Correlation Between Mortality From Aortic Aneurysm, Sex, Administrative Regions and Age Group in Brazil

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Short Report

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Abstract

Introduction

Aneurysmal disease is a focal and permanent dilation of the vessel diameter greater than 50% of its normal diameter, whose natural history is the progressive enlargement of the aneurysm, culminating in its rupture, if not treated. Traditional risk factors are those common to other cardiovascular diseases. However, even though socioeconomic status has gained importance in terms of its influence on vascular diseases, few studies seek to understand the behavior of this disease in countries with high levels of socioeconomic inequality, such as Brazil.

Objective

to analyze the correlation between age group, sex, and mortality from aortic aneurysm in the Brazilian federative units.

Method

study with analysis of secondary data on mortality from Aortic Aneurysms in Brazilian states in the year 2019, extracted from the Global Burden of Disease platform and the Institute for Applied Economic Research. The program used for statistical analysis was Stata® (StataCorp, LC) version 11.0.

Results

Higher mortality was observed in males, with a statistically significant increase in mortality in age groups from 40 years onwards. There are also important regional differences in mortality from standardized Aortic Aneurysms in Brazilian administrative regions.

Conclusion

mortality from aortic aneurysm increases with age, with deaths being detected from the fourth decade of life onwards, although screening only occurs after 65 years of age. Such results may justify the need to include younger individuals, around 40 years of age, in the screening for aneurysm detection.

1 Introduction

Aortic aneurysmal disease is a localized and permanent dilation of the vessel diameter greater than 50% of its normal diameter and represents important socioeconomic impacts due to its high morbidity and mortality\textsuperscript{1,2}. Infrarenal abdominal aortic aneurysm is the most common presentation, with prevalence in
approximately 2% of men over 60 and tends to increase with age, therefore in developed countries this prevalence may be higher, which may be justified partly due to longer life expectancy\(^3\).

The natural history of aortic aneurysmal disease is characterized by the progressive enlargement of the aneurysm that culminates in its rupture if left untreated. Aneurysm is a multifactorial disease and some of these factors are advanced age, atherosclerosis, systemic arterial hypertension, smoking and genetic diseases\(^2\).

In recent years, growing understanding of the influence of socioeconomic aspects on the morbidity and mortality of this disease has become an important instrument to reduce the epidemiological burden\(^2\).

Thus, in view of the changes that have taken place in the epidemiological profile of the Brazilian population, the regional inequalities of a country with continental dimensions, the increase in life expectancy and the improvement of diagnostic methods for aortic aneurysmal disease in Brazil, the objective of the present study was to analyze the correlation between mortality from aortic aneurysm with age group, sex and administrative regions with data extracted from the federative units of Brazil in the year 2019, through an ecological study using analysis of secondary databases.

The increase in the prevalence of diagnoses of aortic aneurysm (AA) is due to increased Brazilian life expectancy, increased access to health services in regions with higher Human Development Indexes and to the advancement of non-invasive diagnostic techniques, such as vascular ultrasound\(^2\).

In a structural analysis, pathological dilation of the aortic wall occurs when there is deterioration of the local connective tissue and remodeling in the arterial wall. This may be due to chronic transmural inflammation, with depletion or destruction of smooth muscle cells, which leads to a high production of metalloproteinases in the extracellular matrix, whose composition involves collagen, proteoglycans, elastin and fibronectin\(^1\,\,^2\).

Intraluminal thrombi can be detected in about 75% of cases of aortic aneurysm and this can be a point of vulnerability that should be avoided when placing an endoprosthesis\(^3\,\,^4\).

The importance of encouraging AA screening is justified by the fact that the disease evolves silently in most cases, or presents nonspecific symptoms such as diffuse abdominal pain; the possibility of making an accurate diagnosis through non-invasive and low-cost methods such as vascular ultrasound; the life expectancy of treated patients is comparable to individuals of the same age group without the disease\(^4\).

Brazil is a country of continental dimensions and with high levels of socioeconomic inequality, presenting characteristics of both a developed and underdeveloped nation within the same territory, according to public data that can be consulted on the website of the Institute of Applied Economic Research (IPEA). This discrepancy results in the country having a high burden of chronic diseases, which is common in developing countries, and facing challenges to manage public health in view of these existing socioeconomic inequalities\(^5\,\,^6\).
At the same time, this disparity presents challenges in health management regarding the burden of Noncommunicable Diseases and Disorders (NCDs) and Infectious and Parasitic Diseases.

