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Title: Trends and differences in mortality of older Portuguese population: a subnational analysis

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Corresponding Author: Miss Sandra Lagarto, M.D.

Corresponding Author's Institution: University of Évora

First Author: Sandra Lagarto, M.D. Human Ecology

Order of Authors: Sandra Lagarto, M.D. Human Ecology; Maria Filomena Mendes, PhD. Sociology

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Research Highlights

- Mortality trends and differentiation, among older population, by age group, sex and causes of death, at a subnational level
- Data analysis of death causes: neoplasm; endocrine diseases; circulatory, respiratory and digestive diseases; undefined causes
- Identifying regional variations and distinct patterns, considering mortality crude death rates, in both mainland and islands

Abstract

The Portuguese population is aging quite differently across the country. From the data available on EUROSTAT, we studied mortality trends and differentiations from 1994 to 2006, among the older Portuguese population, by age group, sex and major causes of death looking for regional variations. From the six selected death causes, three are dominant among the oldest: diseases of the circulatory system, neoplasm and diseases of the respiratory system. Considering general trends, deaths from endocrine diseases suffered, in that period, sharp increases across the country, while those for diseases of the circulatory system decreased. Differences occur occasionally, by sex, but especially in individuals aged 65-69 and 85 and over, concerning the main causes of death. Overall, the Center region presents the largest differences by cause of death, particularly between the two most important ones and the other causes. Also, the Azores and Madeira islands have some distinct patterns considering mortality crude death rates. In these two regions, it was also possible to identify variations by age group, sex and cause of death, different from those observed in mainland regions; however we can't consider either that, together, they're homogenous regions. This paper gives a full picture, at a subnational level, of major mortality death causes among older Portuguese population.

Introduction

In Portugal, as in other European countries, the older population is increasing. Over the last four decades of the twentieth century older population doubled (INE (*Instituto Nacional de Estatística*), 2002). The age pyramid of the Portuguese population is no longer triangular: it has a contraction at the base and an enlargement at the top, which reflects an aging population. Currently, the older population represents more than 17% of total population, according to the estimates of resident population in 2007, by the National Statistics (INE, 2008).

But the older are not distributed equally throughout the country. In the last Population Census, the proportion of persons aged 65 and over reached, in the Alentejo most aged region, in the South of the country – see Portuguese NUTII (Portuguese territorial units for statistical

purposes) in Fig. 1 –, about 22.3% of the total population, soon followed by the Center and the Algarve regions (with 19.4 and 18.6% of older population, respectively). The Azores islands, on the contrary, are the less aged region, with only 12.9% of older population. Considering some aging statistical measures, only the Azores, Madeira and the North regions have below 80 older people for every 100 inhabitants; however, in some regions, this ratio exceeds 100 (Alentejo: 162.6), according to INE (2001).



Figure 1 Portuguese NUTII

The population aging process has been enlarged, either due to falling birth rates, or to increased life expectancy. Projections for the Portuguese Population from 2000 to 2050 (INE, 2005) point that this phenomenon will continue and the percentage of persons aged 65 years or more will double again in forty years – it may reach 40% of the population, in most of the territory, which can lead to a ratio of about 2 older persons per 1 young adult, with higher values in Alentejo region (3 per 4).

So, social problems like poverty, retirement adjournment, lack of autonomy or independence of the older ones and the precarious health care and social services, which often are associated with older ages, turn more relevant studies that characterize causes of death trends in older ages, so that society will know the risk factors and minimize the arising problems from the changes in classical population structure and life prolonging.

There are many studies on health care in Portugal but not many focuses on changes in mortality patterns in the older population. Some characterize mortality trends, at a subnational

level, however with different goals and using classical statistical techniques (Morais, 2002). Some with a spatial approach, by age and sex in a certain time period, these studies evaluate, for instance, the quality of the provided care, avoidable causes of death or isolate death causes diseases variations. The aim of this work is to identify the most important causes of death among the older Portuguese population and the associated differences and variations occurred at a subnational level, considering mortality trends in all the regions of the country (mainland and islands), for both male and female, by age groups.

Brief background to causes of death trend studies

Several approaches to the study of mortality, regarding cause of death variations, are possible. Among others, to study variations on mortality trends by cause one can identify regional differences in a territory (even among a group of countries) – in this case, diseases of circulatory system (such as ischemic heart disease) and different types of cancer are generally analyzed (Singh & Yu, 1996; Smith, 1998).

