

## Mortality Impact of Thoracic Aortic Disease in São Paulo State from 1998 to 2007

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### Abstract

**Background:** The epidemiological characteristics of thoracic aortic diseases (TAD) in the State of São Paulo and in Brazil, as well as their impact on the survival of these patients have yet to be analyzed.

**Objectives:** To evaluate the mortality impact of TAD and characterize it epidemiologically.

**Methods:** Retrospective analysis of data from the public health system for the TAD registry codes of hospitalizations, procedures and deaths, from the International Code of Diseases (ICD-10), registered at the Ministry of Health of São Paulo State from January 1998 to December 2007.

**Results:** They were 9.465 TAD deaths, 5.500 men (58.1%) and 3.965 women (41.9%); 6.721 dissections (71%) and 2.744. aneurysms. In 86.3% of cases the diagnosis was attained during autopsy. There were 6.109 hospitalizations, of which 67.9% were males; 21.2% of them died (69% men), with similar proportions of dissection and aneurysm between sexes, respectively 54% and 46%, but with different mortality. Men with TAD die more often than women (OR = 1.5). The age distribution for deaths and hospitalizations was similar with predominance in the 6th decade. They were 3.572 surgeries (58% of hospitalizations) with 20.3% mortality (patients kept in clinical treatment showed 22.6% mortality;  $p = 0.047$ ). The number of hospitalizations, surgeries, deaths of in-patients and general deaths by TAD were progressively greater than the increase in population over time.

**Conclusions:** Specific actions for the early identification of these patients, as well as the viability of their care should be implemented to reduce the apparent progressive mortality from TAD seen among our population. (Arq Bras Cardiol. 2013; 101(6):528-535)

**Keywords:** Aorta, Thoracic / pathology; Aortic Diseases; Health Profile.

### Introduction

Cardiovascular disease is the leading cause of mortality in the modern era in most developed and developing countries. This behavioral change in developing countries is mainly due to changes in lifestyle brought on by industrialization and urbanization, coupled with the increase in life expectancy, poor eating habits, smoking and the concomitant decrease in infectious and nutritional diseases<sup>1</sup>.

Despite the documented decline in cardiovascular disease mortality in the developed world (myocardial and cerebral infarction), this curve is still markedly ascending in developing countries, and at least 2.8 times higher than in developed ones. The expectation is that this difference will be further accentuated in coming years, according to Reddy and Yusuf<sup>1</sup>.

But Lotufo et al.<sup>2</sup>, analyzing the trend of heart disease mortality in São Paulo in the 1996-2010 period, demonstrated the same kind of behavior in developed countries and even more marked in the social classes with greater purchasing power.

Thoracic aortic diseases (TADs) represent a significant percentage of these deaths, which predominate as dissections and aneurysms. It is believed that, in conjunction with abdominal aortic aneurysms, they are the 13<sup>th</sup> most frequent cause of death in Western countries, accounting for 15,000-30,000 deaths per year in the United States<sup>3</sup>. Others claim that these numbers can be between 43,000 to 47,000 deaths per year<sup>4</sup>.

Much has been written about the complex pathogenesis of TADs, their natural history, the ideal time for interventions, different surgical techniques, outcomes and much is being written about the endovascular approach of diseases of the aorta and its branches<sup>5-9</sup>. Little is known, however, about the epidemiological characteristics of TADs in São Paulo and Brazil, as well as their impact on patient survival and socioeconomic cost to the national health system. Therefore, the aim of this study is to evaluate the impact of TAD mortality in the state of São Paulo, to epidemiologically characterize

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it and analyze the results of the treatment received by this population of patients.

## Method

A retrospective analysis of data from the Hospitalization and Procedure Registry of the Brazilian Unified Health System (SUS) for TAD codes from the International Classification of Diseases (ICD-10, Table 1) and deaths from TAD, collected from the General Mortality Registry of the Department of Forensic Medicine (DFM) of the State of São Paulo, recorded at the Health Secretariat of the State of São Paulo, allowed the creation of the study database comprising all patients registered during the period of January 1998 to December 2007.

Patients with aortic disease with ICD 171.3, 171.4, 171.8, 171.9, which are respectively related to ruptured abdominal aortic aneurysm, abdominal aorta aneurysm with no mention of rupture, ruptured aortic aneurysm at unspecified site and aortic aneurysm at unspecified site with no mention of rupture, were excluded from the study.

