. We considered the deaths of elderly residents in the municipality of Rio de Janeiro that had ischemic heart disease as the primary cause of death (codes I20.0 to I25.9 of the 10th Review of the International Classification of Diseases, ICD-10, World Health Organization - WHO).

Socio-economic data were obtained from the census conducted in 2000 by the Brazilian Institute of Geography and Statistics (IBGE) and accessed from the page of Pereira Passos Municipal Institute of Urbanism[17] or provided by IBGE[18]. We analyzed the various socioeconomic variables available in the census, representing estimates of income, education, family structure, access to different consumer goods, access to basic services and density of persons per household in permanent homes, and the proportion of elderly members. For presentation in the study we selected only estimates that showed a correlation with the rate of IHD mortality.

The spatial analysis unit was the district. In 2000, RJC had 158 districts. For spatial analysis we grouped the districts of Pavuna with Parque Colúmbia, which received the status of district only in 1999[19]; and Barra da Tijuca with Joá, because the latter had no death from any cause in 2000; and Bandeirantes with Grumari, because the latter had only two deaths, not included in the Chapter IX of circulatory system diseases (one in chapter X, and one in Chapter XVIII of ICD-10), and they have the smallest population of all districts of Rio de Janeiro.

For administrative purposes, RJC is divided into 10 health program areas (AP): AP 1.0 includes Centro, Zona Portuária, Rio Comprido, São Cristóvão, Paquetá and Santa Teresa regions; AP 2.1 includes Botafogo, Copacabana, Lagoa, and Rocinha regions; AP 2.2 includes Tijuca and Vila Isabel regions; AP 3.1 includes Ramos, Penha, Ilha do Governador, Complexo do Alemão, and Maré regions; AP 3.2 includes Inhaúma, Méier, and Jacarezinho regions; AP 3.3 includes Irajá, Madureira, Anchieta, and Pavuna regions; AP 4.0 includes Jacarepaguá, Barra da Tijuca, and Cidade de Deus regions; AP 5.1 includes Bangu and Realengo regions; AP 5.2 includes Campo Grande and Guaratiba regions; AP 5.3 comprises the region of Santa Cruz[17]. Figure 1 shows the spatial distribution of the APs.

Of 3,771 IHD deaths occurred in the elderly in 2000, in RJC, 84 were excluded for not having the variable "residence district" duly completed. The mortality rate was standardized by gender and age groups, and categorized by the following age groups: 60 to 69 years, 70 to 79 years, and 80 or more years. The standardization was made by direct method and used the population of RJC as a standard population.

Due to the occurrence of 10.8% of deaths from ill-defined causes in RJC in 2000, and considering the possibility of underestimating the IHD deaths, two corrections for this mortality rate standardized by gender and age have been taken into account. The first used the technique adopted by Oliveira et al which consisted in allocating to the IHD deaths those from ill-defined causes in a proportion equal to that represented by defined deaths in relation to all deaths, excluding the ill-defined, and the adjusted rate was called balanced and adjusted. The second correction was the technique adopted by Melo et al[13] which consisted in the inclusion of all deaths classified as ill-defined causes in the analysis; the adjusted rate was called rate plus ill-defined causes (IDC). The ill-defined causes are classified in Chapter XVIII (R00 to R99) of ICD-10, "symptoms, signs and abnormal clinical and laboratory findings not elsewhere classified."

To analyze the correlation between mortality rate and other variables, we used the Spearman's correlation coefficient. In