Considering, for example, the differences in life expectancy between Portugal and Spain, we find that nowadays, the life expectancy of Portuguese males is one of the lowest in Western Europe (74.9 years, compared with 76.9 of the Spanish males), and the life expectancy of Spanish females is, in turn, one of the highest (81.3 compared with 83.5 years of Portuguese females). A recent study developed by a team of international researchers exposes the differences between Portugal and Spain with regard to mortality trends in the second half of the twentieth century and considering the contribution of specific causes of death (from 1890 to 2003) (Canudas-Romo et al., 2008). This study concludes that, in Portugal, life expectancy seems to finally follow the same path described in Spain, several years delayed. As far as the differences between the two countries, they are larger, to male, aged 20 to 79 and, to female, aged 60 and over. Diseases of the circulatory system and, for males, external undefined causes (usually attributed to trauma) are the major contributors to these differences.

Following this latter approach, a Dutch study examines the patterns of the cohorts in seven European countries, for both males and females and by causes of death in the transition

of the nineteenth century to the twentieth century. The study of the time series, considering individual behavior factors, like smoking at a younger age, may help explain trends in long-term mortality, in other words, at older ages (Janssen, 2005).

While demographic studies, these works often incorporate and have close links with other social and economic sciences, as well as human ecology, epistemology and even regional planning. Often, in age groups approaches, we estimate dependency ratios to measure, for example, the proportion of older by the working age population, which may indicate in a simplistic way, the economic costs associated with a certain age structure dynamics (Grundy, 1997).

All over the world, research has been developed considering the influence of available / provided health care or socio-economic conditions and its influence on mortality (such as marital status and educational level). Some of these works study the older population in countries where the demographic transition is about to be, or has been completed - the case of Taiwan, India (Murray et al., 2005; Singh & Yu, 1996). Comparisons of the mortality indicators with those of the developed countries are made in order to detect differences in major causes of death. On an internal analysis perspective, sometimes, types of social support received by older people and response on reducing mortality are also considered (in a case study in Bangladesh, it's estimated that the mortality rate for females living with their children is about 18% lower than those in nursing or resting homes and therefore without the support of family) (Leunh et al., 1999; Mostafa & Ginneken, 2000).

In some studies, in addition to the usual comparisons by sex, it's has been frequent to explain mortality trends by race or ethnic group (not specific to older ages). Some of these studies conclude, for example, that black people live on average 6 years less than Caucasian and those who did not attend secondary school lose up to 12.8 years, in life expectancy compared to those who attended, with a loss of only 3.6 years (Smith, 1998; Wong et al., 2002). These differences are more credible when it comes to cardiovascular mortality; however some of these studies also defend the existence of external causes to help explain the mortality trends.

Data and methodology

To analyze the mortality trends from 1994 to 2006, it was obtained, from the EUROSTAT, age data on crude death rates (deaths per 100 000 inhabitants), by cause of death and by sex for Portuguese older population - according to the International Statistical Classification of Diseases (ICD) (see Appendix I). The usual 5 years age groups were operate (age 65-69 represents individuals between 65 to 69 years and so on up to 85+ years, for individuals aged 85 and over).

The data for Portuguese regions - North, Center, Lisbon, Alentejo, Algarve (from North to South), Azores and Madeira islands - were worked out using descriptive statistics, considering three years average crude death rate in the same period.

One selected, primarily, from available data sets, 60 categories of causes of death for the females and 58 for males. Considering the absolute maximum value for each case, estimated from the average of 13 annual values by age and sex, a filter was applied using SPSS software for values exceeding the equivalent to 10% of maximum values. For females, all values larger than 30.0 and 70.0 for males were selected. From this new selection, we get 36 causes of death for females and 34 for males. As some of the causes replicate data (also some are correlated), we made a final selection by restricting the study to large groups of causes: we get 16 for females and 14 for males. Based on those categories, we selected the 6 most representative causes among older Portuguese (together represent more than 80% of all the causes of death in each of the 7 regions of the country): **neoplasm** (6-neoplasms ICD-C00-D48), **endocrine diseases** (26-Endocrine, nutritional and metabolic diseases-ICD E00-E90), **diseases of the circulatory system** (33-Diseases of the circulatory system, ICD I00-I99), **diseases of the respiratory system** (37-Diseases of the respiratory system ICD-J00-J99), **diseases of the digestive system** (42-Diseases of the digestive system, ICD K00-K93), **undefined causes** (55-Symptoms, signs, abnormal findings, ill-defined causes ICD-R00-R99). Then, we study regional variations occurred in crude death rates from 1994 to 2006, using the three-year mortality rates by sex in individuals aged 65 to 69 and 85 and over – in the first case, because it is the group among the older population, with longer life expectancy, and where there is a substantial heterogeneity or dynamics of death causes, which may explain differences

in mortality, and in the second case, because it is the age group that has experienced a significant growth regarding life expectancy, mainly due to improvements on health care, which, combined with low fertility rates has been contributing greatly to the aging population process.

