

# Relationship of comorbidities and heart failure mortality in the city of São Paulo, Brazil

Marcia Kiyomi Koike<sup>I,II,III</sup>, Viviane Silva<sup>III</sup>, Flavia Alves Ribeiro Monclús Romanek<sup>III</sup>, Mirian Matsura Shirassu<sup>III,IV</sup>

<sup>I</sup> Universidade Anhembi Morumbi, São Paulo, Brazil.

<sup>II</sup> Universidade de São Paulo, São Paulo, Brazil.

<sup>III</sup> Instituto de Assistência Médica do Servidor Público do Estado de São Paulo (IAMSPE), Programa de Pós-Graduação em Ciências da Saúde, São Paulo, Brazil.

<sup>IV</sup> Instituto de Assistência Médica do Servidor Público do Estado de São Paulo (IAMSPE), Centro de Promoção e Proteção à Saúde - Prevenir, São Paulo, Brazil.

**OBJECTIVE:** The epidemiology of heart failure mortality in the city of São Paulo, Brazil has not been studied. The present study aims to characterize comorbidities associated to cardiac heart failure deaths in São Paulo between 2000 and 2012.

**METHOD:** The mortality information system (SIM/DataSUS) was evaluated and the following parameters were retrieved: age, sex, race, level of education and comorbidities (hypertension, diabetes, obesity, chronic obstructive pulmonary disease). Socioeconomic status was estimated by years of schooling, as: lower (0-3 years) and higher (> 3 years). We analyzed 14,814 death certificates.

**RESULTS:** There was a prevalence of subjects in the subgroup: female, white, married or divorced, aged 78 years and lower socioeconomic status. Hypertension and diabetes were the most frequent comorbidities. There were associations of (a) diabetes with age, (b) age, gender and educational level with hypertension in individuals belonging to both the lower and higher socioeconomic levels.

**CONCLUSION:** Individuals who died of congestive heart failure in São Paulo are mostly elderly, women, caucasian, with little education. Hypertension and diabetes are the two most common chronic diseases associated with death by congestive heart failure.

**KEYWORDS:** Mortality, Heart Failure, Epidemiology.

Koike MK, Silva V, Romanek FARM, Shirassu MM. Relationship of comorbidities and heart failure mortality in the city of São Paulo, Brazil. *MedicalExpress* (São Paulo, online). 2016;3(2):M160205

Received for Publication on December 4, 2015; First review on December 29, 2015; Accepted for publication on February 16, 2016; Online on March 7, 2016

E-mail: mkoike2011@gmail.com

## INTRODUCTION

In the nineties, a projectional study indicated that diseases of the circulatory system would be among those mostly affecting humans in the world by 2020.<sup>1</sup> At the time of writing, in spite of the improvement available pharmacologic options, cardiovascular diseases remain among those affecting most people in Brazil and worldwide.<sup>2</sup> Guyana has the highest mortality rate from cardiovascular disease in South America, followed by Suriname, Brazil and Paraguay. The increase in life expectancy of the population tends to increase the occurrence of cardiovascular disease and associated

diseases such as congestive heart failure (CHF) in the coming decades.<sup>3</sup>

Congestive heart Failure is the endpoint of the process, particularly in the case of cardiovascular diseases such as hypertensive heart disease, especially coronary or valve pathologies.<sup>4,5</sup> According to the World Health Organization, the mortality rate in South and Central America varies widely, Grenada and the Dominican Republic with the highest rates. CHF is a major public health problem in industrialized countries with large elderly populations. Demographic projections estimate that in Brazil, the proportion of elderly will come close to 15% in 2050.<sup>6</sup> Risk factors associated with CHF are hypertension, diabetes mellitus, obesity, the use of cardiotoxic drugs and the aging process itself. The incidence of CHF in the elderly is of 10/1000 after 65 years, doubling with every decade.<sup>7</sup>

DOI: 10.5935/MedicalExpress.2016.02.05

In the United States of America, the elderly account for over 75% of cases of CHF.<sup>8,9</sup> The Framingham study in 1971, using the population of Framingham, USA, showed a prevalence of 3/1000 for individuals aged < 63 years, and 23/1000 for individuals aged 60-79 years.<sup>10</sup> The NHANES-I study, 1992, using the entire population of the USA, showed an increased prevalence of 20/1000 for individuals aged < 63 years, and 80/1000 for persons aged > 65 years.<sup>11</sup> Projections indicate that by 2025, Brazil will have the world's 6<sup>th</sup> largest elderly population, approximately 30 million people (as noted above, 15% of total population),<sup>12</sup> which can result in the multiplication of cases of CHF and expenses related thereto.