SUS assists approximately 75.4% of the population, and for highly complex procedures, such as cardiovascular surgery, assists almost all of the population<sup>10</sup>. Based on this information, it is possible to infer that the analyses of the study data represent approximately 75% of hospital admissions from TAD, almost all surgical procedures, and 100% of the deaths.

The figures related to the total population of the state of São Paulo, with discrimination by year and gender were provided by the Health Department of the State of São Paulo, from the census data from the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística - IBGE). Data interpretation was performed based on the descriptive analysis of the data for the population of the state of São Paulo. Nonparametric Wilcoxon test was used for comparisons between population groups and Spearman's correlation coefficient for the analysis of the event/deaths/year correlation, using SPSS 13.

This study was approved by the Research and Ethics Committee of the institution and Free and Informed Consent Form request does not fit the study model.

## Results

Aneurysms and aortic dissections (ICD 171) occupied the 30<sup>th</sup> position as the most frequent cause of death among the population of the state of São Paulo, according to the SEADE (Data Analysis State System) ranking in the period January 1998 to December 2006 (Table 2) totaling 18,042 deaths from diseases of the aorta. During this period, there were 8,448 deaths from TAD in the ICDs reported in the study, 4,922 deaths in men (58.3%), with 3,539 being secondary to aortic dissection (71.9%) and 1,383 secondary to rupture of thoracic aortic aneurysm (28.1%). The 3,526 women that died from TAD (41.7%) had a similar distribution to that of men, with 71.6% of deaths secondary to aortic dissection and 28.4% secondary to thoracic aortic aneurysm.

During the study extended period, from January 1998 to December 2007, TADs were responsible for 9,465 deaths (0.39% of the total of 2,396,588 deaths in the state of

**Table 1 - Thoracic aortic diseases according to the International Classification of Diseases (ICD-10)**

ICD 10	Diagnostic
I71.0	Dissecting aortic aneurysm
I71.1	Ruptured thoracic aortic aneurysm
I71.2	Thoracic aortic aneurysm with no mention of rupture
I71.3	Ruptured abdominal aortic aneurysm
I71.4	Abdominal aortic aneurysm with no mention of rupture
I71.5	Ruptured thoracoabdominal aortic aneurysm
I71.6	Thoracoabdominal aortic aneurysm with no mention of rupture
I71.8	Ruptured aortic aneurysm at unspecified site
I71.9	Ruptured aortic aneurysm at unspecified site with no mention of rupture

São Paulo in the same period). A total of 5,500 men (58.1%) and 3,965 women (41.9%) died. In these patients, the diagnosis of death attributed to TAD was attained at the DFM in 8,167 patients (86.3%), being 4,601 in men (56.3%) and 3,566 in women (43.7%). There was a total of 6,721 patients (71%) that died with a diagnosis of thoracic aortic dissection (ICD 171.0) and 2,744 (29%) due to thoracic aortic aneurysm (ICD 171.1, 171.2, 171.5, 171.6).

During the same period, TADs were responsible for 6,109 SUS hospitalizations (0.025% of the total 24,009,860 hospitalizations that occurred in São Paulo in the same period), being 4,147 males (67.9%) and 1,962 females (32.1%). During the hospitalization period, 1,298 patients died (21.2%), being 899 men (69.3%) and 399 women (30.7%).

The proportion of men and women hospitalized due to aortic dissection and aneurysm of the thoracic aorta was similar, respectively, 54% (2,238 patients) and 46% (1,909 patients) in the male population *versus* 53.5% (1,049 patients) and 46.5% (913 patients) in the female population. However, the proportion of mortality between the sexes in relation to diagnosis was different, being in dissections and aneurysms, respectively, 24.7% (554 patients) and 18.1% (345 patients) in men *versus* 20.8% (218 patients) and 19.9% (181 patients) in women.

Table 3 shows the progressive increase in mortality from TAD in the state of São Paulo, the high number of patients whose diagnosis of death from TAD was attained in the autopsy room and that the increase in mortality from the disease (36.7%) was higher than the increase of the population (18%) during the same time period.

The distribution of TAD in the population of the state of São Paulo – determined by the number of SUS admissions and the number of deaths of these patients – was different between men and women. Hospital admissions were more frequent in men and they were also responsible for more deaths, respectively, at ratios of 1.65/1 and 1.44/1. There was also a progressive increase in the number of hospitalizations and deaths from TAD over the years (Tables 3 and 4).