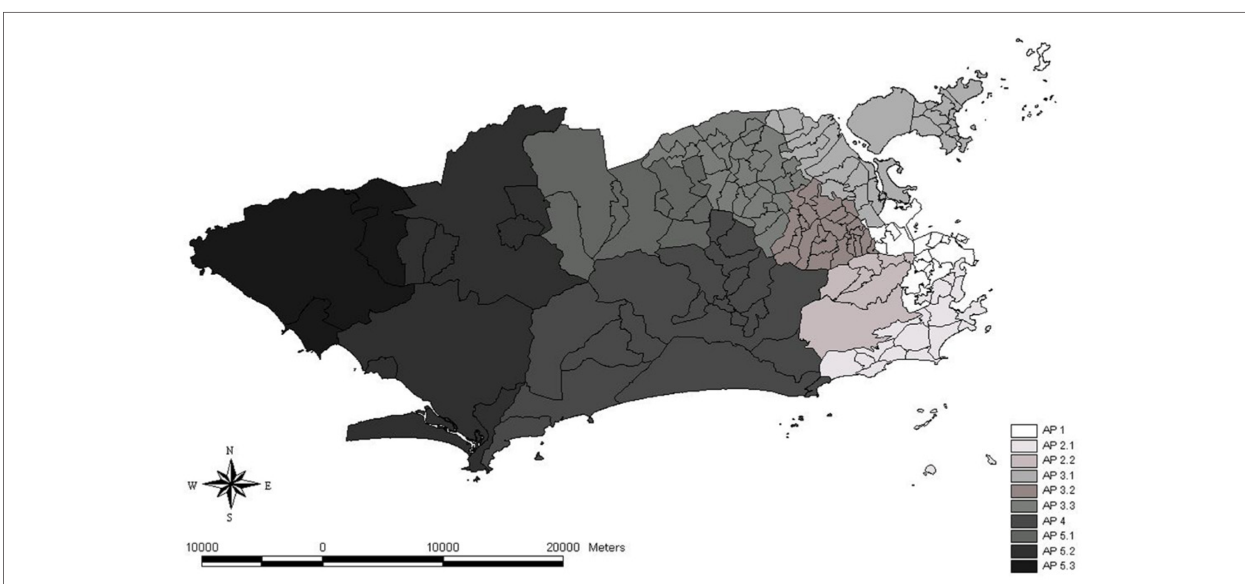

Figure 1 - Spatial distribution of the Program Areas (AP) of Rio de Janeiro.

the calculation, we excluded the districts with very discrepant rates (outliers).

The spatial correlation of the variables was analyzed using the Moran index, which tests the existence of spatial structure and is similar to the correlation coefficient of Pearson. Moran's index can be understood as a correlation coefficient between values of the same variable measured in the district, and it usually ranges between - 1 and 1. When there is spatial autocorrelation, its value tends to 0. The spatial aggregation is expressed by positive values, while negative values express inverse autocorrelation[15].

We used the value of p below 0.05 as significance criterion. Later, we made maps of the variables that had the best correlation with the outcome.

We used the programs SPlus 2000 and ArcGis 8.0 for data analysis.

The study was approved by the Ethics in Research of the Center for Research on Collective Health, Federal University of Rio de Janeiro, and was partially funded by the National Council for Scientific and Technological Development (CNPq) and the *Fundação Carlos Chagas Filho de Amparo à Pesquisa* of the State of Rio de Janeiro (FAPERJ).

Results

The crude IHD mortality rate in the general population was 82.42 per 100,000 inhabitants, whereas in the population over 60 it was 501.70 per 100,000 inhabitants.

Figure 2 shows the spatial distribution of the IHD mortality rate in the elderly, by district, standardized by gender and age group, classified by quartiles. There was great variability among the districts in the distribution of IHD mortality rate (0 to 9,247.77/100,000). The highest rates were found in the Camorim (9247.77/100,000), Saúde (4174.29/100,000), and Cidade Universitária (2612.74/100,000) districts. The median mortality rate was 470.78 per 100,000 inhabitants. Two clusters were observed, one comprising most of the districts of AP 5.2 and 5.3, which showed the lowest rate, and another composed of some districts of AP 1.0, 2.2, and 3.1, where higher rates predominated.

Figure 3 shows the spatial distribution of the proportion of deaths from ill-defined causes, and a heterogeneous behavior was observed among the districts. The highest rates were found in the districts of AP 3.3, 5.1, 5.2, and 5.3.

Table 1 shows the correlation coefficients of Spearman between IHD mortality rate and several socioeconomic variables, which expressed weak, although statistically significant correlations. The correlation was positive with the proportion of elderly people, with households whose head has an income higher than or equal to 15 minimum wages, and with households with individuals, and for the last two the p-value was borderline. The correlation was negative and statistically significant with the proportion of households whose head has an income less than or equal to three minimum wages, including those without income, with the proportion of households that have no computer, with the proportion of couples with children, and with the proportion of households with population density of 4.0 people per bedroom. The correlation with the proportion of households whose head has no income, including those receiving only benefits, was also negative, but with a borderline p-value.