Epidemiological studies of CHF in Brazil are scarce. Most of the available information has been obtained through in-hospital evaluation studies in specialized clinics located in large Brazilian cities or through the information systems of the Ministry of Health (DataSUS database).<sup>13-15</sup>

The city of São Paulo has a prominent economic and cultural expression; however, it presents many contrasts, especially in the fields of education and public health. According to Environmental Company of the State of São Paulo (Companhia Ambiental do Estado de São Paulo - CETESB) and the recommendations of the World Health Organization,<sup>16</sup> the pollution index has reached inadequate levels in recent years, mainly due to the gradual loss of beneficial climate features, reduction of the relative atmospheric humidity and increase of circulating vehicles. The implications of pollution on health, particularly with respect to diseases of the respiratory and cardiovascular systems has been the subject of several reports.<sup>17-20</sup> Thus, it may be safely assumed that in a city where increased population density leads to an increase in the fleet of circulating vehicles and increased pollution, high levels of cardiovascular diseases should be observed.

The databases generated by the information systems of the Ministry of Health have been the focus of several studies and has been the source to establish the epidemiological profile of diseases in the country, with the development of indicators for monitoring and surveillance of population health. Considering the potential impact of CHF in compromising quality of life, health and the economy, prevalence and/or mortality studies acquire importance in the planning process of public expenditure on health. As regards CHF, the epidemiology and comorbidities in residents of São Paulo has been poorly investigated.

This study was aimed to characterize the comorbidities associated with mortality due to congestive heart failure, between 2000 and 2012, in São Paulo.

## ■ MATERIALS AND METHOD

### Study design

This study is a retrospective profile based on a review of the Unified Health System database (SIM - [www.datasus.gov.br](http://www.datasus.gov.br)) and on information provided by the Brazilian

Institute of Geography and Statistics. Corresponding data of CHF mortality (as original cause) in the city of São Paulo were selected according the 10<sup>th</sup> Revision of the International Classification of Diseases (ICD 10), between 2000 and 2012. A total of 750,469 deaths were reported in São Paulo during the 13 years, of which 14,814 deaths were due to CHF.

Inclusion criteria were deaths resulting from CHF (ICD 10: I50, I50.0, I50.1 and I50.9) with records of sex, race and educational level.

### Casuistry

The variables studied were: gender, age, race, educational level and major comorbidities related to the CHF (hypertension, diabetes mellitus, obesity, chronic obstructive pulmonary disease, Chagas disease and heart diseases).

Socioeconomic level was stratified into lower (0-3 years of education) or higher level (> 3 years of education). In Brazil, race is associated with education and this in turn to a level of knowledge/lack of knowledge in self-care.

### Statistical analysis

Data are presented in percentages (%). Statistical analysis was performed with the SigmaStat software, version 3.1. Multiple linear regression analysis (*forward stepwise regression*) was used to identify the population variables and comorbidities related to the most prevalent diseases (hypertension and diabetes) in the two socioeconomic levels, considering data between 2000 and 2012. The level of significance for analysis was set at  $p < 0.05$ .

## ■ RESULTS

We analyzed 14,814 death certificates recorded between 2000 and 2012 in São Paulo. As shown in Table 1, results in each year had constant characteristics between 2000 and 2012.

Most of the deaths occurred among individuals over 60 years old. CHF occurred more frequently in men up to 60 years; however, after 60, it became more frequent in women reaching the highest rate at 80 years old, with 67% as shown in Figure 1. Table 1 shows that the predominant age groups were 70-79 (25%) and 80-89 years old (34%), while only 1.6% of cases occurred in people younger than 40. Caucasians were more affected than the others with (77%), married and widowers exhibited the highest percentages, with 33% and 48%, respectively. Education level showed that the population affected by the CHF had up to 3 years of study. There was a predominance of individuals with lower socioeconomic level.