When analyzing the trend of increase in the number of hospitalizations from TAD, the number of deaths of

**Table 2 - Ranking of mortality rate by different causes in the state of São Paulo from January 1998 to December 2006**

Cause	Ranking	N. of deaths
AMI	1 <sup>st</sup>	177,484
Pneumonia	2 <sup>nd</sup>	111,427
CVA	3 <sup>rd</sup>	80,952
Firearm	5 <sup>th</sup>	76,691
DM	6 <sup>th</sup>	75,428
CHF	8 <sup>th</sup>	64,479
Automobile accidents	14 <sup>th</sup>	35,962
Breast cancer	18 <sup>th</sup>	28,496
Prostate cancer	23 <sup>th</sup>	26,941
Aortic diseases	30 <sup>th</sup>	18,042
Pulmonary embolism	36 <sup>th</sup>	14,400
Emphysema	45 <sup>th</sup>	11,668
Cardiac Arrhythmia	52 <sup>th</sup>	10,181
Alzheimer's	58 <sup>th</sup>	9,376

Source: Fundação Seade, SESSP; AMI: acute myocardial infarction; CVA: cerebral vascular accident; DM: diabetes mellitus; CHF: cardiac heart failure.

hospitalized patients and the total number of deaths, which was above the annual increase in the population, we observed a significant positive correlation in all three situations, respectively,  $r = 0.976 - p < 0.001$ ;  $r = 0.891 - p < 0.001$  and  $r = 0.915 - p < 0.001$ .

Figure 1 illustrates the progressive increase in deaths over the years, which was than the population increase ( $r = 0.796$ ,

$p = 0.006$ ), its differential increase between men and women, and significantly higher mortality in men over the years.

The odds ratio (OR) of a man with TAD to die is 1.5 times greater than that of a woman dying from the same cause (OR = 1.498 [CI: 0.95:1.13-1.19,  $p < 0.0001$ ]).

The 6,109 hospital admissions due to TAD generated 3,572 surgeries (58.5% of patients) for the correction of the underlying disease. Patients maintained exclusively on clinical treatment had a mean hospital mortality of 22.5%. There was a decrease in mortality to 20.3% in those patients in whom drug treatment was associated with surgical treatment. This difference was significant. Figure 2 illustrates the difference in outcome year by year with both types of treatment.

Patients hospitalized due to TAD were predominantly at the age range of 60-70 years, with the distribution shown in Figure 3A, as well as the highest number of deaths (Figure 3B).

The number of surgeries to correct TAD ranged from 0.7-1.5 patient/100,000 inhabitants/year. The mortality of these procedures had little impact when compared with the overall mortality from TAD (7.7%).

The number of hospitalizations from TAD when compared to the number of hospitalizations for all causes in the state of São Paulo is very significant, but when comparing the mortality of these patients in relation to the total SUS admissions, the disease severity can be observed, as well as the progressive increase in its prevalence (Table 3).

During part of the study period, from January 2004 to December 2007, it was possible to identify SUS admissions from TAD throughout the national territory, and São Paulo accounted respectively for 38.5%, 38.8%, 39.2% and 48.4% of these hospital admissions (Table 5). Regardless of regional differences in health systems and the greatest concentration of these patients in the state of São Paulo, the result of medical

**Table 3 - Number of hospitalizations and deaths from TAD and from all causes and their association with population increase in the state of São Paulo from 1998 to 2007**

TAD/Year	Total of HAA	HAA from TAD	% HAA TAD/total	Deaths/DFM	Deaths/hospitalized	Total deaths	% deaths TAD/general	Pop. SP	Deaths TAD x 10 <sup>-5</sup>
1998	2,380,248	337	0.01%	656	88	744	0.32%	35,283,992	2.1
1999	2,393,348	398	0.02%	728	94	822	0.35%	35,816,704	2.3
2000	2,398,344	385	0.02%	756	85	837	0.35%	37,032,403	2.26
2001	2,345,452	450	0.02%	763	102	865	0.37%	37,630,105	2.3
2002	2,360,704	566	0.02%	795	116	911	0.38%	38,177,734	2.4
2003	2,376,517	563	0.02%	868	145	1013	0.42%	38,709,339	2.6
2004	2,400,029	683	0.03%	947	133	1080	0.44%	39,239,362	2.75
2005	2,443,863	883	0.04%	899	154	1053	0.45%	40,442,820	2.6
2006	2,431,106	889	0.04%	922	201	1123	0.46%	41,055,761	2.74
2007	2,480,249	955	0.04%	837	180	1017	0.39%	41,663,623	2.44
Total		6109		8167	1298	9465			
% of variation		283%		28%	105%	36.70%			