In recent years, there have been intense changes in various socioeconomic and behavioral aspects and advances in health diagnostic technologies.

These factors combined can favor a higher incidence of NCDs, such as cardiovascular diseases.\(^7\)

It is therefore necessary to make efforts to understand the relationship between population characteristics such as age group, sex, demographic region and their relationship with aortic aneurysmal disease in Brazil, as identifying this relationship can contribute to access to diagnostic methods in groups that are more prone to developing the disease by strengthening public policies of Primary Health Care.

2 Methods

2.1 Study design

An ecological study was carried out using the Brazilian federative units and the federal district as sample units, evaluating secondary data using the Global Burden of Disease (GBD) and the Institute of Applied Economic Research (IPEA) databases, referring to the year 2019.

2.2 Data source

Global Burden of Disease (www.healthdata.org)

The Global Burden of Disease (GBD) is a database that quantifies health loss by hundreds of diseases, injuries and even risk factors so that health systems can be improved and disparities eliminated. It is possible through this tool to measure the morbidity and mortality of various diseases around the world, and with the exponential increase in its influence in recent decades it has become an international
consortium of over 3,600 researchers, in which estimates are systematically updated. The GBD is managed by the Institute for Health Metrics and Evaluation (IHME) which feeds the database with a set of interactive data views.

Institute of Applied Economic Research (www.ipea.gov.br)

The Institute of Applied Economic Research (IPEA) is a federal public body linked to the Ministry of Economy. Its research activities provide technical and institutional support to government actions for the formulation and reformulation of public policies and development programs in Brazil.

The Human Development Index (HDI) was conceived by the Pakistani Mahbub ul-Haq in 1990 and served as an empirical basis for the human development reports of the United Nations Development Program (UNDP) and is used as a basis for measuring the degree of development of a given society in terms of education, health and income.

In 1996, IPEA and the João Pinheiro Foundation of Minas Gerais adapted the HDI and developed the Municipal Human Development Index (MHDI), which calculated indexes at a territorial level less aggregated than the national level.

The MHDI replaces the Gross Domestic Product per capita with the average family income and the combined school enrollment rate with the average number of years of study in
the adult population (aged 25 and over). The calculated index is published in the Atlas of Human Development of Brazil\textsuperscript{9,10} and the closer to 1, the better the index for that city.

### 2.3 Study variables

The indicators analyzed in this study were mortality from aortic aneurysm, age group (classified by grouping ages into 19 to 40 years; 41 to 60 years; 61 to 80 years and; 80 + years), sex (male and female) and Brazilian regions (North, Northeast, Midwest, Southeast and South) in 2019.

These data were obtained from the GBD database and classified according to the Tenth Revision of the International Classification of Diseases (ICD-10) using website tools that allow access to all Brazilian federative units in addition to IPEA to verify the Municipal Human Development Index (MHDI) for Brazilian capitals and the Federal District.

### 2.4 Data analysis

To analyze if the disposition of the data is normally distributed, the Shapiro-Wilk test was used. In accordance with the normality of the data (Shapiro Wilk, \( p > 0.05 \)), Student's t-test was used for variables with two categories and ANOVA to compare variables with more than two categories. Linear regression was used to estimate the differences in mortality by sex, regions and age group, estimating the angle (B) and respective 95% confidence
3 Results

In Brazil, mortality from Aortic Aneurysm (AA) was 3.93 deaths per 100,000 people in the year 2019. This mortality was higher in the Southeast region, where it caused 5.2 deaths per 100,000 people (p = 0.003), in males (5.02 deaths per 100,000 men, p < 0.001) and in those with 80 or more years of age (61.4 deaths per 100,000 people; p < 0.001) (Table 1).