When analyzing the correlation between balanced and adjusted IHD mortality rate and socioeconomic variables, we observed the same pattern found in mortality from IHD, without correction in the proportion of elderly (positive correlation), and in the proportion of couples with children

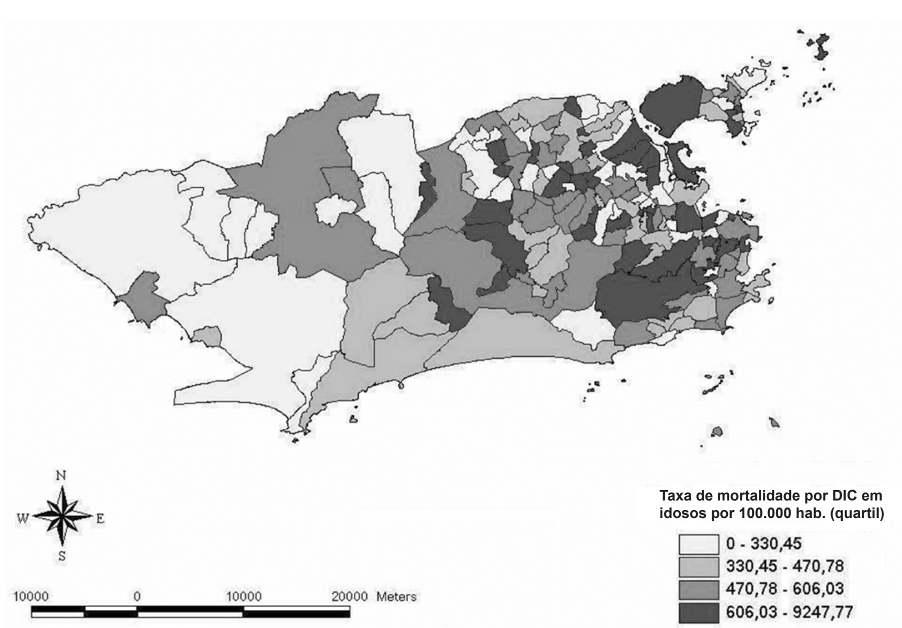

Figure 2 - Spatial distribution of the IHD mortality rate in the elderly, standardized by gender and age, in Rio de Janeiro in 2000.

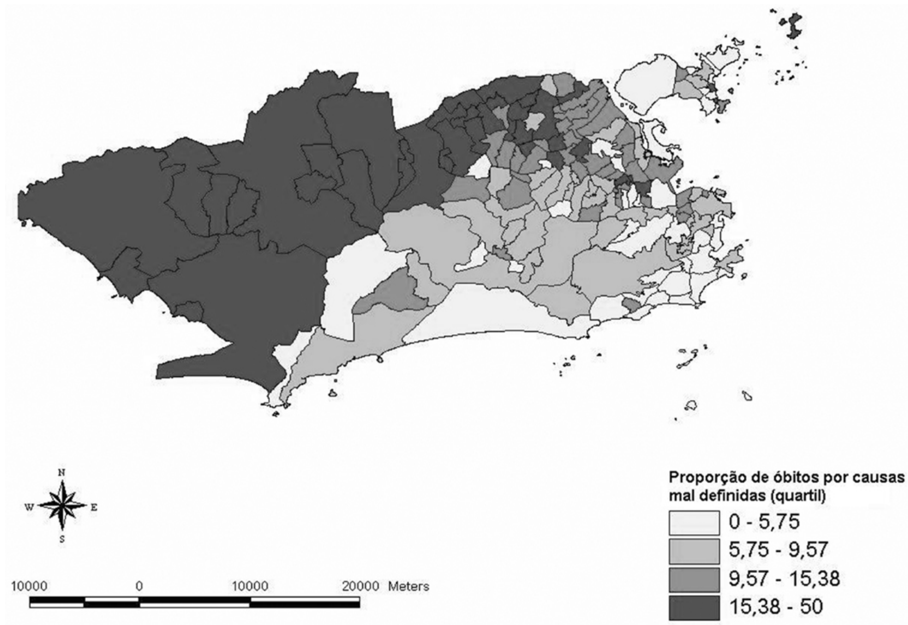

Figure 3 - Distribution of the proportion of ill-defined causes in the municipality of Rio de Janeiro in 2000.