TAD: thoracic aortic diseases; HAA: hospital admission authorization

**Table 4 - Female and male population hospitalized due to or dead from TAD and number of deaths per year per 100,000 inhabitants in the state of São Paulo from 1998 to 2007**

TAD/year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total
F H+D-TAD	361	415	449	476	529	536	648	701	711	702	5.528
F D/year	286	332	346	354	391	406	456	458	497	439	3.965
F D DAT x 10 <sup>-5</sup>	1,6	1,8	1,8	1,8	2	2,1	2,3	2,2	2,4	2,1	
M H+D-TAD	632	711	688	737	832	895	982	1081	1100	1090	8.748
M death/year	458	490	491	511	520	607	624	595	626	578	5.500
M death TAD x 10 <sup>-5</sup>	2,6	2,8	2,7	2,8	2,8	3,2	3,2	3	3,1	2,8	
Female pop.	17.899.523	18.167.033	18.893.040	19.207.646	19.508.370	19.793.470	19.805.188	20.723.102	20.989.036	21.351.076	
Male pop.	17.384.469	17.649.671	18.139.363	18.422.459	18.669.364	18.915.869	19.434.174	19.719.718	20.066.725	20.312.547	

Source: Datasus. F H+D-TAD: number of women hospitalized for or who died from TAD a year. F death/year: number of deaths a year among women. F death TAD x 10<sup>-5</sup>: number of deaths from TAD a year in women per 100,000 inhabitants. M H+D-TAD: number of men hospitalized for or who died from TAD a year. M death/year: number of deaths a year among men. M death TAD x 10<sup>-5</sup>: number of deaths from TAD a year in men per 100,000 inhabitants. Female pop: female population in the state of São Paulo year by year. Male pop: male population in the state of São Paulo year by year.

or surgical treatment did not show any difference in hospital mortality ( $p = 1.0$ ).

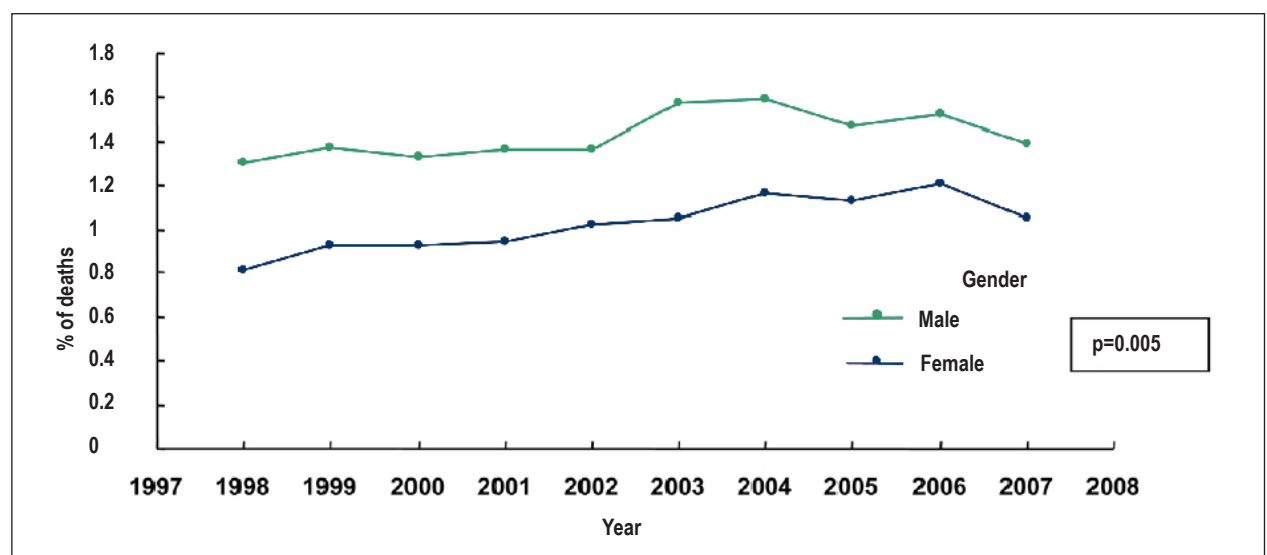
## Discussion

The prevalence of TAD in the population of the state of São Paulo cannot be properly measured by the current data recording model of the Health Secretariat.