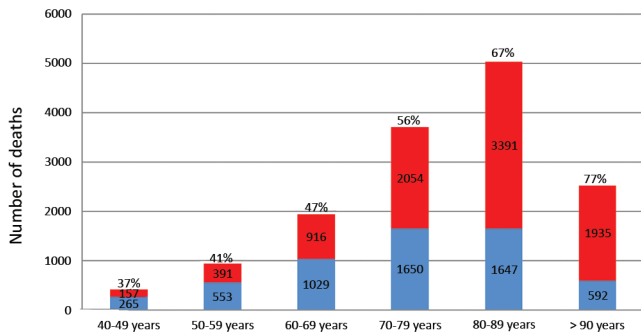
The study of comorbidities showed that 48% of individuals suffered from high blood pressure and 27.5% from diabetes mellitus; in 15% of cases, we found the occurrence of hypertension and diabetes, concomitantly.

**Table 1** - Mortality Information System Data on DataSUS, showing the characteristics of individuals who died of congestive heart failure as original underlying cause, in São Paulo, between 2000 and 2012

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total (% , n)
<b>Gender</b>														
Man (% , n)	39%, 503	40%, 474	40%, 418	38%, 392	40%, 407	39%, 468	39%, 410	40%, 439	39%, 449	40%, 473	39%, 476	41%, 508	42%, 467	40%, 5,884
Women (% , n)	61%, 775	60%, 700	60%, 628	62%, 641	60%, 611	61%, 737	61%, 633	60%, 671	61%, 698	60%, 724	61%, 732	59%, 732	58%, 648	60%, 8,930
<b>Age Group (years old)</b>														
< 40	1.4%	1.8%	2.3%	1.7%	1.4%	1.7%	2.1%	1.1%	2%	1.1%	1.1%	1.3%	1.5%	1.6%, 232
40 a 49	2.5%	3.3%	3%	2.3%	3.3%	2.2%	2.7%	2.6%	2.7%	2.3%	3.1%	3.1%	3.9%	2.8%, 422
50 a 59	6.4%	5.8%	6%	5.6%	7.8%	4.8%	5.2%	7%	6.1%	6%	6.1%	7.6%	8.3%	6.4%, 944
60 a 69	14.2%	11.4%	14.3%	14.3%	12.9%	13.3%	12.7%	13.3%	13%	13.8%	13.1%	12.7%	11.8%	13.1%, 1,945
70 a 79	26.1%	29.8%	28%	26.8%	26.1%	23.7%	25.3%	24.4%	24.3%	22.9%	24.6%	20.6%	23.1%	25%, 3,704
80 a 89	32.2%	31.4%	30.6%	33.5%	31.7%	34.8%	36%	34.9%	35.1%	36.8%	35.7%	35.7%	33%	34%, 5,038
>90	17.1%	16.4%	15.8%	15.7%	16.8%	19.5%	16%	16.7%	16.8%	17%	16.3%	19%	18.3%	17.1%, 2,529
<b>Race</b>														
White (% , n)	79%	80%	79.9%	80%	77.3%	79.9%	79.2%	75.1%	77.1%	76.6%	74.8%	73.2%	72.9%	77.3%, 11,022
Brown (% , n)	11.5%	11.7%	11.7%	11%	13.7%	11.5%	11.1%	15.1%	14.1%	14%	14.5%	16.7%	17.3%	13.4%, 1,910
Black (% , n)	5.6%	5.9%	6.1%	6.5%	6.2%	6.1%	7.8%	8%	6.8%	6.9%	7.9%	7.9%	7.6%	6.9%, 979
Yellow (% , n)	4%	2.4%	2.3%	2.4%	2.7%	2.6%	2%	1.8%	2%	2.5%	2.7%	2.2%	2.3%	2.4%, 351
Indian (n)		1		1		1								3
<b>Marital Status</b>														
Singles (% , n)	14.3%	15.5%	13.2%	16.3%	18.8%	12.8%	15.5%	12.9%	14.5%	13.7%	14.8%	15%	17%	15%, 2,141
Married (% , n)	33.4%	34.6%	34.4%	32.3%	32.3%	32.6%	33.5%	34.6%	33.8%	32.8%	34%	33%	32%	33.3%, 4,789
Widowers (% , n)	2.1%	2%	2.5%	3.1%	3.9%	4.1%	4.2%	4.1%	3.5%	5%	5.2%	5%	4%	3.7%, 542
Divorced (% , n)	50.2%	47.9%	49.9%	48.4%	45%	50.5%	46.8%	48.4%	48.1%	48.5%	46%	47%	47%	48%, 6,897
<b>Education</b>														
0 Years of study (% , n)	23%	20.2%	22.1%	18.5%	20%	20.5%	19.4%	18%	17.2%	14.9%	17.2%	22.9%	22.3%	19%, 2,481
1-3 Years of study (% , n)	37.6%	38.8%	36.1%	37.5%	33.5%	30.3%	30.8%	31.8%	29.7%	29.6%	32.5%	45.3%	42.5%	35.4%, 4,435
4-7 Years of study (% , n)	25.8%	25.1%	22.5%	24.6%	26.5%	28.4%	29.8%	29.6%	32%	29.7%	28.7%	14.4%	15.7%	25.3%, 3,176
> 8 Years of study (% , n)	13.6%	15.9%	19.3%	19.5%	20.1%	20.2%	20.1%	20.6%	21.1%	25.8%	21.6%	17.5%	19.6%	19.5%, 2,447
<b>Socioeconomic Level</b>														
< SL (% , n)	60.7%	59%	58.2%	56%	53.4%	50.8%	50.1%	49.8%	46.9%	44.5%	49.7%	68.1%	64.8%	55.1%, 6,916
> SL (% , n)	39%	41%	42%	44.0%	46.6%	49%	50%	50%	53%	55.5%	50.3%	31.9%	35.2%	44.8%, 5,623
Total death by CHF	1.278	1.174	1.046	1.033	1.018	1.205	1.043	1.110	1.147	1.197	1.208	1.240	1.115	14,814