Results and discussion

At first, we analyze the mortality trends by sex, by age and selected cause of death, for Portugal, and then we go to a restricted analysis throw major death causes at a subnational level.

The average rates estimated from the values of annual crude death rates for the period under review, by age and sex, have a large range of values and high variance, which increases in higher ages (with a large number of deaths) on males (except for the age 85+).

Considering trends before age 79, the decrease in mortality is almost inexistent; in age 80 and over, there's a slight decreasing trend, with larger variability in age 85 and over. This occurs for both male and female, although the mortality on females of all ages is, in general, substantially lower than on males. Also, it should be noted that in Portugal, mortality trends, among the population aged 65 or more years, evolve exponentially.

To explain trends, not only by sex and age, but also by cause of death, we represent the 65 categories of disease initially considered, according to the ICD. As mentioned before (see *Data and methodology*), this set illustrate the main families of causes, but simultaneously disaggregated causes, hence the analysis of Fig. 2 must consider that fact (there are correlations between marginal causes and the major causes or "family").

Basically, there are four main groups of death causes responsible for mortality among the older Portuguese population: neoplasm (mainly due to malignant tumors - groups 6 to 24), endocrine diseases (whose figures correspond almost entirely to diabetes mellitus - groups 26 to 27), diseases of the cardio-pulmonary-digestive system (predominance of circulatory system diseases such as ischemic diseases, followed by diseases of the respiratory system and then the digestive system - groups 33 to 42), accidents and undetermined causes (groups 55 to 59).

