ELDERLY MORTALITY IN BRAZIL: TRENDS, DIFFERENTIALS , CAUSES AND LINKS WITH SOCIOECONOMIC INDICATORS.

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Version presented at the XXIVth IUSSP General Population Conference 2001 - Salvador, Bahia, Brazil to the "Mortality and Ageing " Session

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INTRODUCTION

The increase of the life expectation in Brazil in the last decades (60.0 years in 1980 (Paes, 1993) and 67.6 years in 1996 (FIBGE, 1996)), together with the fast decline of the total fertility rates of the population (4.35 in 1980, and 2.28 in 1996), has been providing an aging of the Brazilian population. This is the most growing age group when compared with the other age segments. The elderly population in Brazil varied from 6,1% in 1980 to 7,4% in 1991 and 8,1% in 1996, being foreseen for 2010 that this contingent will represent about 9,2% of the overall Brazilian population. It is projected that from 1950 to 2025 the Brazilian population should grow five times, while the age group over 60 years old will be enlarged in fifteen times (Veras and Alves;1994). In the same period, United States, Japan and China will be growing 3.5, 5.0 and 6.5 times, respectively.

Brazil is the largest Latin American country in terms of both area and population size. Its population approximately 169 million at latest count (2000) is distributed unevenly over its vast territory and is the fifth most populous country in the world. The average annual growth rate has fallen to 1,6% in 1996, after rates of 3.0% in the 1950s.

Geographically, the country can be divided into five major regions, each one having distinctive social and economic characteristics. Figure 1 illustrates the physical location and composition in terms of the 26 States (Federate Units).

The limitation of the mortality statistics can be the main responsible for the scarce number of regional studies of the Brazilian elderly mortality. Lessa (1998) said that those studies are very important for the understanding of the morbimortality changes and the establishment of health politics of reduction of the incidence of certain diseases and its consequences in the population. Ruzicka and Lopes (1990) also highlight the importance of such data for a best investments of the expenses in public health and that such a study should just serve as a starting point since several factors, besides the regional differences influence in the results.

The studies that approach the mortality in a general way are very common. An important verification is the existence of few mortality studies for causes in Latin America and in the third world, which was already highlighted by Chackiel (1986), concluding that such fact can probably be associated to subjects linked to the quality of the data. Quite a few studies refer to the adult population and they are still scarcer when it is to associate the elderly mortality

with social and economic factors, whose discussion are necessary for a better understanding the processes involved in the individuals' death.

Since the 40's, the researchers increased the investigation on causes and physiopathology of diseases, with the aim of getting a diagnosis and more precise treatment. As a result of those works, there was an identification of many risk factors, some of them being directly related with socioeconomic factors.

Some aspects involved in the study of the mortality, according to socioeconomic factors, are discussed in Nicholls (1991). He mentioned several works accomplished in different countries with comparative analyses among Latin America, United States and Europe. Some authors investigated the relationship among changes in the economic activities and the evolution of the mortality rates. Bravo and Vargas (1991) examined this relationship among changes of short and medium periods in the economic activity and the mortality rates and morbidity in Costa Rica, Chile and Guatemala. Chackiel and Plaut (1994) in a study on the situation and the demographic tendencies in Latin America since the 50's remind that the falls in both mortality and fertility rates happened independently of the factors linked to socioeconomic variables. They emphasized the progresses in the medicine and the sanitary conditions, system of public health and programs of attention to groups and specific problems, besides the high urbanization level in Latin America. Similar conclusions can be found in Frenk et al. (1991), that also analyze the main mechanisms involved in the epidemiologic transition such as: change in risk factors, decrease of fertility and progresses in medical technology in Latin America

A work on the historical evolution of adult mortality and its determinant in Costa Rica between 1920-1990, was accomplished by Rosero-Bixby (1994) who also analyzed the role of some social and economic indicators and their relationship with several causes of deaths. Following this line of studies, Gruska (1995) discusses the tendencies, causes and differentials of the adult mortality in Argentina. The indicators used in this work try to reflect aspects linked to the habitation infrastructure, literacy level and the gross national product “per capita.”

Few works have been focusing on the association between Brazilian adult mortality and social and economic variables. Carvalho and Ribeiro (1976) made a pioneer study about proportional mortality in some Brazilian capital cities, concluding that it is a result of the interaction between several factors: doctor-sanitariums, demographics, economics and socials. Another illustrative work using statistical techniques can be found in the paper published by Sichieri et al. (1992). The focus is on adult mortality and chronic-degenerative diseases in some capital cities of the country. Cerqueira (1998) did a similar work using all Brazilian capital cities to verify the relationship among several causes of death and some socioeconomic indicators.

The limitation of the mortality data in Brazil can be the main responsible for the absence of studies focusing on the relationship of Brazilian regional mortality by causes of deaths with social and economic aspects of the population.

But, even considering the limitation of the data for some Brazilian States, they can not simply be discards, since part of the explanatory power of those statistics can be rescued. According to Preston (1984), the knowledge of about at least two thirds of the deaths registration are enough to supply tolerable estimates. The problem then consists of knowing the actual magnitude of the levels of mortality indicators. In the same way, Paes (1993) affirms that the pattern and the tendencies for most of the regional mortality in Brazil can be satisfactorily estimated and known.

Therefore, the present work seeks to draw the profile of the Brazilian regional elderly mortality for all Federate Unites (States), during the period from 1980 to 1995. To study the tendencies of the main causes of deaths by sex and to investigate the association between elderly mortality and some social and economic factors.

2. MATERIAL AND SOURCE OF DATA

The CD - ROM of the System of Information of Mortality of the Ministry of the Health (Ministério da Saúde, 1996) was used as source of data. The data of this work refer to the period of 1979/80/81,1984/85/86, 1990/91/92 and 1995 for the 26 Brazilian States. This study was done by sex to the population aged sixty-five and over.

The years 1980, 1991 and 1996 correspond to the census count years, and since they offer a larger availability of demographic, social and economic indicators (FIBGE, 1983; 1995). They were chosen for estimating the rates of standardized mortality. It was in this period that both the Brazilian epidemiological and demographic transition started having its strongest impact in the country, which are still in course.

Quality of the data

The great difference among regions with relation to household structure, income, transporting, sanitary conditions and other conditions of life has influenced the collection of mortality data. Political factors and administrative instabilities mark the evolution of vital registration in Brazil over a long period. The history of the knowledge of vital events in a systematic way is relatively recent. It was only in 1974 that the government officially assigned the Brazilian Census Bureau - FIBGE, the task of compiling and publishes annually the vital registration statistics for all 26 States of the country. Under this condition it is not surprising that this data has not been largely used in the estimation of demographic indicators.

In Brazil, the standardization of the instruments used to collect data regarding causes of death was only implanted in 1976, with the installation of the System of Information on Mortality of the Ministry of the Health. The model of certification for the deceased was proposed by the World Organization of Health by the selection and codification of the basic causes of death by the International Classification of Diseases, from 1979 to 1995, using the rules of the ninth revision.

Two and half decades of production of those statistics, therefore, were not enough to remove the scientific delay regarding the knowledge of their behavior and even less on the mortality pattern for death causes. The lack of geographical coverage of registered deaths and the imprecision that the causes of death are registered, are still preoccupying and pending subjects.

The basic death data is committed for a series of factors, which makes the under-registration and the quality of the basic causes of deaths stand out. Discussions accomplished by Paes (1997) pointed out that the data produced by the FIBGE are even less under-registered than the one produced by the Ministry of the Health (MH). According to Paes, in 1980, the FIBGE registered for men about 85% of the deaths of the country, while the MH, just 77%. And for women the coverage was respectively 79% and 75%. The disparities among the sources decreased in 1990, once FIBGE and MH respectively accused a coverage of deaths around 88% and 84%. For women the coverage was, respectively, 84% and 83% for both sources.