Less frequent diseases were: chronic obstructive pulmonary disease, obesity, and heart valve disease. We had expected to find the occurrence of dilated cardiomyopathy, Chagas disease or ischemic disease, such as myocardial infarction, coronary heart disease or angina, but none of these occurred, as may be seen in Table 2.

Using a multiple linear regression analysis, we identified relationships between population variables and most prevalent comorbidities (hypertension and diabetes) in the two socioeconomic levels. There was a correlation between population variables and the occurrence of high blood pressure or diabetes as comorbidities in



**Figure 1** - Proportion of deceased due to the congestive heart failure by gender (women in red/men in blue) according to age. The percentages refer to the proportion of women in each age group.

individuals with lower or higher socioeconomic status. Highly significant correlations ( $p < 0.001$ ) between age and comorbidities were found in both socioeconomic levels. Moreover, in the lower socioeconomic status, being a woman ( $p = 0.002$ ), non-white ( $p = 0.003$ ), marital status divorced or widowers ( $p = 0.019$ ) and presence of diabetes ( $p < 0.001$ ) were predictors for the occurrence of high blood pressure. Gender ( $p < 0.001$ ) and presence of hypertension ( $p < 0.001$ ) were predictors for diabetes. The correlation between population variables and occurrence of high blood pressure or diabetes in higher socioeconomic level, showed similar results, with gender ( $p = 0.011$ ), low educational

level ( $p < 0.001$ ) and presence of diabetes ( $p < 0.001$ ) detected as predictors for the occurrence of hypertension.

## DISCUSSION

Mortality statistics represent sources of information to evaluate the health status of a population. This study evaluated the characteristics of residents of São Paulo who died because of congestive heart failure between the years 2000 and 2012. Analysis of death certificates in the SUS Information System showed that most deaths occur in older adults, female and caucasian. Although São Paulo is an economically prominent city, its population exhibits contrasting features, with a higher incidence of deaths due to CHF in individuals with little schooling. The most common comorbidities, namely hypertension and diabetes, showed a close relationship, while other potential comorbidities showed no significant occurrence.