The Datasus database, which belongs to the Executive Secretariat of the Ministry of Health, allows the identification of all deaths from TAD, inpatient or not, and informs all admissions with their respective ICDs. It does not allow, however, the identification of repeated hospitalizations of the same patient (all readmission are counted as a new patient). Furthermore, no patient with a TAD diagnosis being followed as outpatient is likely to be identified and individualized by the record system. If we add to this the large number of patients with TAD, with no diagnosis and no access to preventive

health care, we become aware of the limitations of our health system, and we can suppose that a large number of patients with TAD remain unidentified at risk of aortic dissection and/or rupture in our country.

For these reasons, more accurate statements on the incidence and prevalence of TAD are difficult to be made accurately. Differently from what occurs in Sweden, for instance, where all patients have access to health care, they are consistently recorded and easily tracked. It has been reported that the disease is currently more prevalent there than before, affecting men and women differently, respectively, 16.3 and 9.1 per 100,000 inhabitants per year. It has also been reported that the number of surgeries is increasing and higher in men, with 5.6 surgeries per 100,000 inhabitants per year versus 3.0 in women. However, it is noteworthy that in women, despite the lower number of cases, this represents a 15-fold increase compared to the last measurement versus a 7-fold increase in men. The number of deaths from the disease is decreasing,



**Figure 1 - Percentage of deaths of men and women from TAD per year in the state of São Paulo from 1998 to 2007.**

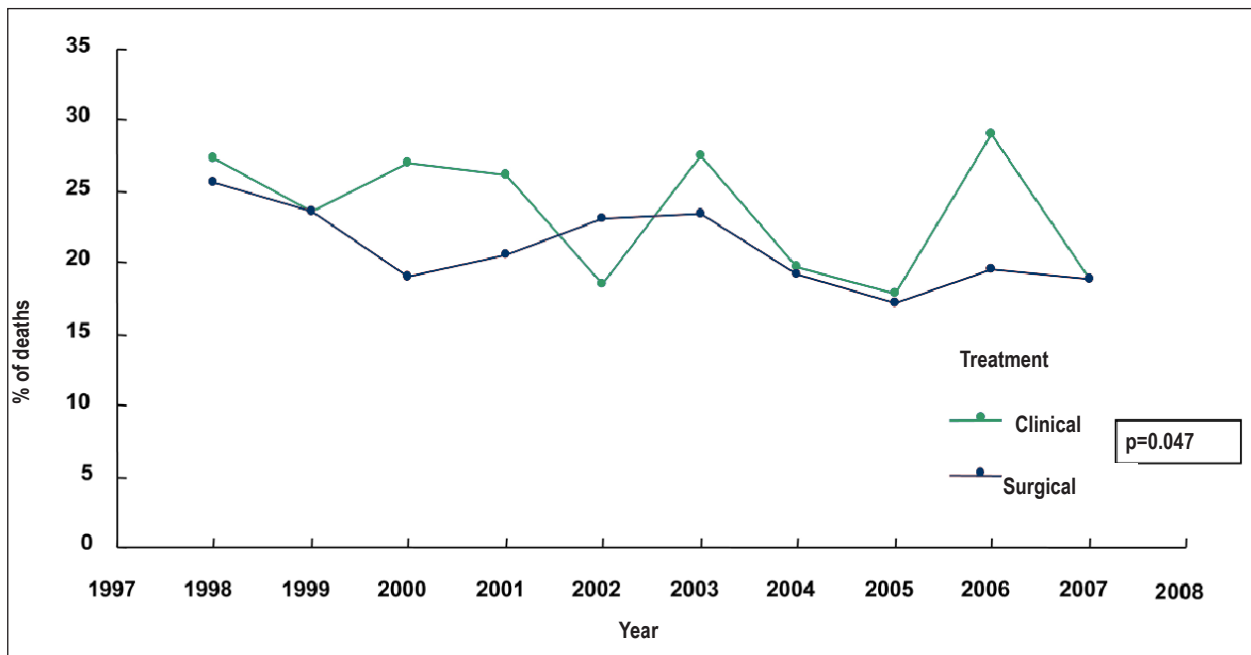


Figure 2 - Percentage of deaths in patients hospitalized due to TAD maintained in clinical treatment and those submitted to surgery in São Paulo state from 1998 to 2007.