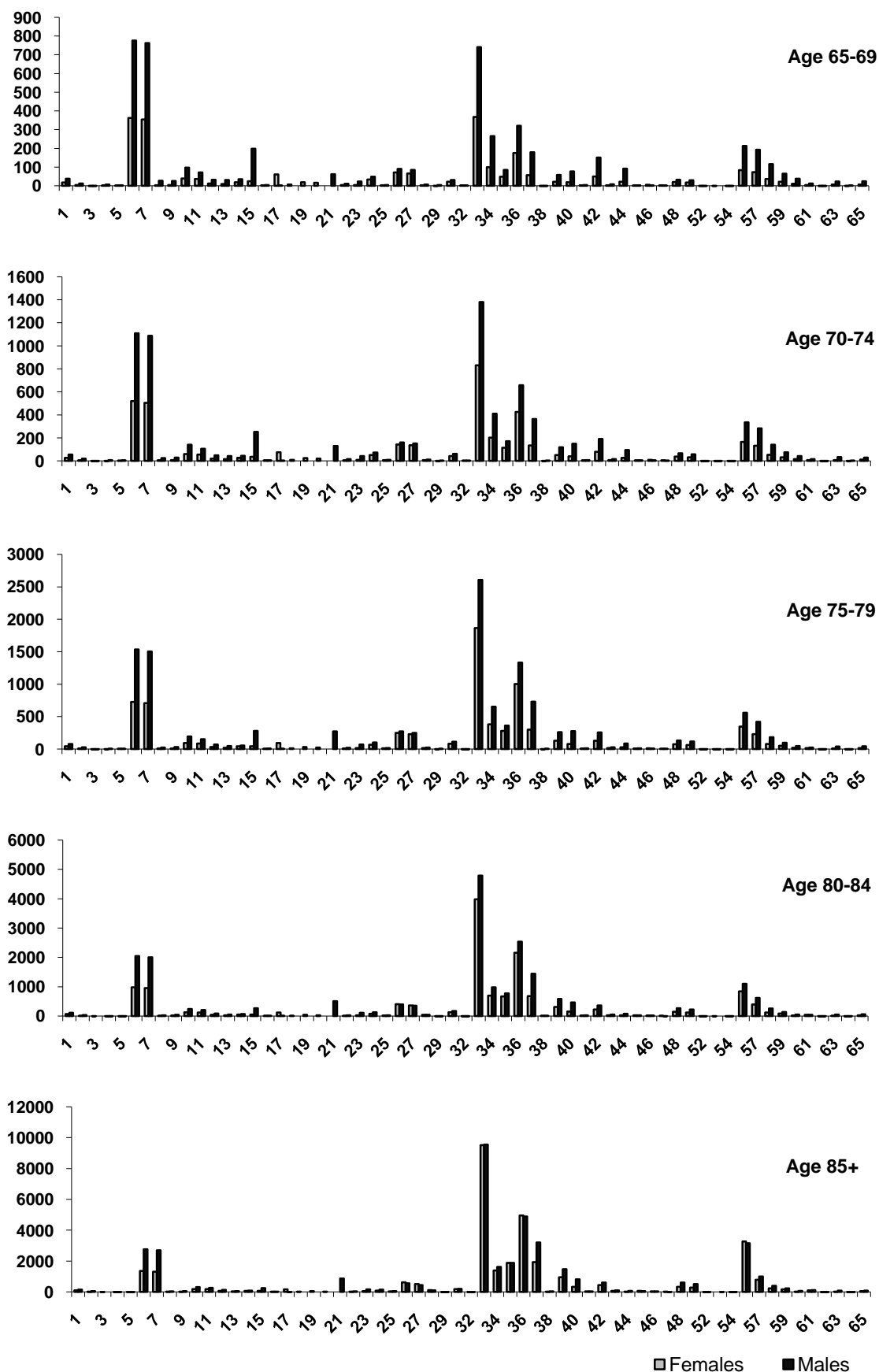


Figure 2 Crude death rate, by cause of death (according to ICD), sex and age (average values, estimated per 100 000 inhabitants from 1994 to 2006)

Thus, we find that as people age, most of the death causes lose expression, including neoplasm (which are the main cause of death among males aged 65 to 69) and become more important the dominant causes which are, on both male and female aged 70 and over, diseases of the circulatory system. This pattern is similar among males and females, however with higher mortality rates on males (exception to age 85+ with similar mortality rates both males and females). Table 1 illustrates the main differences between males and females, considering crude death rates associated to major causes of death in the period under review.

Table 1 Crude death rate for Portugal, by sex, age and main causes of death (average values, estimated per 100 000 inhabitants from 1994 to 2006)

ICD	Females					Males				
	65-69	70-74	75-79	80-84	85+	65-69	70-74	75-79	80-84	85+
1. Infectious and parasitic diseases	17.3	26.2	42.7	67.0	103.2	38.3	54.2	76.3	109.7	148.6
6. Neoplasms	362.3	518.4	725.5	979.7	1353.6	775.5	1108.1	1533.5	2044.2	2761.0
25. Diseases of the blood, immunological disorders	3.3	5.6	9.9	18.0	38.4	:	:	:	:	:
26. Endocrine, nutritional and metabolic diseases	70.9	142.2	247.2	401.5	615.1	89.8	160.5	270.5	395.9	564.1
28. Mental and behavioural disorders	3.0	7.3	16.2	42.1	121.7	6.8	10.3	22.6	45.8	101.3
31. Diseases of the nervous system and the sense organs	21.7	40.8	80.3	127.1	174.9	31.5	61.1	113.6	168.1	202.5
33. Diseases of the circulatory system	368.3	831.4	1864.5	3979.4	9508.7	741.4	1381.9	2609.3	4790.0	9555.5
37. Diseases of the respiratory system	56.7	133.9	299.7	680.9	1936.6	179.5	363.5	729.0	1441.3	3207.7
42. Diseases of the digestive system	49.3	78.8	128.4	225.7	436.6	150.8	191.1	254.8	357.3	606.4
45. Diseases of the skin and subcutaneous tissue	1.9	3.7	9.7	27.2	66.5	:	:	:	:	:
46. Diseases of the musculoskeletal system/connective tissue	5.3	8.0	10.7	17.5	30.1	:	:	:	:	:
48. Diseases of the genitourinary system	19.8	36.2	73.9	147.5	330.4	32.9	64.8	134.0	263.7	599.3
55. Symptoms, signs, abnormal findings, ill-defined causes	83.3	164.8	347.8	844.1	3263.0	213.1	335.6	559.7	1102.9	3151.3
58. External causes of injury and poisoning	36.2	51.8	78.3	123.5	228.6	115.6	139.7	183.2	259.4	400.5
59. Accidents	:	:	:	:	:	65.4	75.1	99.1	141.4	233.7
63. Suicide and intentional self-harm	7.3	11.6	16.3	26.6	45.6	24.3	28.4	41.4	57.9	85.9
65. Events of undetermined intent	17.3	26.2	42.7	67.0	103.2	38.3	54.2	76.3	109.7	148.6

: Not significant values according to methodological criteria applied

Inevitably, all death causes increase gradually with age, and the predominant ones - diseases of the circulatory system (33) or respiratory system (37) - have a sharp increase in age 85+ (or even age 80 and over in the first case), the undefined causes of death (55) also have a similar pattern.