The objective analysis of the health situation demands quality in the registration of the information, which in turn allows a process of decision-making and the development of health actions based on evidence. The selection process used in this study was based on the original underlying cause or the primary cause entered into the system (SIM). However, the specialist doctor who accompanied the patient in the process of health-disease does not always carry out the completion of the death

**Table 2** - Information System Data on DataSUS Mortality, showing the correlation between comorbidities and socioeconomic level of individuals who died of congestive heart failure as original underlying cause, in São Paulo, between the years in 2000 and 2012

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total (% e/ou n)
<b>Comorbidities</b>														
Hypertension (% , n)	48.4%	37.7%	45.2%	36.5%	53.2%	45.3%	46.6%	46.6%	52.5%	53.3%	52.8%	48.5%	51.2%	47.7%
< SL (% , n)	64	44	59	57	56	69	47	69	64	68	84	110	87	878
> SL (% , n)	29	34	35	38	43	33	50	54	70	84	67	34	45	616
Diabetes (% , n)	27.1%	36.7%	30.3%	27.3%	27.4%	34.7%	28.4%	29.2%	25.9%	21.8%	23.4%	24.9%	25.6%	27.5%
< SL (% , n)	33	52	30	37	25	37	27	39	31	32	35	50	41	469
> SL (% , n)	19	24	33	34	26	41	32	38	35	30	32	24	25	393
COPD (%)	14.6%	14.0%	16.3%	8.8%	9.1%	10.7%	9.6%	8.3%	8.4%	8%	8.7%	10.8%	8.1%	10.1%
< SL (% , n)	16	13	16	16	11	10	11	11	9	12	10	21	15	171
> SL (% , n)	12	16	18	7	6	14	9	11	10	10	15	11	6	145
Hypertension + Diabetes (%)	9.9%	11.6%	8.2%	27.3%	10.2%	9.3%	15.4%	19.9%	14.1%	17.2%	15.0%	15.8%	15.1%	14.7%
< SL (% , n)	15	12	11	37	9	11	15	22	11	18	23	33	25	242
> SL (% , n)	4	12	6	34	10	10	17	20	25	31	20	14	14	217
Obesity (n)	3	1	3	2	2	5	5	3	3	7	5	9	16	64
Hypertension + COPD (n)	4	4	6	5	2	3	1	2	3	5	3	7		45
Diabetes + COPD (n)	4	3	1	3	1						3		1	16

certificate. This may explain the failure to find expected co-morbidities, such as dilated cardiomyopathy, Chagas disease or ischemic disease, such as myocardial infarction, coronary heart disease or angina, in the certificates. Despite this inconsistency the SIM database is deemed appropriate and has been used in several epidemiological studies.<sup>21,22</sup>

It must be stressed that this study was conducted in São Paulo; in spite of being the most important Brazilian metropolis, it includes social and economic contrasts that impacts on quality of life (health, education and environment). Our data show that the population in the lower socioeconomic stratum is the most affected and evolves to death as a consequence of CHF.

The data permit us suggest that: 1) hypertension and diabetes are most common diseases related to CHF independent of socioeconomic level; 2) educational and socioeconomic levels were correlated to hypertension; 3) age and gender correlated to comorbidities independent of socioeconomic level.

## ■ CONCLUSION

This study showed the profile of individuals who died of congestive heart failure, between 2000 and 2012, in São Paulo. Most are elderly, women, white, with little education. Hypertension and diabetes are the two most common chronic diseases associated with death by CHF; both are age-dependent and related to gender.

## ■ CONFLICT OF INTEREST

Authors declare no conflict of interest regarding this project.

## ■ AUTHOR CONTRIBUTION

Koike MK: conception, design, intellectual and scientific content of the study, critical revision, manuscript writing and final approval of the manuscript; Silva V: conception of the study, technical procedures, acquisition of data and manuscript writing; Romanek FARM: conception of the study, technical procedures and acquisition of data; Shirassu MM: conception, design, intellectual and scientific content of the study, critical revision.