However, only the MH produces deaths by cause, which implies that the studies that involve the basic causes suffer still more restrictions with relationship to the quality of the data. From the basic cause of death, an important indicator refers to the percentile *of ill-defined* causes, that is, those declarations, whose basic cause was

not very well established in the death certificate. They still represent an important part of the total of registered deaths and, because of this, they occupy an important place in the collection of those statistics

The estimates of the coverage of deaths, which estimates are supposedly constant for all the ages above four years (Brass, 1975), were found by Paes, (1993) and Paes (1997). Using the statistics from FIBGE, the estimated the under-registration of deaths in Brazil and from the MH to calculate the percentage of *ill-defined* cause of death. The results show that the levels are still high, about 14% for both sexes in 1990 (Table 1). And, of those registered deaths, about 18% of them presented *ill-defined* causes. The junction of those two problems (under-registration of deaths and the ill-defined cause of death in the certificates) in Brazil results in an expressive volume of deaths which basic cause was unknown. Table 1 shows the results for the period 1959-1990.

Since the Brazilian regional inequalities are reflected in the quality of the death data, the States were classified, in this study, in five categories according to the percentage of deaths with "unknown cause". Table 2 shows this classification for all 26 Brazilian States.

Table 1: Coverage of deaths and ill-defined cause to Brazil by sex: 1959-90

Year	Male		Female	
	Coverage (%)	Ill defined (%)	Coverage (%)	Ill defined (%)
1959	64,2	-	61,0	-
1980	85,0	20,1	79,0	21,8
1990	88,5	17,5	84,1	19,3

Source: Paes (1997)

In spite of the doubtful quality of the regional data for some States in the country (mainly those from the North and Northeast regions), it is believed that a careful use of them allows one to extract reasonable conclusions about the levels and tendencies of the mortality indicators.

Necessary for estimating mortality rates, the quality of the censuses populations of 1980 and 1991 for all the Brazilian states were analyzed for Paes (1997), which found that the general level of age misreporting was low for 1991 in both sexes. For 1980, however, some irregularities seem to have happened for some states in the North and Northeast of the country, of doubtful quality. But, since the mortality rates generated in this work involve the elderly in five-years-age-group, these possible problems with the age misreporting are lessen and do not affect the reliability of the mortality levels estimated in this work.

Table 2: Classification of the Brazilian States according to the percentage of *unknown cause* of death by sex: 1991

CAUSE OF DEATH	STATES
	MALE
0-15	RJ, SP, DF
16-30	MG, PR, SC, RS, MS,
31-50	RR, AP, ES, MT, GO
51-75	RO, AC, AM, PA,PI, CE, RN, PB, PE, AL, SE, BA,
76e+	MA
	FEMALE
0-15	SP, DF
16-30	MG, RJ, PR, SC, RS,
31-50	AP, ES, MS, MT, GO, RR
51-75	RO, AC, AM, PA, MA, PI, CE, RN, PB, PE, AL, SE, BA
76e+	-

(*) Note: The percentage of "unknown cause of death" means the combination of the percentage of under-registration of deaths and the percentage of ill-defined cause of death.

The death causes

The death causes were classified in agreement with the 17 groups of causes using the Ninth Revision of the International Classification of Diseases (ICD). These groups of causes, for its time, were split according to the main subcauses, in agreement with the ICD adapted to Brazil(Ministério de Saúde, 1999). The most important subcauses were selected based on the approach of the larger incidences of its group and also in its percentile participation in the general mortality. 24 subcauses were selected for male and 29 for female. But, only the most important are discussed here.

Socioeconomic variables

The investigation of the association between mortality rates and factors of socioeconomic nature has been an old concern of the researchers on the subject. Studies can be observed involving economic aspects, with strong monetary influence, using such indicators as: Gross National product, gross domestic product "per capita", and family income, among others. An argument about the contribution of economic factors in the decline of the mortality is made by Preston (1976), who suggests the use of the Gross National Product "per capita", as an important indicator of the pattern of life for a population.

Later on, the influence of indicators of social nature was discussed, as in the case of the measuring the quality of habitation and life conditions. Most of the researchers on this subject agree with the use of variables linked to aspects like income, education and living conditions, as indicators of the socioeconomic level of a population and also as possible determinants associated to mortality level (Cerqueira (1998); Gruska (1995); Chackiel and Plaut (1994); Bixby (1994), Preston (1976), among others).

In this way, the mortality rates were defined as dependent variables for the selected causes of deaths. And, as explanatory variables, along with its respective codes, in parentheses, which will be used in the modeling,

were chosen as follows. The criteria for choosing the type of variable are: first, their combined contribution to the explanatory power of the model; second, the ease with which the individual variables can be interpreted; and third, convention and prevalence in the literature (Donauhue, 2001; Link and Phelan, 1995). From FIBGE (1996) were taken: (3), (4), (5) and (6). From IPEA (1998) were taken: (1) and (2).

(1) - Life Expectancy at birth (LIFEEXP);
(2) - Per capita Gross National Domestic Product (GNP);
(3) - Coefficient of Lethality: number of deaths per hospital internment (LETHAL);
(4) - Number of hospital beds per inhabitants (BED);
(5) - Percentage of urban population (URBAN);
(6) -Number of beneficiary from the National Social Security System per inhabitant (BENEFIT).

3. METHODOLOGY

The standardized mortality rates by sex and causes of death were generated for all 26 Brazilian States using the age group population of Brazil in 1991 as the standard population. It was proceeded to the investigation between the mortality rates and the socioeconomic variables described in the Section 2. At first, the classical multiple lineal regression model was adjusted in a simultaneous way to the group of defined variables and, later on, through the procedure "stepwise."

The classical multiple regression model had its origins in the works of Gauss in the period from 1809 to 1821, being quite explored by the literature, as in the works of Searle (1971) and Draper and Smith (1981).

The fittings of the number of deaths could be made naturally through the binomial model, since it involves a risk rate, having as denominator, the population-pattern, in the age group from 65 years and over. However, Cerqueira (1998) studying the adult mortality in capital cities in Brazil, found a strong rejection of the binomial model in fittings of adult mortality rates. Because of this, the rates were used by 100,000 inhabitants, which can be fitted as a continuous variable. The selected model was the "normal model". It was chosen due to the operational facilities and for its acceptance in the fittings.

The linear regression model is defined by a dependent variable Y, with independent observations and identically distributed according to the *normal* model, with averages μ_i and constant variance σ^2. On the other hand, there is a group of one or more variable X, named independent variables or explanatory.

The multiple regression model can be written as:

$$Y=\beta_0+\beta_1X_{1i}+\beta_2X_{2i}+\ldots+\beta_kX_{Ki}+\in_i$$

where $\in \sim N(0, 1)$ *and* β_i are the coefficients of the explanatory variables.

The diagnosis stage of the linear regression model consisted of the verification of the distance in relation to the hypotheses of the regression model, presence of outliers, presence of influential points (the *distance D of Cook;* Cook 1977), besides the multicollinearity problems.

The "residues" are the indicators of analysis of the discrepancy degree between the observed values and the fitting values of the model; that is, the analysis of the "residues" was proceeded through graph means. The problem of multicollinearity consists of the occurrence of high correlation degree among two or more explanatory variables. Table 3 shows the correlation among the variables.

Fittings of Multiple Regression

The fittings of multiple regression were done for the main causes of death investigated, for all Brazilian States. The fittings suggested removing the States of Acre and Roraima in the North and Tocantins and the Federal District, since they appeared as "outliers" for most of the causes of death investigated.