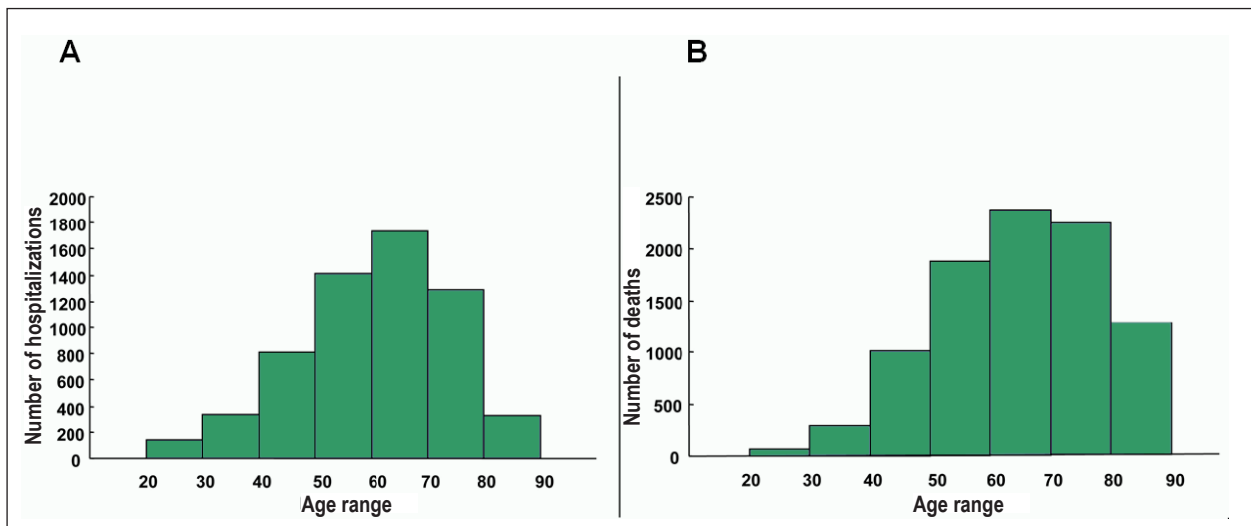


Figure 3 - A) Histogram of the number of hospitalizations from TAD by age group in the state of São Paulo from 1998 to 2007. B) Histogram of the number of deaths from TAD by age range in São Paulo state from 1998 to 2007.

but 22% of death diagnoses are made at the autopsy<sup>11</sup>, while in the state of São Paulo this number is 86.3%.

When analyzing the disease in its most advanced stages, i.e., when investigating patients requiring hospitalization, or those undergoing or not non-surgical procedures and those who died from this disease, the epidemiological observations are accurate and capable of characterizing the aggressiveness of the disease.

The mortality in the state of São Paulo from aortic disease is close to the lowest estimate of the United States, with almost 14,000 deaths per year for a population of 308,745,538 Americans<sup>12</sup>.

In São Paulo there were 18,042 deaths in nine years for a population that ranged around 40 million during the period.

Perhaps the biggest difference lies in the number of patients with access to medical treatment and treatment outcome. The figures show the lethality of TAD; not because it is the 30<sup>th</sup> most frequent cause of death by disease in the state, but mainly for being responsible for 0.39% of total deaths and only represents 0.025% of total hospital admissions (the number of deaths is 1,600% greater than the number of hospitalizations). Of the total of 14,276 patients identified as having TAD, 10,763 died during the study period (75.4%).

**Table 5 - Number of hospitalizations and deaths from TAD in the state of São Paulo and in Brazil from 2004 to 2007 (Source: DATASUS)**

TAD/year	2004	2005	2006	2007
SP	683	883	889	955
Brazil	1772	2278	2267	1974
% deaths SP	19,5	17,4	22,6	18,8
% deaths Brazil	21,8	19	20,6	17,5
Ratio. n. of deaths SP/Brazil	38,50	38,80	39,20	48,40

Source: Datasus. SP: number of hospitalizations from TAD in the state of São Paulo a year. Brazil: number of hospitalizations from TAD in Brazil a year. % deaths SP: percentage of deaths in hospitalized patients due to TAD in the state of São Paulo a year. % deaths Brazil: percentage of deaths in hospitalized patients due to TAD in Brazil a year. Ratio of deaths SP/Brazil: percentage of the ratio of deaths from TAD in São Paulo and in Brazil a year.