## RELAÇÃO DE CO-MORBIDADES E MORTALIDADE POR INSUFICIÊNCIA CARDÍACA NA CIDADE DE SÃO PAULO, BRASIL

**OBJETIVO:** O perfil epidemiológico da mortalidade por insuficiência cardíaca na cidade de São Paulo, Brasil ainda não foi estudado. O presente estudo tem como objetivo caracterizar comorbidades associadas a mortes por insuficiência cardíaca em São Paulo entre 2000 e 2012.

**MÉTODO:** O sistema de informações sobre mortalidade (SIM/DATASUS) foi examinado, obtendo-se os seguintes parâmetros: idade, sexo, raça, nível de educação e comorbidades (hipertensão, diabetes, obesidade, doença pulmonar obstrutiva crônica). O nível socioeconômico foi estimado por anos de escolaridade, a saber: inferior (0-3 anos) e superior (> 3 anos). Foram analisados 14.814 atestados de óbito.

**RESULTADOS:** Houve uma prevalência de indivíduos do subgrupo: sexo feminino, cor branca, casadas ou divorciadas, com idades entre 78 anos e nível socioeconômico baixo. Hipertensão e diabetes foram as comorbidades mais frequentes. Houve associações de (a) diabetes com a idade, (b) a idade, sexo e nível educacional com hipertensão arterial em indivíduos pertencentes a ambos os níveis socioeconômicos mais baixos e mais altos.

**CONCLUSÃO:** Os indivíduos que morreram de insuficiência cardíaca congestiva em São Paulo são na sua maioria mulheres idosas, caucasianas, com pouca educação. Hipertensão e diabetes são as duas doenças crônicas mais comuns associadas à morte por insuficiência cardíaca congestiva.

**PALAVRAS-CHAVE:** Mortalidade, insuficiência cardíaca, epidemiologia.

## ■ REFERÊNCIAS

1. McMurray JJ, Stewart S. Epidemiology, aetiology, and prognosis of heart failure. *Heart*. 2000;83(5):596-602. <http://dx.doi.org/10.1136/heart.83.5.596>
2. Lopez AD, Mathers CD. Measuring the global burden of disease and epidemiological transitions: 2002-2030. *Ann Trop Med Parasitol*. 2006;100(5-6):481-99. DOI: <http://dx.doi.org/10.1179/136485906X97417>
3. Azambuja MI, Foppa M, Maranhão MF, Achutti AC. Economic burden of severe cardiovascular diseases in Brazil: an estimate based on secondary data. *Arq Bras Cardiol*. 2008;91(3):148-55, 163-71. <http://dx.doi.org/10.1590/S0066-782X2008001500005>
4. Conraads VM, Beckers PJ. Exercise training in heart failure: practical guidance. *Heart*. 2010;96(24):2025-31. <http://dx.doi.org/10.1136/hrt.2009.183889>
5. Piña IL, Apstein CS, Balady GJ, Belardinelli R, Chaitman BR, Duscha BD, et al. Exercise and heart failure: A statement from the American Heart Association Committee on exercise, rehabilitation, and prevention. *Circulation*. 2003;107(8):1210-25. <http://dx.doi.org/10.1161/01.CIR.0000055013.92097.40>
6. Chaimowicz F. [Health of Brazilian elderly just before of the 21st century: current problems, forecasts and alternatives]. *Rev Saude Publica*. 1997;31(2):184-200. <http://dx.doi.org/10.1590/S0034-89101997000200014>
7. Kalogeropoulos A, Georgiopoulou V, Kritchevsky SB, Psaty BM, Smith NL, Newman AB, et al. Epidemiology of incident heart failure in a contemporary elderly cohort: the health, aging, and body composition study. *Arch Intern Med*. 2009;169(7):708-15.
8. Ammar KA, Jacobsen SJ, Mahoney DW, Kors JA, Redfield MM, Burnett JC, et al. Prevalence and prognostic significance of heart failure stages: application of the American College of Cardiology/American Heart Association heart failure staging criteria in the community. *Circulation*. 2007;115(12):1563-70. <http://dx.doi.org/10.1161/CIRCULATIONAHA.106.666818>