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Standardized mortality by average age (95% CI)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>3.93 [3.36 to 4.50]</td>
<td>-</td>
</tr>
<tr>
<td>Regions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>North</td>
<td>3.04 [2.35 to 3.73]</td>
<td>0.003*</td>
</tr>
<tr>
<td>Northeast</td>
<td>3.26 [2.40 to 4.12]</td>
<td></td>
</tr>
<tr>
<td>Midwest</td>
<td>4.56 [3.05 to 6.07]</td>
<td></td>
</tr>
<tr>
<td>Southeast</td>
<td>5.24 [3.02 to 7.46]</td>
<td></td>
</tr>
<tr>
<td>South</td>
<td>4.36 [3.68 to 5.04]</td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>5.02 [4.25 to 5.80]</td>
<td>&lt; 0.001**</td>
</tr>
<tr>
<td>Female</td>
<td>3.03 [2.62 to 3.45]</td>
<td></td>
</tr>
<tr>
<td>Age group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 40 years</td>
<td>0.36 [0.31 to 0.41]</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>41 to 60 years</td>
<td>3.40 [2.97 to 3.83]</td>
<td></td>
</tr>
<tr>
<td>61 to 80 years</td>
<td>21.50 [19.14 to 23.85]</td>
<td></td>
</tr>
<tr>
<td>80+ years</td>
<td>61.43 [53.14 to 69.72]</td>
<td></td>
</tr>
</tbody>
</table>

*ANOVA, **Student’s t-test

Regarding the behavior of AA in Brazilian regions, the North Region had a mortality rate of 3.77 per 100,000 inhabitants among men (3.77, 95% 95%CI 2.80 to 4.74), 2.37 among women (2.37, 95%CI 1.85 to 2.88) and mean difference representing 1.4 AA deaths per man for each death from the same disease in
women (1.4, 95%CI 0.32 to 2.38); p = 0.008. The Northeast region presents a similar behavior, with a mean difference in mortality of (1.41, 95%CI 0.21 to 2.62); p = 0.023 (Table 2).

### Table 2
Differences in mortality from aortic aneurysm between sexes in Brazil in 2019, according to regions and age groups.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Male</th>
<th>Female</th>
<th>Mean difference (95% IC)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>5.02 [4.25; 5.80]</td>
<td>3.03 [2.62; 3.45]</td>
<td>1.99[1.13;2.86]</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Regions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North</td>
<td>3.77 [2.80; 4.74]</td>
<td>2.37 [11.85; 2.88]</td>
<td>1.40 [0.32; 2.38]</td>
<td>0.008</td>
</tr>
<tr>
<td>Northeast</td>
<td>4.05 [2.92; 5.17]</td>
<td>2.63 [1.95; 3.30]</td>
<td>1.41 [0.21; 2.62]</td>
<td>0.023</td>
</tr>
<tr>
<td>Midwest</td>
<td>5.81 [3.30; 8.32]</td>
<td>3.40 [2.63; 4.18]</td>
<td>2.40 [0.71; 4.10]</td>
<td>0.016</td>
</tr>
<tr>
<td>Southeast</td>
<td>6.95 [4.09; 9.82]</td>
<td>3.90 [2.19; 5.62]</td>
<td>3.05 [0.48; 5.61]</td>
<td>0.027</td>
</tr>
<tr>
<td>South</td>
<td>5.84 [4.63; 7.06]</td>
<td>3.16 [2.89; 3.44]</td>
<td>2.67 [1.87; 3.48]</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Age group</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 40 years</td>
<td>0.48 [0.42; 0.55]</td>
<td>0.36 [0.32; 0.40]</td>
<td>0.24 [0.17; 0.32]</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>41 to 60 years</td>
<td>4.43 [3.84; 5.02]</td>
<td>2.45 [2.16; 2.74]</td>
<td>1.98 [1.32; 2.63]</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>61 to 80 years</td>
<td>28.16[25.01;1.32]</td>
<td>15.91[14.10;17.72]</td>
<td>12.25 [8.63; 15.86]</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>80 + years</td>
<td>73.05[62.73;83.36]</td>
<td>54.49[46.74; 2.24]</td>
<td>18.55 [5.75; 1.36]</td>
<td>0.005</td>
</tr>
</tbody>
</table>

The Midwest and South regions had a similar mortality from AA among men (5.81, 95%CI 3.30 to 8.32) and (5.84, 95%CI 4.63 to 7.06), respectively, as well as among women (3.40, 95%CI 2.63 to 4.18) and (3.16, 95%CI 2.89 to 3.44), respectively. In addition, they also presented similar mean differences with statistical significance (p = 0.016 and p < 0.001, respectively) (Table 2).