TAD was responsible for a mortality rate that was similar to two-thirds of all deaths due to the most common cancer in women, and approximately 4/5 of the most common cancer in men, as well as being responsible for twice more deaths than Alzheimer's disease.

It is also a matter of concern to observe that the increase in the number of deaths was several times higher than the progressive increase in the population. And, considering that TAD onset is mainly related to the aging process, it is possible to imagine the potential alarming number of citizens who will develop the disease in our country. It should be emphasized, however, that LeMaire and Russell<sup>13</sup>, in a review study, showed TAD distribution for the age range similar to that in our study even though they reviewed studies performed mainly in developed countries, with a life expectancy greater than ours.

It is noteworthy the fact that, similarly to other cardiovascular diseases, males were preferentially affected (58% versus 42%), but the distribution of aortic dissection and aneurysms was similar between the two genders, respectively, 72% and 28%. However, disease mortality differed; while more men died due to aortic dissection (25% versus 21%), more women died due to aneurysms (20% versus 18%).

Grubb and Kron, in turn, despite reporting the occurrence of aortic dissection in women at a proportion similar to ours (32%), showed that they had significantly higher mortality than the male population (30% versus 21%)<sup>14</sup>.

In addition to the number of deaths being several times higher than the gradual increase in population, the number of hospitalizations was 15.7 times higher than the population growth in the period, which, although still modest, represents a higher efficiency in the diagnostic and possible treatment procedures offered to these patients.

These figures are initially encouraging, as they seem to demonstrate a progressive medical care improvement in this subgroup of patients; however, they also become a source of

concern, especially when we see the results obtained with those patients maintained on medical therapy or referred for surgical intervention.

The mortality with both therapeutic options is very high. Obviously, one must stress that there are no information on the preoperative conditions of these patients, or specifically on the territory of the affected aorta (especially important in cases of acute aortic dissections) or whether the patients maintained on medical treatment had contraindications to surgery, due to disease stage or refusal to undergo the procedure, but a mortality rate > 20% for both options is still very high.

It also draws attention the low number of hospitalized patients who were referred for surgery. Considering that admissions for aortic disease treatment aim at some type of intervention, why were only 58.5% of these patients submitted to surgery? Do these numbers reflect the ignorance by the medical professional on the ideal moment to refer a patient for surgery? Does it reflect a number of inappropriate hospitals or hospitals without adequate infrastructure to perform this type of procedure? Does it reflect a high number of refusals to undergo the procedure by the patient, due to inadequate physician-patient relationship or suspicion of improper performance of this type of procedure at the hospital of origin? Does it reflect a lack of competent professionals to perform this type of procedure?

One can only imagine that problems are multiple, mainly by delayed access of the patient to the appropriate place of treatment, due to the inefficiency of the health system as a whole.

The similarity of the results obtained in the state of São Paulo when compared to the rest of Brazil is a matter of concern, mainly because São Paulo has the most resources in the Union and thus, it should have congregated over time, more experience in dealing with this type of patient, and yet, it is still unable to show lower mortality rates.

As TAD progresses asymptotically in most patients and the diagnosis is most often attained in the autopsy room, objective measures at public health level should be implemented to actively attain the diagnosis of this disease, which is responsible for such a high number of deaths per year.

In conclusion, we can state that, despite numerous study limitations related to the limited diagnostic information that ICD imposes and the way patients are registered in SUS, public health actions must be implemented in order to better identify patients with TAD, so that better hospital centers can be established for the care of patients with TAD, better and more specific training can be provided to all the professionals involved in the management of patients with TAD regarding the multidisciplinary approach of this patient, aiming at reducing mortality and offering better quality of life to our population.

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## Author contributions

Conception and design of the research: Dias RR, Fernandes F, Ramires FJA, Mady C, Stolf NAG; Acquisition of data e Writing of the manuscript: Dias RR, Mejia OAV; Analysis and interpretation of the data: Dias RR, Mejia OAV, Fernandes F, Ramires FJA; Critical revision of the manuscript for intellectual content: Dias RR, Fernandes F, Ramires FJA, Mady C, Stolf NAG, Jatene FB.

## Potential Conflict of Interest

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

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## Study Association

This study is not associated with any post-graduation program.

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