Table 3: Coefficient of Determination between selected variables to Brazil by sex: 1980–1991-1995.

VARIABLES	GNP	BED(%)	URBAN(%)	BENEFIT(%)	LETHAL(%)
			1980		
BED(%)	0.703				
URBAN(%)	0.745	0.710			
BENEFIT(%)	-0.170	0.304	0.167		
LIFEEXP	0.881	0.766	0.699	-0.048	-
			1991		
BED(%)	0.338				
URBAN(%)	0.738	0.604			
BENEFIT(%)	-0.255	0.386	0.115		
LETHAL(%)	0.313	-0.209	0.215	-0.006	
LIFEEXP	0.885	0.311	0.572	-0.207	0.299
			1995		
BED(%)	0.143				
URBAN(%)	0.628	0.440			
BENEFIT(%)	-0.252	0.524	0.079		
LETHAL(%)	0.456	0.369	0.741	0.471	
LIFEEXP	0.838	0.055	0.395	-0.216	0.323

The first two States, besides adjusting badly, possessed in both years committed quality, and high percentage of ill-defined deaths. The state of Tocantins, in spite of presenting reasonable quality of deaths, it was part of another State until early 1980. And, the Federal District, for its characteristic of being typically urban. The multiple fittings were accomplished using the mortality rates. After withdrawing the atypical States, the results produced a relative improvement in the quality of the adjustment. This improvement occurred for practically all causes investigated. For instance, for females in 1980, the *malignant neoplasm of trachea, bronchus and lungs,* increased the *coefficient of determination (R2)* from 48,2% to 81%.

Selected Final models

The results found for the fittings of the multiple regression models showed a better quality, measured by the *coefficient of determination*, when the atypical States were withdrawn. Furthermore, was observed that the effect of multicollinearity can modify the interpretation of the results due to some incoherence found in some cases. In order to identify which independent variables are most important in the predicting equation, one very useful technique is called the "stepwise multiple regression procedure". This method consists of the choice of a better regression equation, here used by the process "backward", which, for its time, it consists on the withdrawal of variables in order to obtain the most appropriate final regression model. Therefore, the search for the best regression equation (final model) was identified for each cause of death. The final models refer to the set of Brazilian states with the exception of the atypical ones. The results obtained for males and females are presented for each selected variable in the final model, along with the t-value, the *significant probability* and the *coefficient of multiple determination*, R^2.

4. NATIONAL PANORAMA

Three were the most important causes of death in the period for Brazil for both sexes*: circulatory diseases, neoplasm* and *respiratory diseases*, which involve all main subcauses of death. Table 4 shows the percentile and the mortality rates standardized for the main causes of deaths.

Data from WHO (1995), relative to the main death causes all over the world in 1998, show the prevalence of the *circulatory diseases*, and their strong association with factors due to the lifestyle adopted at the industrialized countries - the stress, sedentary habits and obesity. And, with similar importance, the death causes associated to the human behavior like cancer of *respiratory diseases*, *tuberculosis and respiratory infections*, which are traditionally associated to the poverty, maintain its importance (Waldman, 1998).

In Brazil, for the elderly, the scenery has not been different. Figure 2 shows the mortality rates for each 100,000 elderly. The rank of the main groups of death causes for both sexes remained unchanged in the period of 1980-1995, except for female in the fifth position, which was occupied by *the endocrine, nutritive and metabolic diseases and immunity disturbances*. But the sex-gap widened as a byproduct of a larger decline in female mortality. The rank was the same, which was dominated by *circulatory diseases* followed by the *ill defined causes* and *neoplasm* in this order. Together, the first and the third cause of death, in 1980 were responsible for a substantial percentage, about 55% of the total deaths, dropping for 50% in 1995 for males and around 58% in 1980 and 51% in 1995 for females.

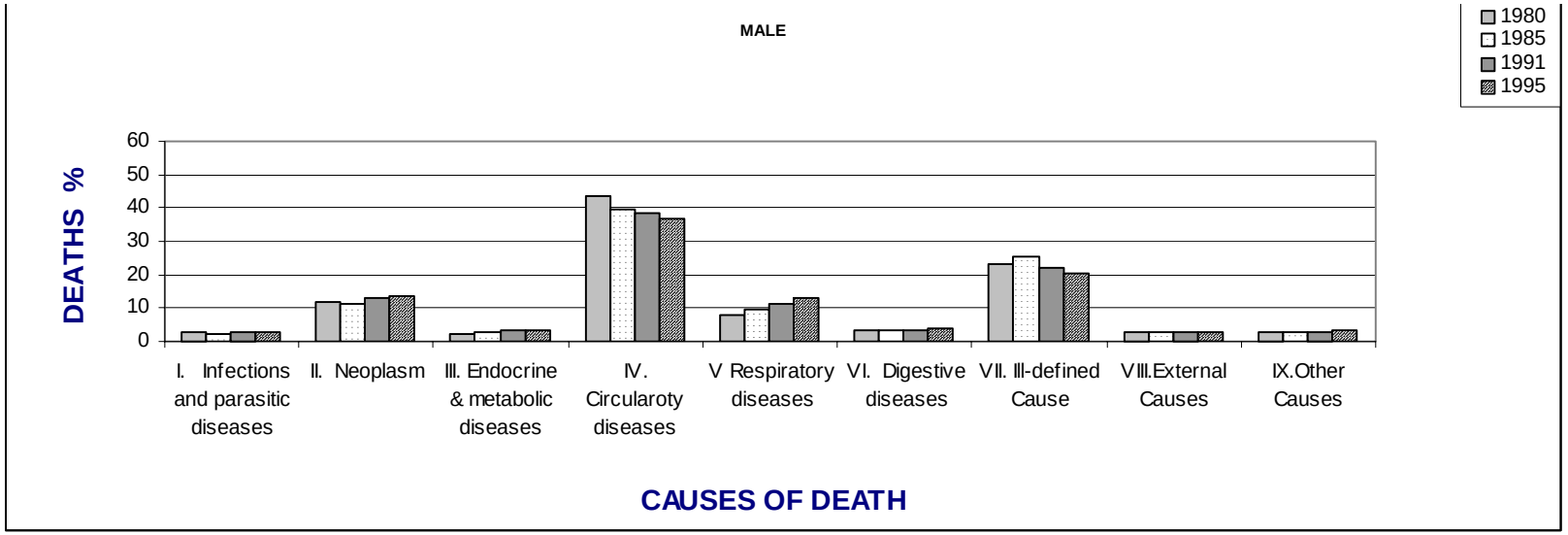
Table 4. Percentage of deaths and mortality rates for the main causes of deaths to Brazil by sex: 1980-95.