The Southeast Region had the highest standardized AA mortality rates between sexes in the Federative Units, as well as the highest mean difference between sexes, with 3.05 deaths from AA in men for each death of the same pathology (3.05, CI95% 0.48 to 5.61); p = 0.027 (Table 2).

When evaluating mortality from AA in different age groups, in patients up to 40 years of age, an average difference in mortality from AA of 0.24 male deaths for each female death from AA (p < 0.001) was observed. For ages ranging between 41 to 60 years old, mortality from standardized AA among men is 4.43 per 100,000 inhabitants (4.43, 95%CI 3.84 to 5.02) and 2.45 per 100,000 inhabitants among women (2.45, 95%CI 2.16 to 2.74), with a mean difference of 1.98 (1.98, 95%CI1.32 to 2.63); p < 0.001 (Fig. 1).
In patients with more advanced age, there was a higher mortality between sexes. Between the ages of 61 and 80, standardized mortality from AA for men and women was 28.16 and 15.91 per 100,000 inhabitants, respectively, with a mean difference of 12.25 (95% CI 8.63 to 15.86); p < 0.001). In the age group of 80 years or older, standardized mortality from AA for men and women was 73.05 and 54.49 per 100,000 inhabitants, respectively. The mean difference is (18.55, 95% CI 5.75 to 31.36); p = 0.005 (Table 2).

When comparing the MHDI of Brazilian capitals, the lowest indexes were observed in the north and northeast (Fig. 2).

In the North Region, the indexes were Manaus (0.741), Belém (0.721), Rio Branco (0.737), Porto Velho (0.751), Boa Vista (0.765), Macapá (0.741) and Palmas (0.755).

In the Northeast Region, the indexes were São Luís (0.705), Teresina (0.715), Fortaleza (0.746), Natal (0.737), João Pessoa (0.717), Recife (0.741), Maceió (0.696), Aracaju (0.717) and Salvador (0.723).

In the Midwest Region, the indexes were Goiânia (0.783), Cuiabá (0.783), Campo Grande (0.781) and Federal District (0.862).

In the Southeast Region, the indexes were Rio de Janeiro (0.817), São Paulo (0.842), Belo Horizonte (0.787) and Vitória (0.784).

In the South Region, the indexes were Porto Alegre (0.802), Florianópolis (0.818), Curitiba (0.799).

4 Discussion

The present study showed that mortality from aortic aneurysmal disease increases with age, which corroborates the published data from a study carried out from 2007 to 2014 by the team from the Centro Hospitalar de Vila Nova de Gaia e Espinho in the city of Vila Nova de Gaia, Portugal, which has around 300,000 inhabitants and also supports neighboring towns.

In capitals where MHDI is lower, the population has, in general, less access to health services, lower life expectancy, lower education and the combination of these factors influence the lower number of notifications of deaths from AA in the North and Northeast regions of Brazil (Fig. 2).

The prevalence of this disease is 2% in males aged over 60 years and with the increase in life expectancy of Brazilians, the tendency is for these numbers to increase. This pathology is potentially fatal, since mortality can occur due to hemorrhagic shock caused by the rupture of the aneurysm and should this occur, requires urgent surgery, however the mortality in this type of surgery is high. According to our findings, standardized mortality from AA increases as a result of age in both sexes. In female individuals, from the age of 60 onwards, mortality from AA increases substantially, assuming a greater difference between the sexes for the age groups from 75 to 89 years, which does not seem to occur among individuals with ages up to 59 years.
Demographic transitions in the world population have been intensely occurring in the last 100 years due to the behavior of births, deaths and migrations. According to World Health Organization estimates, the global population aged 60 years or older is expected to almost double from 2015 to 2050, with percentages ranging from 12–22%, representing about 2 billion individuals (total of 9.2 billion)\(^{13,14}\).

According to data from the GBD and the findings of our study, as is the case in other large countries such as Canada, China, the United States, Russia and Australia, Brazil presents similar data in relation to overall mortality from aortic aneurysm\(^8\), despite having regions with lower MHDIs such as the north and northeast of the country.