Table 1 - Correlation between IHD mortality rate in the elderly and socioeconomic variables, Rio de Janeiro, 2000

Socioeconomic variables	Spearman's correlation coefficient					
	IHD *		Bal. and adj. IHD †		IHD plus IDC ‡	
	Rs	p	rs	P	rs	p
Proportion of elderly people	0.33	0.000	0.26	0.001	-0.10	0.223
Proportion of households whose head has no income, including those receiving only benefits	-0.14	0.077	-0.06	0.464	0.26	0.001
Proportion of households whose head has an income less than or equal to three minimum wages. Including those who have no income	-0.19	0.019	-0.11	0.177	0.22	0.008
Proportion of households whose head has an income higher than or equal to 15 minimum wages	0.15	0.072	0.05	0.512	-0.29	0.000
Proportion of households that do not have computer	-0.21	0.010	-0.12	0.140	0.23	0.005
Proportion of couples with children	-0.26	0.001	-0.22	0.008	0.06	0.494
Proportion of households with one individual	0.15	0.060	0.08	0.332	-0.19	0.018
Proportion of households with a population density of 4.0 people per bedroom	-0.20	0.013	-0.14	0.096	0.10	0.232

** IHD mortality rate in the elderly, standardized by gender and age. † IHD mortality rate in the elderly, balanced and adjusted for ill-defined causes. ‡ IHD mortality rate in the elderly plus ill-defined causes (IDC).*

(negative correlation). For the other variables, there was no statistically significant correlation.

When analyzing the correlation between socioeconomic variables and IHD mortality rate plus IDC, we found a pattern that was distinct from the one mentioned above. The correlation became positive and statistically significant for the following variables: proportion of households whose head has no income, including those who only receive benefits; proportion of households whose head has an income less than or equal to three minimum wages, including those without income; and proportion of households that have no computer. The addition of IDC to the IHD mortality rate reversed the direction of the association for 4 variables, which followed the pattern of worse socio-economic conditions and increased IHD mortality. The proportion of households whose head has an income higher than or equal to 15 minimum wages, and the proportion of individual residents, which showed positive correlations with the rate without correction, became negatively correlated.

Table 2 shows the autocorrelation of the IHD mortality rate in the elderly and socioeconomic variables, given by Moran's I. There was no spatial dependence for the IHD mortality rate or for the two corrections used for this rate. The socioeconomic variables analyzed showed Moran I index with values ranging from 0.26 to 0.54, all with statistical significance (p = 0.000), indicating the existence of spatial dependence.

Table 2 - Spatial autocorrelation of IHD mortality rate in the elderly and socioeconomic variables in Rio de Janeiro in 2000

Variables	Moran Index I	p-value
IHD mortality rate	-0.02	0.777
Balanced and adjusted IHD mortality rate	-0.03	0.683
IHD mortality rate plus IDC	0.04	0.341
Proportion of elderly people	0.44	0.000
Proportion of households whose head has no income, including those receiving only benefits	0.29	0.000
Proportion of households whose head has an income less than or equal to three minimum wages, including those who have no income	0.35	0.000
Proportion of households whose head has an income higher than or equal to 15 minimum wages	0.54	0.000
Proportion of households that do not have a computer	0.43	0.000
Proportion of couples with children	0.54	0.000
Proportion of households with one individual	0.46	0.000
Proportion of households with a population density of 4.0 people per bedroom	0.26	0.000

The spatial distribution of the balanced and adjusted IHD mortality rate is shown in Figure 4, which shows that the cluster, previously existing, of low IHD mortality rates in AP 5.2 and 5.3 decreased, whereas the cluster of high mortality rates at AP 2.2 was maintained.

Figure 5 shows the spatial distribution of IHD mortality rates plus IDC, which shows that the previously existing cluster of high mortality rates at AP 2.2 decreased. Similarly, the cluster of low mortality rates at AP 5.3 presented moderate rates. Three clusters of high mortality rates were also observed, one in AP 3.3, the second in AP 4.0, and the third in AP 5.1. However, the districts of Guaratiba, Barra de Guaratiba and Cosmos, all belonging to AP 5.2, continued to experience low rates of IHD mortality in the elderly.