9. Young JB. The global epidemiology of heart failure. *Med Clin North Am.* 2004;88(5):1135-43, ix. <http://dx.doi.org/10.1016/j.mcna.2004.06.001>
10. McKee PA, Castelli WP, McNamara PM, Kannel WB. Natural history of congestive heart failure: the Framingham study. *N Engl J Med.* 1971;285(26):1441-6. <http://dx.doi.org/10.1056/NEJM197112232852601>
11. Schocken DD, Arrieta MI, Leaverton PE, Ross EA. Prevalence and mortality rate of congestive heart failure in the United States. *J Am Coll Cardiol.* 1992;20(2):301-6. [http://dx.doi.org/10.1016/0735-1097\(92\)90094-4](http://dx.doi.org/10.1016/0735-1097(92)90094-4)
12. [Review of the II Guidelines of the Sociedade Brasileira de Cardiologia for the diagnosis and treatment of heart failure]. *Arq Bras Cardiol.* 2002;79 Suppl 4:1-30. [http://dx.doi.org/10.1016/0735-1097\(92\)90094-4](http://dx.doi.org/10.1016/0735-1097(92)90094-4)
13. Martins SJ, Cardenuto SL, Golin V. Mortality risk factors in patients over 65 years of age hospitalized in a São Paulo, Brasil university hospital. *Rev Panam Salud Publica.* 1999;5(6):386-91. <http://dx.doi.org/10.1590/S1020-49891999000500002>
14. Barretto AC, Nobre MR, Wajngarten M, Canesin MF, Ballas D, Serro-Azul JB, et al. [Heart failure at a large tertiary hospital of São Paulo. *Arq Bras Cardiol.* 1998;71(1):15-20. <http://dx.doi.org/10.1590/S0066-782X1998000700004>.
15. Tavares LR, Victor H, Linhares JM, de Barros CM, Oliveira MV, Pacheco LC, et al. Epidemiology of decompensated heart failure in the city of Niterói: EPICA - Niterói Project. *Arq Bras Cardiol.* 2004;82(2):121-4. <http://dx.doi.org/10.1590/S0066-782X2004000200003>
16. Companhia Ambiental do Estado de São Paulo. Publicações e relatórios. <http://www.cetesb.sp.gov.br/ar/qualidade-do-ar/31-publicacoes-e-relatorios>. Acesso em: 9 de novembro de 2011.
17. Ito K, Thurston GD. Daily PM10/mortality associations: an investigations of at-risk subpopulations. *J Expo Anal Environ Epidemiol.* 1996;6(1):79-95.
18. Olmo NR, Saldiva PH, Braga AL, Lin CA, Santos UeP, Pereira LA. A review of low-level air pollution and adverse effects on human health: implications for epidemiological studies and public policy. *Clinics (São Paulo).* 2011;66(4):681-90. <http://dx.doi.org/10.1590/S1807-59322011000400025>.
19. Pope CA, Burnett RT, Turner MC, Cohen A, Krewski D, Jerrett M, et al. Lung cancer and cardiovascular disease mortality associated with ambient air pollution and cigarette smoke: shape of the exposure-response relationships. *Environ Health Perspect.* 2011;119(11):1616-21. <http://dx.doi.org/10.1289/ehp.1103639>.
20. Pope CA, Burnett RT, Thurston GD, Thun MJ, Calle EE, Krewski D, et al. Cardiovascular mortality and long-term exposure to particulate air pollution: epidemiological evidence of general pathophysiological pathways of disease. *Circulation.* 2004;109(1):71-7. <http://dx.doi.org/10.1161/01.CIR.0000108927.80044.7F>
21. Lima CR, Schramm JM, Coeli CM, da Silva ME. Review of data quality dimensions and applied methods in the evaluation of health information systems. *Cad Saude Publica.* 2009;25(10):2095-109. <http://dx.doi.org/10.1590/S0102-311X2009001000002>.
22. Ministério da Saúde. Saúde Brasil 2008: 20 anos de Sistema Único de Saúde (SUS) no Brasil. 2009; 416 p.