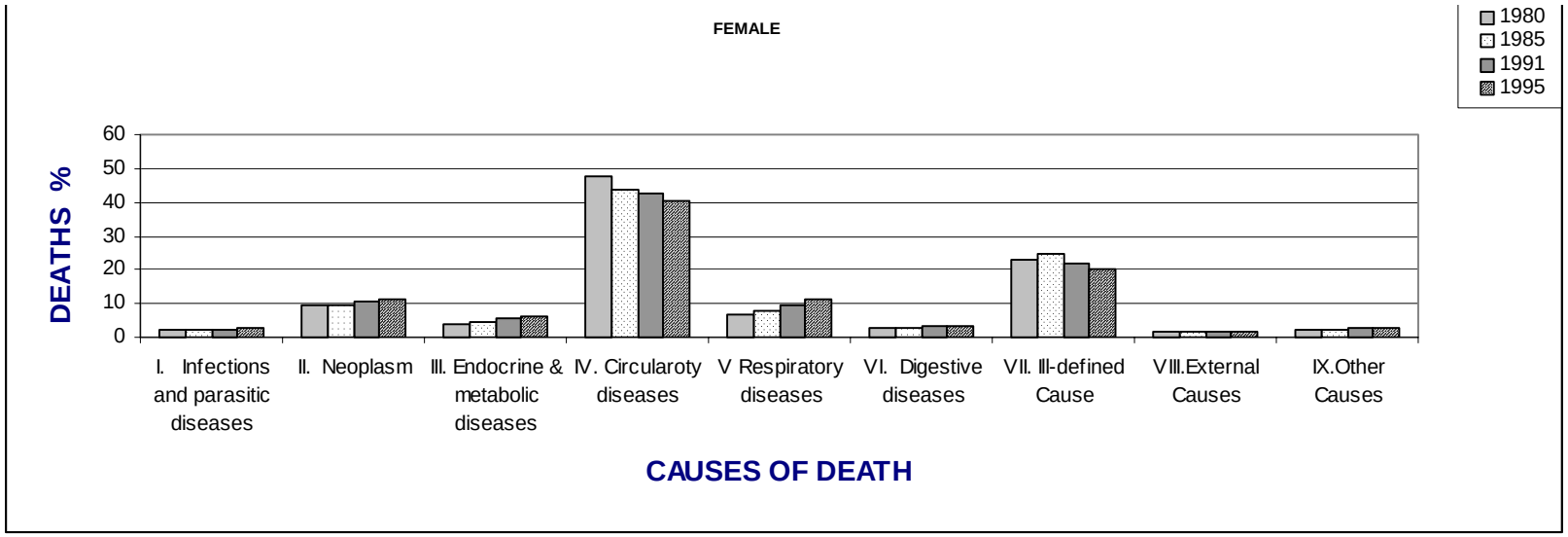
CAUSE OF DEATH	PERCENTAGE OF DEATHS				MORTALITY RATE		
	1980	1985	1991	1995	1980	1991	1995
Male							
I.Infections and parasitic diseases	2,60	2,54	2,61	2,63	150,54	157,47	150,96
II. Neoplasm	11,67	11,40	12,76	13,54	677,03	764,40	769,76
III.Endocrine & metabolic diseases	2,43	2,65	3,30	3,63	145,94	199,34	208,41
IV. Circularoty diseases	43,34	39,86	38,49	36,98	2669,23	2334,11	2127,10
V Respiratory diseases	7,75	9,38	11,22	12,95	489,29	686,32	751,73
VI. Digestive diseases	3,30	3,34	3,66	3,77	192,87	220,25	215,43
VII. Ill-defined Cause	23,32	25,41	22,13	20,20	1478,81	1358,45	1181,62
VIII.External Causes	2,91	2,85	2,86	3,04	170,50	171,69	173,42
IX.Other Causes	2,72	2,56	2,96	3,25	166,44	179,54	188,04
Female							
I.Infections and parasitic diseases	2,09	2,32	2,42	2,54	96,59	102,59	110,10
II. Neoplasm	9,66	9,42	10,61	11,15	445,11	453,80	490,15
III. Endocrine & metabolic diseases	4,02	4,53	5,44	5,99	187,70	231,11	260,59
IV. Circularoty diseases	47,94	43,88	42,35	40,51	2281,77	1783,21	1742,54
V Respiratory diseases	6,53	8,11	9,54	11,15	313,03	399,16	475,41
VI. Digestive diseases	2,84	2,96	3,27	3,46	132,49	138,41	149,59
VII. Ill-defined Cause	22,80	24,81	21,90	20,46	1089,47	914,60	870,21
VIII.External Causes	1,77	1,71	1,78	1,75	82,97	75,13	75,78
IX.Other Causes	2,36	2,26	2,7	2,99	111,04	113,90	128,77

The *circulatory diseases* was the only defined cause to decrease its relative importance in this period (43% to 37% for men and 48% to 42% for women). In contrast all the other major causes of death and in particular the diseases of *respiratory system* (7.7% to 13% for men and 6.,5% to 9.5% for women) inflated Brazilian mortality figures. This cause together with *circulatory diseases* and *neoplasm* were the key points of the mortality transition in the period.

Infectious and parasitic diseases represent a very small percentage of elderly mortality, but it is important to note that 15 years were not enough to break or to cease even the slight increase of these diseases in the country. Comparing to the more developed countries, there is still much room for improvements, for what is expected is that degenerative diseases largely replace these diseases.

Figure 2: MORTALITY RATES FOR *THE* MAIN CAUSES OF DEATHS TO BRAZIL: 1980-95.





The *ill defined causes* also presented fall around 23% to 20% for both sexes, suggesting an improvement in the diagnosis and in the quality of the information on causes of death. Although the importance of the *ill defined* causes declined from 1980 to 1995, it remained in the second position in terms of both percentile ant mortality rates for both sexes during the whole period (Table 2 and Figure 2). Chaimowicz (1997), calls the attention for the fact that in Brazil, in 1994, 60% of overall death certificates included in the category *of ill defined diseases*, referred to the elderly. Evidently, this fact reflects the deficiencies in the declaration of death certificate to this segment of the population. However, it is hoped that around 80% of defined causes of death (Table 1) constitute a satisfactory magnitude to extract conclusions about the tendencies and behaviors of the death causes in the country (Preston (1984) and Paes (1993)).

5. REGIONAL PANORAMA

Studying the adult mortality in the country, Paes (1999) found that the Brazilian States presented several mortality levels and that the profile of the diseases has not been uniform. Now, the question is to know what is the behavior to the elderly population. Monteiro (1997), studying the regional differences in the growth of the elderly population observed that the proportion of the population aged sixty and over grew in different rhythms in the great areas of Brazil. According to him, two groups can be distinguished after the 80's: the Northeast, Southeast and South presented, for different reasons, the largest proportions of elderly population. In the Southeast and South, the reduction of the fertility was the main factor, but in the Northeast the population emigration in reproductive age also contributed significantly to this aging. However, the North and Center-west in the last decades received significant contingent of young adults. That is why the growth of the elderly population didn't happen in such an intense rhythm, presenting elderlys' smaller proportion in 1991. Therefore, the regional characteristics are reflected in the several groups of death causes. Diseases of *circulatory system*, followed by *cancers* and then diseases of the *respiratory system*, were all more substantial causes of death in more developed regions in the country than in less developed ones. The following discussion focuses on these three most important causes of deaths in the elderlys' mortality.

Circulatory diseases

This group represents the main death cause in adults in several countries of the world. The situation is not different for the elderly, which diseases have been mainly associated with factors introduced by the lifestyle adopted at the industrialized countries (Waldman, 1998). The *circulatory diseases* in Brazil for the elderly emerged as the main cause of death for both sexes during the period from 1980 to 1995, for all States. Figure 3 shows that proportionally these diseases were more important for old women, which corresponded approximately to a little more than 40% of the total of deaths for the country as a whole in the period. But, in terms of mortality rates, the levels were higher for old men.

In spite of its importance, a decline was verified in the mortality during the period for most of the States, particularly for those from South and Southeast regions were both the levels and the quality of the recorded data

are higher. Such decrease seems to be due to an effective reduction of the levels of mortality of this cause of death and not because the doubtful quality of the data for some states from north and northeast, that could influence the results. Educational programs gone back to changes of alimentary habits and of the diagnosis and precocious treatment are the main aspects mentioned by Waldman (1998). The explanation for the general decrease of the circulatory mortality in the country for the elderly had as the main responsible the States that compose the first two groups, which population accounted for around 57% of the overall population.