Discussion

This study found no strong correlations between the socioeconomic variables available and IHD mortality in the elderly in the districts. A possible explanation may be related to a heterogeneous socioeconomic profile within each district. Therefore, the socioeconomic variables represent an average value that would not be able to discriminate variations at this level of aggregation.

Some correlations found in this study are opposite to what has been described in the literature, which generally indicates a higher IHD mortality associated with a more unfavorable socioeconomic profile. Studies conducted by the World Health Organization revealed that the developing countries, which are the places with the lowest socioeconomic conditions, concentrate most of the burden of cardiovascular diseases[20]. A study conducted in Bambuí, Minas Gerais

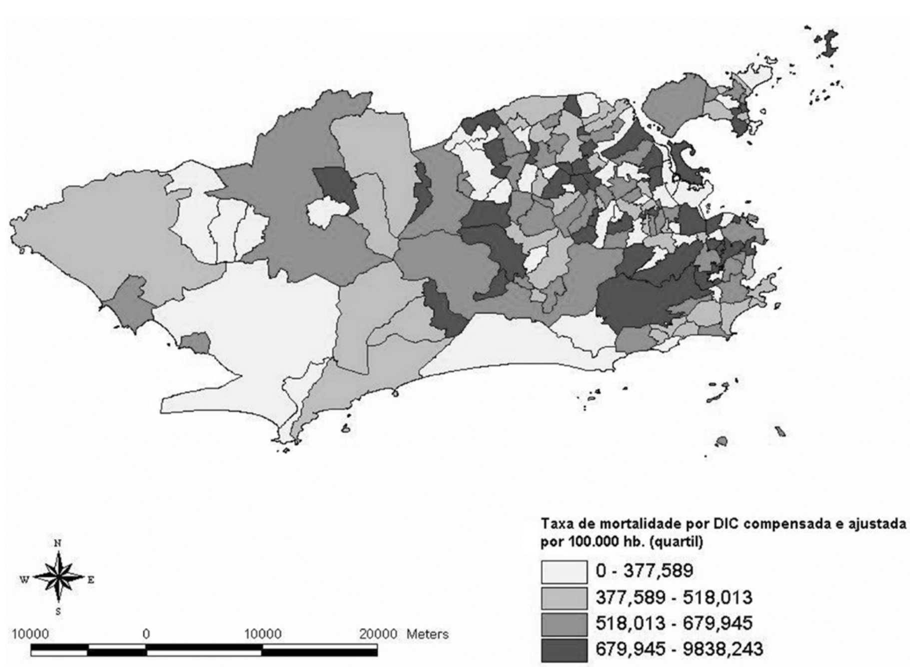

Figure 4 - Spatial distribution of the balanced and adjusted IHD mortality rate in the elderly in Rio de Janeiro in 2000.

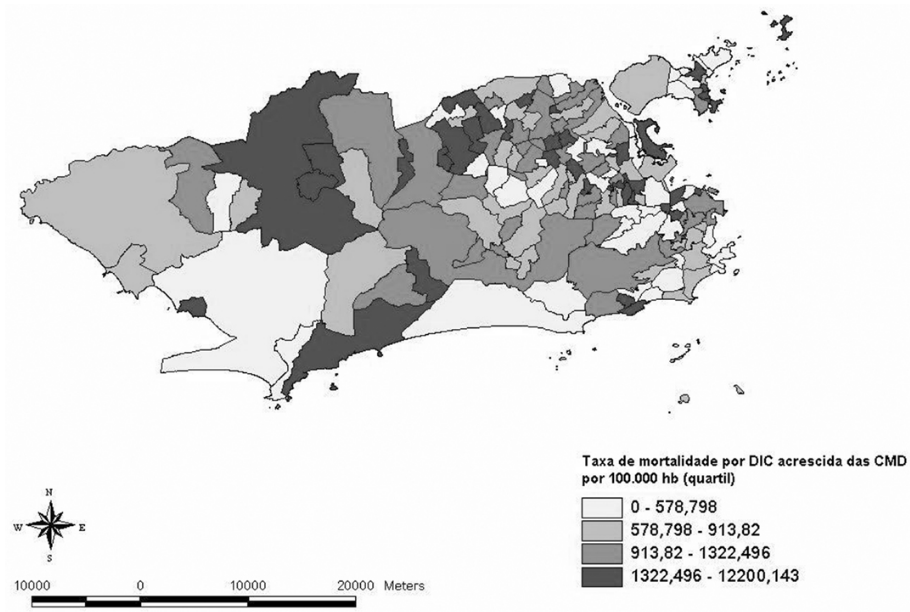

Figure 5 - *Spatial distribution of the IHD mortality rate in the elderly plus ill-defined causes (IDC) in Rio de Janeiro in 2000.*