As for the remaining causes, neoplasm prevail, with values close to the death rates attributed to diseases of the circulatory system, for individuals aged 65 to 69 (lower on females; higher on males), which are only overcome by diseases of the circulatory system and undefined causes on both males and females aged 85 and over. It is also clear, from the analysis of the data in Tab. 1, the largest number of deaths on males (comparing to females), to all ages and all death causes. Exceptions are deaths due to endocrine diseases (on individuals aged 80 and over, with associated death rate considerably higher on females), mental diseases and undefined causes (in these two last death causes only at age 85+).

Considering other differences between males and females, we highlight the inclusion, in the preliminary list of selected diseases (as significant for the analysis of the main causes of death among females) of the diseases of the blood or immune system (25), the skin diseases or cutaneous tissues (45) and the diseases of the musculoskeletal system (although with values of magnitude minimum if we compare with other causes, and especially the dominant ones) and accidents, as a significant cause of death to males. Table 2 shows a picture of the country regarding main causes of death among the older Portuguese (with Δ representing the variation from time period 1994 to 2006 compared to the estimated crude death rate for the triennium 1994-2006).

At this point, one refer that the six major death causes selected for subnational level analysis represent over 80% of all causes by sex and age group (in some cases, as in Madeira, more than 95%, for females, aged 85 and over from 1994 to 1996). Additionally, if we subtract values of indefinite causes, the remain identifiable causes represent 64.6% (Algarve, females, age 85+, 1994-1996) to 91.5% (Azores; females, age 65-69; 2004-2006) of all death causes.

Considering variations, there is, in general, a reduction in mortality attributed to this set of causes on both male and female and considered age groups, which supports the aging population process and increasing of life expectancy that we have witnessed in recent decades.

Table 2 Major causes of death among the older Portuguese population (% crude death rate)