In fact, such decline can be confirmed by observing the behavior of the mortality rates for the main sub-cause of death (not shown): *cerebrovascular diseases, pulmonary circulation diseases and other heart diseases* and also *myocardium acute infarct*. The mortality rates for these sub-causes of death declined mainly in the two first groups of States. An opposite behavior was found for the groups of States with larger percentile of "unknown cause of deaths" (North and northeast).

Most developed countries has already passed by the transition characterized by an increase of the levels of *circulatory diseases* mortality followed by a declining path (WHO, 1995). Such speculation could be the case for the most developed States in Brazil belonging to South and Southeast regions (first and second group of States). On the other hand, it could be the case that, the less developed ones, in a previous stage of mortality transition, are still increasing their levels of *circulatory diseases*.

The multiple regression analysis revealed for both sexes, that all variables presented in the final model a significant association (less than 5%) with the *circulatory diseases* (coefficient of determination around 93% , 79%, and 75% , respectively in 1980, 1991 and 1995), and that they presented positive coefficient (Table 5 and 6). The variables GNP and BED were strongly associated in 1980 and 1991 for both sexes. But for 1995, these two variables appeared together with LETHAL for males and, for females, GNP appeared together with LETHAL. Such associations indicated, for both sexes, that GNP and BED represented the variables with larger influence during the whole period for this kind of death in Brazil. These results indicate larger mortality rates for States with higher economic power and higher amount of hospital beds during the whole period between 1980 and 1995.

That is, these results reinforce the fact that the *circulatory diseases* prevailed in regions economically more developed. Indeed, Figure 3 reveals that the highest levels of mortality for this cause of death occurred in the States of South and Southeast regions in the country, particularly for São Paulo, Rio de Janeiro, Rio Grande do Sul and Paraná and the Federal District. This fact may indicate a higher levels of smoking and arterial hypertension in those States among others. Similar conclusion for some Brazilian capital cities was found by both Sichieri et al. (1992) and more recently for Cerqueira (1998) studying the adult population.

Reinforcing those relationships, Bixby (1991) highlights a positive and significant association between the cardiovascular mortality (for both sexes) and the development in Costa Rica in 1990. However, this author calls the attention for the possibility that some sick adults could emigrate to places with better sanitary infrastructure and with a better development level. The autoselection effects could interfere in the associations. But, such a study would demand a quality and availability of data beyond that of what the Brazilian statistics can offer.

According to Gruska (1994), the World Bank (1981) used data from the Pan American Organization for several American countries between 1981 and 1984 and was concluded that the incidence of *circulatory diseases*

were larger in the populations with higher per capita income. Then, it is suggested that the mortality in Brazil for *circulatory diseases* in the period 1980 - 1995, seems to have reflected associative links of socioeconomic variables similar to those experienced by other Latin American countries.

Neoplasm

To the country as a whole, *neoplasm* was the second cause of death, only overcome by *circulatory diseases*. With the demographic transformations observed in the last years and with the forecasting that in a near future Brazil will be the sixth country with the largest number of elderly people in the world (Veras, 1994), consequently it will expressively increase the gross rates and the relative weight of cancer in the mortality profile.

As it was already observed, in the national context, an increment was verified in the mortality by neoplasm diseases, in terms of both the percentile participation and in the mortality rates, during 1980-1995. For the elderly, the mortality rates by *neoplasm* (Figure 4) were more important for men, differently of that verified by Paes (1999) for the adult population aged 10 to 64. Among the men, the States of Santa Catarina and Amapá, all the States from the Centre-west and 8 States from the Northeast, except Pernambuco, presented an increment in the mortality by cancer. For women, an increment was observed for Santa Catarina, Espírito Santo, Mato Grosso, Goiás, Acre, Amazonas and for all States of the Northeast, except Piauí. These results show that the increase in the mortality rates predominated for the less developed States in the country.

Malign Neoplasm of the Colon; malignant neoplasm of trachea, bronchus and lungs; prostate cancer are among the most important types of cancer. It was verified for all of them that an increment in the mortality rates for the majority of the States, mainly for the States from South and Southeast regions. The only important sub-cause of death that did not follow this tendency was *stomach cancer*. A similar behavior was also verified by Paes (1999) for both sexes for the latter. This descent prevailed for all five groups of States adopted in this work. This fact suggests that indifferently of the quality of the data this tendency happened in the whole country during the period.

It is difficult to explain the importance of social and economic factors in a simple way in the mortality of the elderly population due to *neoplasm*. However, the correlation, in terms of R^2, between the mortality for *neoplasm* and the variables investigated for every years was high, around 85% (Table 5 and 6). In spite of the unclear association, the final models for both sexes revealed for 1980 a predominant link between mortality rates with variables more directly related with economic power: GNP and BED. But for 1991 and 1995, although these two variables appeared alone as significant variables, the model suggested an association with LIFEEXP and variables more related with social aspects: BENEF and LETHAL. It can be argued that during the first period 1980-1991, the elderly mortality for *neoplasm* was higher in States more economically developed. For the second period 1991-1995, and with different degrees and intensities, the mortality was more strongly linked with States with better social welfare and medical care conditions.

Cerqueira (1998) did a work to the Brazilian capital cities for adults for 1980 and 1990. Studying the relationship of *malignant neoplasm of the stomach* and *malignant neoplasm of trachea, bronchus and lungs*, he found that the variable (GNP) was strongly associated in 1980 and the social variables, instruction levels and women's participation in the labor market, were linked in both years mainly for 1990. In some how these results

seems to agree with the one found in this work for the *neoplasm* for the elderly. On the other hand, according to Mendonça and Teixeira (1995), factors as the urbanization, the industrialization and the increase of the life expectation, are among the most important factors, which explain the increased number of cancer in the elderly population. But, the variable URBAN was not significant in none of the years investigated and LIFEEXP appeared as significant variable only in the 90´s years, particularly for men. The urbanization process in the country is spread out all over the country. But perhaps, because this process was more accelerated in more recent years for the less developed regions in the country, this fact could explain the association of the variable URBAN with the States from North and Northeast, where, in fact, the mortality rates by *neoplasm* increased.

Respiratory Diseases

Paes (1999) found that the *respiratory diseases* were considered the fifth cause of death for adults in Brazil during the period 1980 - 1990 for both sexes, but the mortality rates were higher for males. And, during this period, the levels for females varied relatively very little. These results are important to shed some light to understand the elderly population mortality, since the adults are less affected by the *ill defined cause of death.*

Figure 5 shows that this behavior was not different for the elderlys. For both sexes the mortality rates were below 1,000 deaths for 100,000 elderlys for most of the States. But the rates were more important for the States of the South and Southeast regions and the highest levels were observed for males. Independently of the group of States there was an increase of the mortality rates in both sexes for most of the States, particularly for males (Figure 5).

This cause of death is increasing its importance particularly among elderlys who are carriers of chronic diseases and AIDS (Laurenti, 1981). The main sub-causes of *respiratory diseases* were *pneumonia* and *chronic bronchitis, emphysema and asthma*. Lessa (1998) considers the latter as a chronic disease, which are not transmissible, of social importance and that they determine larger population impact and mortality. The knowledge about the behavior of these diseases in Brazil is still very scarce. The *pneumonia* is considered the most feared of these infections, because it varies according to the socioeconomic level of the affected populations, and it assumes special relevance in the developing countries (Niobey et al, 1992). Both illnesses presented an antagonistic mortality pattern in the analyzed period for the elderly. The *pneumonia* revealed an increment in the mortality rates for most of States, and *the chronic bronchitis, emphysema and asthma*, a decrease for both sexes.