State, found an association between having had less than 4 years of schooling and a worse risk profile for cardiovascular disease in adults[21]. Another study conducted in Salvador, Bahia, showed a high proportion of multiple cardiovascular risk factors associated with the black population with less schooling[22]. Another study conducted in Botucatu, São Paulo, found no association between the risk of cardiovascular death and socioeconomic indicators in a cohort of elderly, raising the possibility that the group studied was very homogeneous as regards these traits [23].

In our study, we found a correlation between lower IHD mortality in the elderly, standardized by age and gender, and some variables that reflect lower socioeconomic level: districts with larger proportion of low-income, and districts with larger proportion of households without a computer. On the other hand, the proportion of permanent private households, whose head earns more than 15 minimum wages, was associated with higher mortality from IHD. These findings may be related to the selection of the elderly age group. It is possible that low socioeconomic status results in adverse differences regarding cardiovascular outcomes, especially ischemic events before 60 years of age, in earlier stages of life. Perhaps it was for this reason that studies with no age restrictions found an inverse relationship between socioeconomic status and IHD, and this study did not. The selection group may have masked the relationship that exists between these phenomena throughout the subjects' lives. Competition with other causes of mortality in this age group, such as stroke and respiratory diseases, could also minimize possible associations between socioeconomic status and mortality from IHD.

Another explanation for the associations observed could be the confounding induced by the proportion of deaths from ill-defined causes, which is larger in economically disadvantaged districts. Therefore, by correcting the IHD mortality rate by adding the ill-defined causes, some of the associations were reversed and showed results similar to those described in the literature. Anyway, the results of this study can not be generalized for people's entire life.

It should be noted that a multicenter study conducted in Brazil, to determine the risk factors for AMI, also found that this occurrence was more prevalent among those who had the best socioeconomic conditions[4].

The correlations between higher proportion of couples with children with lower IHD mortality, and higher proportion of households with individuals and higher mortality have been described and may be related to the influence of psychosocial factors. The literature has referred to the influence of marital status and social support for the elderly on cardiovascular mortality[23,24].

This study found no significant spatial autocorrelation of IHD mortality in the elderly. Another recent study on the spatial distribution of mortality from acute myocardial infarction (AMI) in RJC found a weak, although statistically significant spatial dependence. This study, unlike ours, exclusively examined mortality from AMI and in all age groups, emphasizing the high proportion of early deaths observed (below 65 years). The authors showed a heterogeneous pattern of spatial distribution of AMI deaths associated with a strong social gradient, considering this "mosaic pattern" consistent with the social inequalities existing in our municipality[13].

The study[13] found a sub-risk standard of mortality from AMI in the western area, especially in AP 5.1 and AP 5.3, which is not consistent with the socioeconomic background and the access to health services in the area, less favored than the others in the municipality. The authors hypothesized that the mortality rate from AMI may have been underestimated due to the high proportion of ill-defined causes of death in this region. The authors chose to make the adjustment in the mortality rate by adding ill-defined causes.

The limitations of this study relate primarily to the quality of data, which originated from secondary databases. As for the SIM, studies[25,26] point out that the mortality data in Brazil are large and of reasonable quality. Its coverage in 2002 was 83.3% for the country as a whole, ranging from 92.6% in Rio Grande do Sul to 52.9% in Maranhão[1]. Although a gradual improvement has been observed in the quality of mortality data in Brazil, about 14% of deaths are still classified as ill-defined[25]. In the municipality of Rio de Janeiro, these have accounted for an average of 10% of deaths over the years[27]. In 2000, the proportion of deaths classified as ill-defined was 10.8%.

The reliability of the data in Rio de Janeiro is traditionally regarded as satisfactory, but we must also consider the weight of ill-defined causes, still above the values considered low, which would be around 4% to 6% of deaths from ill-defined causes[25].