Some rich countries, like France, had around 120 years to adjust and adapt to these changes in the demographic profile of its population, going from 10–20% of the population aged 60 or over, however, countries such as Brazil and India will have about 20 years to adapt their health systems and pension systems to accommodate this population\(^{15}\).

The demographic transition shows an aging Brazilian population and with this there is a higher prevalence of a number of chronic noncommunicable diseases, such as aortic aneurysm\(^{16}\). In Brazil, the elderly population grows about 650,000 each year, and before that, efforts are made to provide a multiplicity of aspects for health promotion and disease prevention in this population\(^{17}\).

Some risk factors such as systemic arterial hypertension, obesity and dyslipidemia are related to unhealthy lifestyles. Smoking is more frequently identified in populations of low socioeconomic status\(^{18}\). In addition, being male and having high blood pressure are risk factors for multivessel diseases\(^{19}\).

Aneurysmal disease affects more men than women in Brazil, but women aged 45 and over also show an increase in the number of cases and this distribution occurs in a similar way in all the federative units of Brazil and in the Federal District, despite differences in MHDII. Women are at four times greater risk than men for rupture of aneurysms of equivalent diameters, in addition to higher postoperative mortality for both techniques, endovascular or open surgery, both in emergency and elective treatment\(^{20}\).

Data from the National Health Survey showed that women had more access to antihypertensive medication, blood pressure measurement, more blood glucose, triglycerides and cholesterol serum analysis, and greater access to at least one medication dispensed by the Popular Pharmacy Program, a fact that combined with the natural protective effect estrogen levels have in women, these can contribute to protection against atherosclerotic effects and related cardiovascular events, but once an aortic aneurysm develops, the risk of rupture is greater than in men\(^{20,21}\).

It is estimated that the risk of rupture, in 5 years, of an abdominal aortic aneurysm under 5 cm is less than 5%, while those larger than 5 cm carry a risk of 25 to 43%\(^{22}\). Considering that aortic aneurysm is an insidious disease of slow growth, in incidental diagnosis the cost/benefit of screening work in non-elderly individuals is often questioned\(^{23,24}\).
The international literature shows that screening the population aged 65 and over is cost-effective, reducing the specific mortality from aortic aneurysm by 44%. The cost/benefit of aortic aneurysm surgery proved to be advantageous when the largest transverse diameter is greater than 55 mm\textsuperscript{24}.

The recommendation of the National Guideline for the Treatment of Abdominal Aortic Aneurysm is strongly against conventional surgery or endovascular treatment in asymptomatic patients with small aneurysms (less than 55 mm) and patients with abdominal aortic aneurysms between 40 and 55 mm should be followed up with clinical evaluations and imaging exams every 6 months, regardless of gender\textsuperscript{25}.

The current medical literature recommends, in most cases, screening from the age of 65 years\textsuperscript{24}, however our results have already shown deaths from aortic aneurysms in individuals in the fourth decade of life in regions with higher MHDI where life expectancy is higher, education and access to information about the disease are more widespread and access to health services is greater. Therefore, early screening for aortic aneurysmal diseases should be considered.

## 5 Conclusion

A statistically significant correlation was observed between age group, gender and aortic aneurysm in the Federative Units and in the Federal District of Brazil. The older the population studied, the higher the incidence of deaths due to aneurysms.

Regions with lower access to health services, lower education levels and lower life expectancy had lower records of death from aortic aneurysm.

Thus, screening in populations at risk and in individuals in the fourth decade of life and older should be considered, given that aortic aneurysm complications, such as rupture and dissections, can be catastrophic.

## Declarations

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**Author contribution statement:**
Research Ethics Committee (REC): as this research was conducted using anonymous patient data taken from public databases, REC approval is not required.

Author Contributions:

KSS: conceptualization, writing, review and editing, data curation, methodology and project administration. SJG, DMML: writing, review and editing, data curation. FWSF, DMML: conceptualization, formal analysis, funding acquisition, software, writing, review and editing, data curation, methodology and project administration.

References


Figures

Figure 1

Mortality from aortic aneurysm (per 100,000 people)
Figure 2

Differences in MHDI in Brazilian states and the Federal District