This cause of death presented several explanatory variables in the final models for both sexes (Table 5 and 6). But, GNP was the predominant variable for both sexes, except in 1991 for males. This association indicates that the elderly mortality rates for *respiratory diseases* was strongly associated in States with higher economic power of the population. In 1995, the variables GNP and LETHAL were significant (R^2 around 81% and 84% for males and females respectively) for both sexes. In fact, the mortality levels for this cause were higher for the States of the South and Southeast regions, which are more developed economically. However, for 1980 and 1991, in both sexes, there was a mixture of economic and social variables which were significant and related with the mortality by *respiratory diseases*. The only variable that did not shown any relationship was URBAN. This variable in fact was not related with any of the three main causes of death in Brazil. This suggest that there was an independence of the urbanization process with the mortality for this kind of death in elderly population.

7. FINAL CONSIDERATIONS

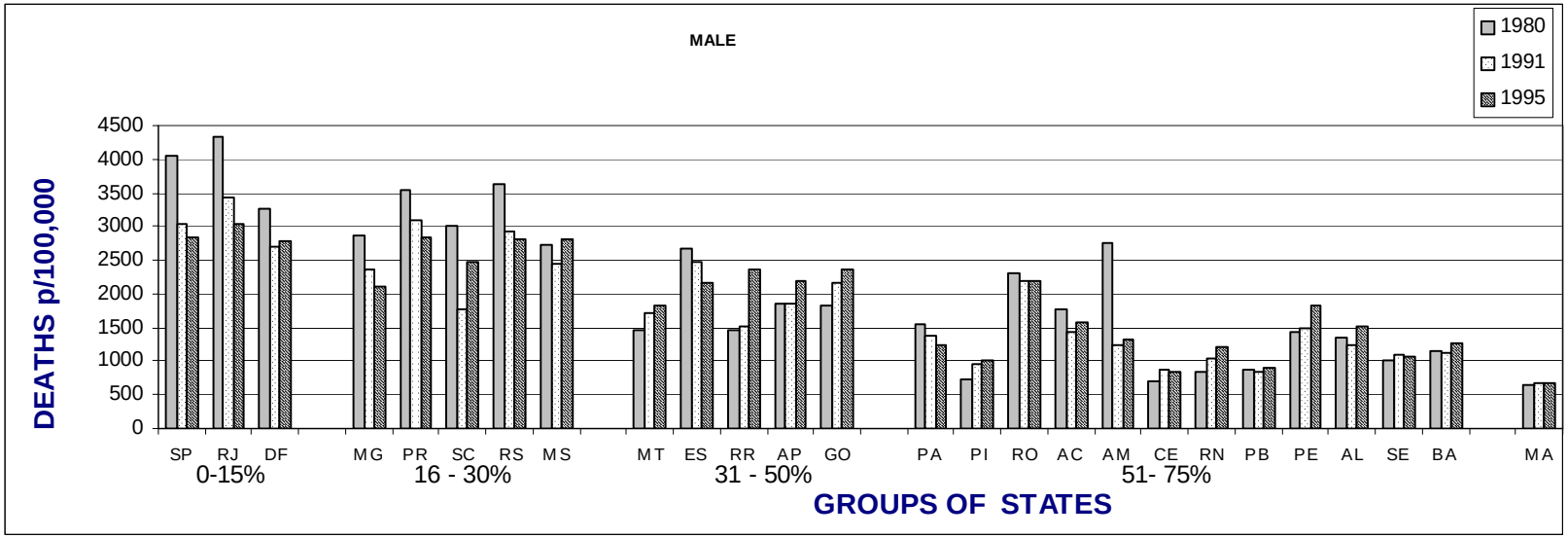
To trace the regional panorama of the elderly mortality is a complex task because the country includes a wide variety of social and economic aspects, which reflect in the mortality. The complexity increases due to the large inequalities in the quality of the death data. The aging of the Brazilian population isn't also happening in a homogeneous way. The results suggest deep inequalities in the levels of health. But, in spite of the health system of the country does not seem prepared to care and assist the increasing number of elderly in the population, it can be noted an improvement of the general conditions of health of these population in the period 1980 - 1995, measured by observed mortality trends.

More difficult, however, is to analyze the regional trends of the mortality classified by causes of deaths. The growth or decline of the mortality rates by cause of death was not limited to a specific region nor was a privilege of the most developed regions. Despite these important regional differences, the States presented some characteristics in common: the States from the South and Southeast regions and in some how the Centre-West seem to be in a more advanced step of the mortality transition in Brazil than the States belonging to the North and Northeast regions.

The levels of mortality rates were more underestimated in the past than in the more recent years. And, since the trends of the mortality rates for most of the States increased (*neoplasm* and *respiratory diseases*) or decreased (*circulatory diseases*) in a systematic way during the period, these behaviors seem to act independently of the quality of the data. The results, however, don't authorize any credit related on the mortality levels that are clearly underestimated, particularly for the States from North and Northeast regions.

The final models propitiated different relationship, depending on sex and timing. On could be tempted of synthesizing the accomplished investigations, saying that, independent of the year and for both sexes, the variables with larger representation in the associations with the most important cause of deaths - *circulatory diseases*, *neoplasm* and *respiratory diseases* - were GNP and BED for 1980 and 1991 and for 1995 these two ones together with LETHAL. In the association, there was a positive predominance of the two economic variables in the 80´s and a mixture of economic and social variables in 1995. But this attempt perhaps sounds as impertinence, because in the investigation the central point was not a search for a better model, but the identification of variables with significant contribution in the elderly mortality. And, statistic significance may not be sufficient to explain a relationship. In fact, the peculiarities from each region and the obtained information, make one to believe that there still much to study in the profiles of the Brazilian elderly's mortality. It is necessary to rehabilitate the vital registration statistics of Brazil and to take complete advantage of their full potential, to evaluate their strengths and weaknesses, and to give due credit to this important source of information, which has historically been neglected in the country.

Figure 3: STANDARDIZED MORTALITY RATE BY *CIRCULATORY DISEASES* ACCORDING TO UNKNOWN CAUSES CLASSIFICATION FOR BRAZILIAN STATES BY SEX: 1980-95