In the state of Rio de Janeiro, there was an increase in ill-defined causes, particularly the code R99 which corresponds to unknown causes, coinciding with the publication of SES Resolution n.o 550 of January 23, 1990[28], which states that, having exhausted the attempts to determine the underlying cause of death (and if there is no suspicion of violent death), death is declared due to "undetermined cause." A study on the investigation of deaths from ill-defined causes conducted by the Epidemiological Information Management of SMS-RJ showed that 13.5% of the recovered deaths belonged to the group of diseases of the circulatory system[27].

Some authors suggest correcting the mortality rate from cardiovascular disease, including DIC, by proportionally distributing different defined causes of death[12]. Other authors[29] consider as insatisfactory the practice of proportional redistribution of well-defined causes among deaths from ill-defined causes. Still others have opted for the adjustment by the addition of ill-defined causes[13].

In this study, we found that the highest rates of ill-defined causes were found in the districts of AP 3.3, 5.1, 5.2, and 5.3, which can be connected to the issue of access to health services and quality of service to the population. It must be noted that these regions have poor tertiary health care coverage[13], which can be directly associated with the large proportion of R99 code of ICD-10, used in situations in which "undetermined" is the only information contained in the death certificate[27]. Occasionally, an elderly patient who has access to medical help, may arrive dead or die soon after being admitted, making it impossible to obtain an accurate diagnosis.

The analysis of the correlation between the IHD mortality rate, standardized by gender and age, and socioeconomic variables found some associations which, albeit weak, resulted in increased mortality associated with higher socioeconomic status in the elderly. This finding may be partly related to the proportion of ill-defined causes. On the other hand, it may be related to a distinct profile in the age group of elderly, already observed in another study[23]. In this study, we used two different methods of correction of ill-defined causes. The first, called balanced and adjusted IHD mortality rate in the elderly[12], set aside most of the associations previously reported, because, although weak, they were statistically significant. The IHD mortality rate plus IDC in the elderly, (obtained by the second correction method), reversed some of the associations found initially at the IDC rate without correction. The associations found with the IHD mortality rate plus IDC tended to show greater mortality in districts with low socioeconomic status, which is consistent with what is found in the literature[12,21-23]. However, the variable proportion of households with one resident, which previously was positively correlated with IHD mortality, started to have a negative correlation, and the proportion of households with a density of more than 4 people per bedroom started to show a weak and not significant positive correlation. This correction included all deaths from ill-defined causes in the mortality rate from IHD plus IDC, which probably does not reflect reality, tending to overestimate the mortality rate. Moreover, the highest proportions of deaths from ill-defined causes can be found in AP 3.3, 5.1, 5.2, and 5.3, which are economically disadvantaged. The correction of the rate by the addition of these ill-defined deaths tend to elevate mortality in association with less favorable socioeconomic conditions.

The sub-risk of death of elderly people from IHD in the districts of the AP 5.2 remained the same after the two corrections were made.

Santos and Noronha[9], while discussing the quality of data for spatial analysis in health care, based on secondary data, referred to the problems of the variable used for the geo-referenciation, such as lack of information and misclassification. In this study, we found 2.2% deaths of patients whose district of residence was unknown. Moreover, we can not control the misclassification of the residential area, which may have been influenced by a neighboring district that is better known.

Conclusion

In dealing with some descriptor variables of socioeconomic characteristics of urban space in Rio de Janeiro and the distribution of IHD mortality rates in the elderly, this study found spatial dependence for socioeconomic variables, but not for IHD mortality in the elderly. Despite the fact that the urban space is very heterogeneous within the districts, this finding demonstrates a degree of agglomeration in terms of socioeconomic status. There were strong correlations between the socioeconomic variables and mortality from IHD. Some correlations, although weak, showed an increased mortality associated with more favored socioeconomic status in the elderly, taking into account IHD mortality rate standardized by gender and age. Possible explanations for these results may be related to a heterogeneous distribution of the proportions of ill-defined causes, the distinctive profile of this age group, or a confouding related to the selection of this age group.

Further studies are needed to better understand the impact of ill-defined causes on such associations, the relationship between urban spaces in Rio de Janeiro, known to be heterogeneous within each district, using geographical units that are smaller than the district, and the health and disease process, particularly with regard to cardiovascular mortality in the elderly. Finally, the understanding of the spatial distribution of variables associated with this process can collaborate with the decisions of managers and actors in the health system.

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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