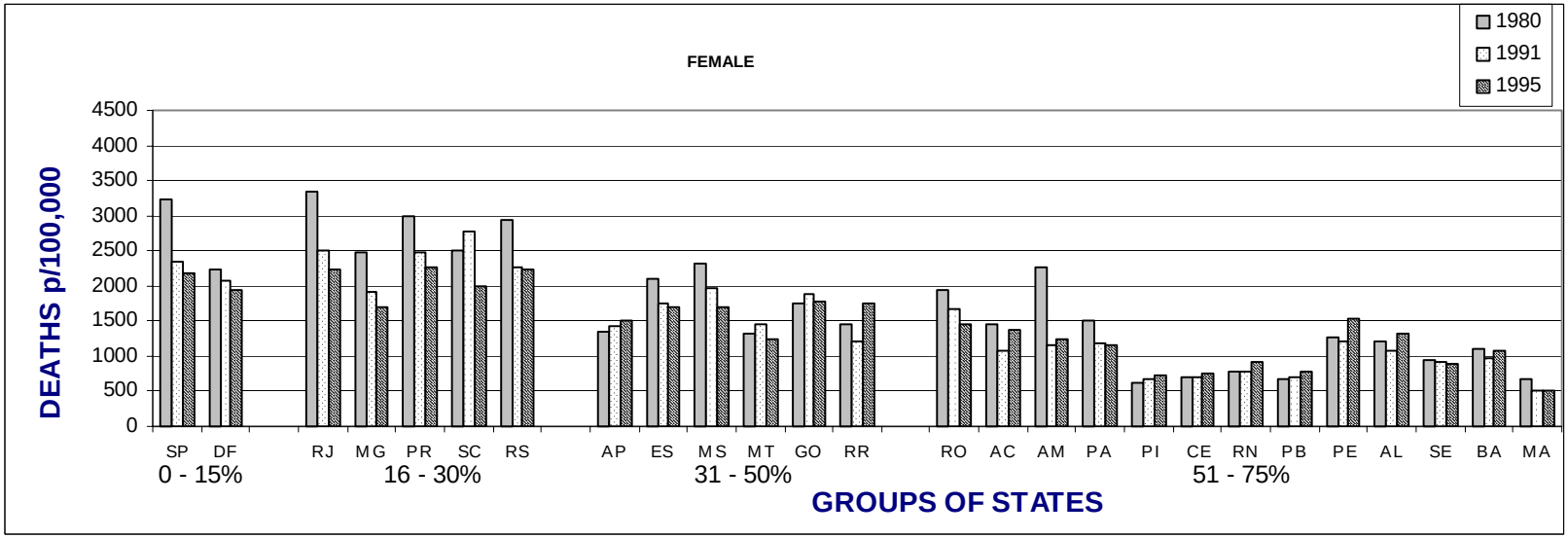


Figure 4: STANDARDIZED MORTALITY RATE BY *NEOPLASM* ACCORDING TO UNKNOWN DEATH CAUSES CLASSIFICATION FOR BRAZILIAN STATES BY SEX: 1980-95

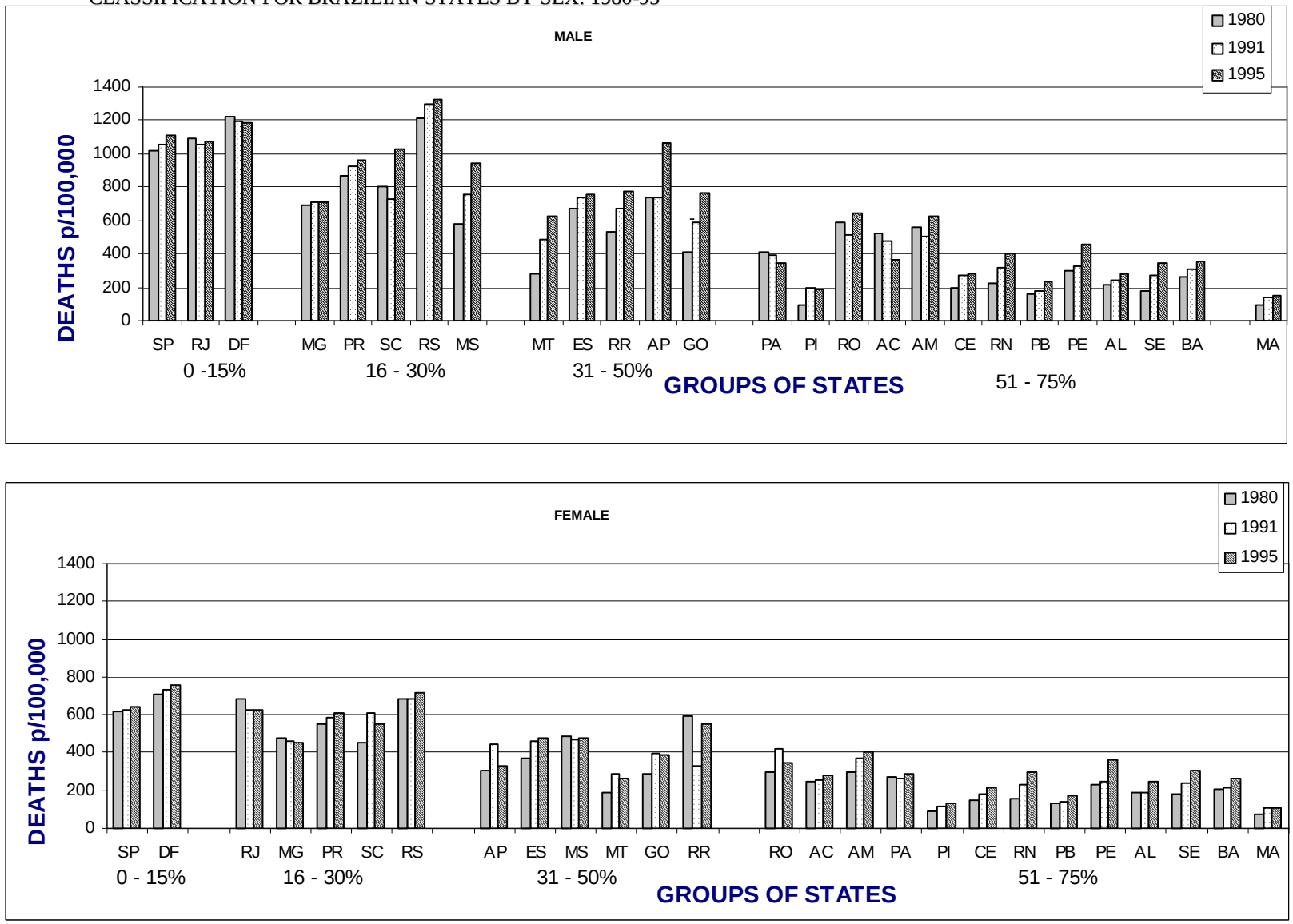
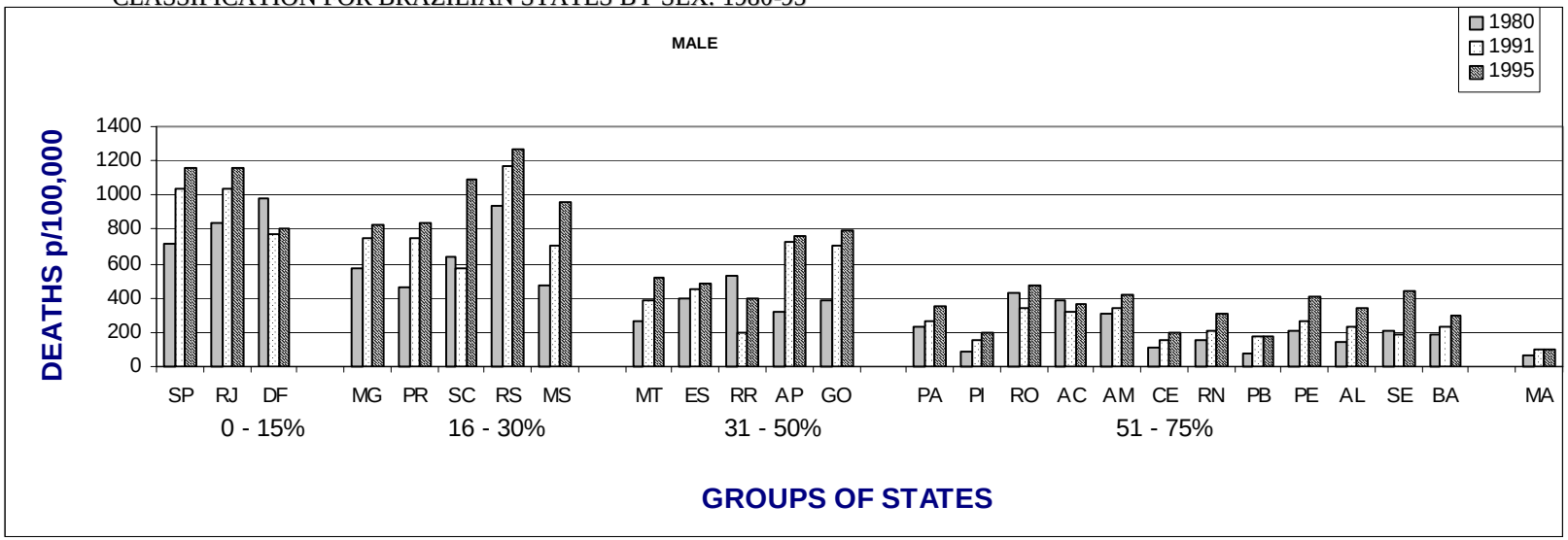


Figure 5: STANDARDIZED MORTALITY RATE BY *RESPIRATORY DISEASES* ACCORDING TO UNKNOWN CAUSES CLASSIFICATION FOR BRAZILIAN STATES BY SEX: 1980-95



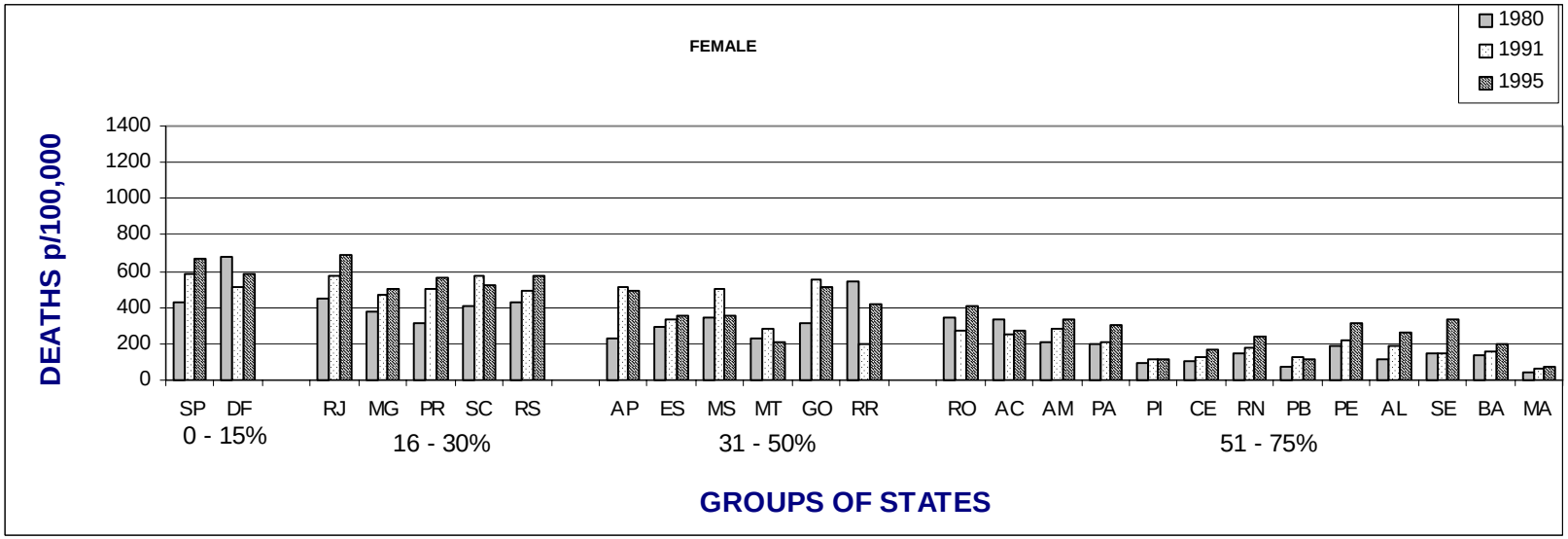


Table 5: FINAL MODELS OF THE RELATIONSHIP BETWEEN CAUSE OF DEATH AND SOCIOECONOMIC VARIABLES OF THE AGEING POPULATION OF BRAZIL FOR MALES: 1980 - 1991 - 1995

1980			1991			1995		
Variable	**t-value**	**Significance**	**Variable**	**t-value**	**Significance**	**Variable**	**t-value**	**Significance**
Circulatory diseases								
CIRC = - 768 + 593 GNP + 2421 BED R2 = 92.9%			CIRC = - 1039 + 400 GNP + 3971 BED R2 = 77.2%			CIRC = - 1125 + 270 GNP + 308 LETHAL+ 3582 BED R2 = 79.9%		
GNP	8.32	(1)	GNP	5.16	(1)	GNP	4.51	(1)
BED	2.56	(2)	BED	3.20	(1)	LETHAL	2.28	(2)
						BED	2.22	(2)
Malignant Neoplasm								
NEO = - 352 + 147 GNP +1032 BED R^2 = 87.5%			NEO = - 5300 + 82.9 LIFEEXP + 1281 BED R^2 = 83.0%			NEO = - 3054 + 69.1GNP + 227 LETHAL + 43.1 LIFEEXP R^2 = 87.6%		
PIB	5.29	(1)	LIFEEXP	7.01	(1)	GNP	1.76	(3)
BED	2.80	(2)	BED	2.93	(1)	LETHAL	4.73	(1)
						LIFEEXP	2.03	(3)
Respiratory diseases								
RESP = -2066 + 28.7LIFEEX + 58 BENEFIT + 95.5GNP R^2 = 90.6%			RESP = - 4684 + 70.4 LIFEEXP + 1615 BED R^2 = 78.4%			RESP = - 508 + 128 GNP + 237 LETHAL R^2 = 81.4%		
LIFEEXP	2.30	(2)	LIFEEXP	5.45	(1)	GNP	4.66	(1)
BENEFIT	3.56	(1)	BED	3.38	(1)	LETHAL	4.08	(1)
GNP	3.33	(1)						

"(*) Results using simple lineal regression model due to problems of multicolinearity.

(1) Significant at the level of 1% (2) Significant at the level of 5% (3) Significant at the level of 10%

Table 6: FINAL MODELS OF THE RELATIONSHIP BETWEEN CAUSE OF DEATH AND SOCIOECONOMIC VARIABLES OF THE AGEING POPULATION OF BRAZIL FOR FEMALES: 1980 - 1991 - 1995

1980			1991			1995		
Variable	**t-value**	**Significance**	**Variable**	**t-value**	**Significance**	**Variable**	**t-value**	**Significance**
Circulatory diseases								
CIRC = - 445 + 480 GNP + 1694 BED R^2 = 93.1%			CIRC = - 956 + 377 GNP + 3142 BED R^2 = 81.4%			CIRC = - 68 + 182 GNP + 313 LETHAL R^2 = 73.0%		
GNP	8.70	(1)	GNP	6.19	(1)	GNP	3.78	(1)
BED	2.32	(2)	BED	3.22	(1)	LETHAL	3.06	(1)
Malignant Neoplasm								
NEO = - 160 + 79.4 GNP + 618 BEDs R^2 = 87.5%			NEO = -1699 + 93.8GNP + 30.1BENEF + 22.5LIFEEXP R^2 = 92.8%			NEO = - 156 + 63.1 GNP + 119 LETHAL R^2 = 88.7%		
GNP	5.56	(1)	GNP	4.37	(1)	GNP	6.17	(1)
BED	3.27	(1)	BENEF	4.40	(1)	LETHAL	5.49	(1)
			LIFEEXP	2.45	(3)			
Respiratory diseases								
RESP = - 632 + 10.6 LIFEEXP + 336 BED + 34.3GNP R^2 = 86.4%			RESP = - 299 + 94.6 GNP+ 781 BED R^2 = 84.7%			RESP = - 163 + 58.0 GNP+ 115 LETHAL R^2 = 84.3%		
LIFEEXP	1.29	(3)	GNP	6.97	(1)	GNP	5.00	(1)
BED	2.04	(3)	BED	3.59	(1)	LETHAL	4.68	(1)
GNP	2.06	(3)						

(*) Results using simple lineal regression model due to problems of multicolinearity.

(1) Significant at the level of 1%

(2) Significant at the level of 5%

(3) Significant at the level of 10%

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