Region	Causes of death (diseases)	Female						Males					
		Age 65-69			Age 85+			Age 65-69			Age 85+		
		1994- 1996	2004- 2006	Δ	1994- 1996	2004- 2006	Δ	1994- 1996	2004- 2006	Δ	1994- 1996	2004- 2006	Δ
North	Neoplasms	29.6	35.8	21%	5.9	8.1	36%	29.5	34.6	17%	10.7	13.8	29%
	Endocrine	5.9	6.5	10%	2.0	3.8	91%	2.4	3.6	48%	1.4	2.9	107%
	Circulatory system	37.1	23.7	-36%	54.1	43.7	-19%	34.0	22.4	-34%	47.3	36.7	-22%
	Respiratory system	4.9	5.6	15%	9.7	13.2	36%	7.7	8.2	7%	13.9	17.9	29%
	Digestive system	6.0	5.1	-16%	1.7	2.4	39%	6.1	6.8	12%	1.7	2.7	59%
	Undefined causes	8.2	10.7	31%	22.7	19.5	-14%	10.4	11.0	6%	20.6	15.6	-25%
	% Total	91.7	87.4	-5%	96.2	90.6	-6%	90.0	86.6	-4%	95.6	89.6	-6%
Algarve	Neoplasms	28.8	34.2	19%	6.0	6.4	8%	27.6	31.8	15%	9.4	12.4	32%
	Endocrine	9.1	4.7	-48%	2.1	4.8	132%	2.8	3.9	37%	1.4	3.1	124%
	Circulatory system	31.3	28.1	-10%	47.0	39.4	-16%	34.4	25.9	-25%	44.6	30.7	-31%
	Respiratory system	3.7	3.8	2%	7.4	11.7	57%	4.5	5.9	33%	9.3	17.6	90%
	Digestive system	2.5	4.1	67%	2.1	3.6	68%	3.5	5.1	49%	2.5	3.5	41%
	Undefined causes	6.6	8.8	33%	29.4	23.2	-21%	9.1	8.9	-3%	23.1	17.6	-24%
	% Total	81.9	83.6	2%	94.0	89.0	-5%	81.9	81.6	0%	90.2	84.9	-6%
Center	Neoplasms	29.2	34.2	17%	6.1	7.9	29%	27.4	32.8	20%	11.2	13.6	22%
	Endocrine	5.4	6.2	14%	2.2	4.7	108%	3.1	3.8	25%	1.9	3.8	101%
	Circulatory system	37.3	25.6	-31%	54.1	44.9	-17%	31.6	22.4	-29%	47.8	37.7	-21%
	Respiratory system	4.2	4.3	3%	7.2	12.8	78%	6.0	5.7	-5%	11.7	17.4	49%
	Digestive system	5.9	4.6	-23%	2.1	2.9	41%	7.9	6.6	-16%	2.5	3.3	34%
	Undefined causes	6.7	10.0	49%	23.0	16.9	-27%	9.3	11.3	21%	18.6	13.8	-26%
	% Total	88.6	84.8	-4%	94.7	90.0	-5%	85.2	82.5	-3%	93.6	89.5	-4%
Lisbon	Neoplasms	33.9	39.0	15%	8.7	8.7	0%	33.2	38.0	14%	14.4	15.4	7%
	Endocrine	5.2	6.8	30%	2.7	3.9	44%	3.8	4.5	18%	2.0	4.1	100%
	Circulatory system	36.2	29.1	-20%	62.8	53.4	-15%	34.3	27.5	-20%	51.4	43.7	-15%
	Respiratory system	4.3	4.1	-5%	8.9	12.0	35%	6.0	6.3	4%	13.9	16.4	17%
	Digestive system	4.6	3.2	-30%	2.5	2.6	4%	5.9	5.5	-7%	2.9	3.0	1%
	Undefined causes	3.7	5.0	35%	7.8	8.8	13%	4.1	5.1	24%	6.7	6.7	0%
	% Total	87.9	87.1	-1%	93.5	89.5	-4%	87.4	86.8	-1%	91.4	89.3	-2%
Alentejo	Neoplasms	29.3	33.2	13%	6.1	7.5	24%	25.7	31.3	22%	11.5	12.8	11%
	Endocrine	8.4	7.9	-6%	2.7	5.4	101%	4.0	4.1	2%	1.7	3.6	117%
	Circulatory system	34.4	29.3	-15%	56.2	45.2	-20%	33.3	24.6	-26%	48.3	39.0	-19%
	Respiratory system	4.0	4.2	4%	6.2	9.7	57%	5.6	7.2	29%	10.5	14.7	40%
	Digestive system	4.4	3.2	-27%	2.4	3.3	36%	5.0	4.6	-8%	3.9	2.8	-28%
	Undefined causes	6.9	7.8	13%	20.6	18.9	-8%	8.1	9.4	15%	15.5	13.8	-11%
	% Total	87.4	85.6	-2%	94.1	90.0	-4%	81.6	81.2	-1%	91.5	86.8	-5%
Azores	Neoplasms	27.5	26.1	-5%	7.4	6.8	-8%	27.9	33.2	19%	10.5	11.4	8%
	Endocrine	8.4	14.6	73%	3.7	7.4	100%	2.3	5.1	119%	1.5	5.4	246%
	Circulatory system	43.8	41.2	-6%	52.2	50.2	-4%	42.7	34.9	-18%	52.0	42.1	-19%
	Respiratory system	4.0	4.2	4%	6.2	9.7	57%	5.6	7.2	29%	10.5	14.7	40%
	Digestive system	6.2	4.5	-27%	1.2	2.1	74%	7.3	7.8	7%	3.1	3.2	3%
	Undefined causes	1.1	1.0	-10%	22.6	13.3	-41%	1.7	1.3	-23%	14.2	8.0	-44%
	% Total	91.6	92.5	1%	95.1	90.7	-5%	90.7	92.2	2%	92.0	87.6	-5%
Madeira	Neoplasms	18.5	26.4	43%	5.4	6.0	10%	18.2	22.6	24%	8.8	9.9	12%
	Endocrine	7.6	10.4	37%	3.9	6.4	65%	3.4	4.6	38%	2.8	4.8	70%
	Circulatory system	42.2	29.7	-29%	45.3	37.5	-17%	30.2	23.5	-22%	37.6	31.5	-16%
	Respiratory system	3.3	8.2	147%	15.2	26.2	72%	12.0	11.6	-3%	20.2	24.9	23%
	Digestive system	2.4	3.0	25%	2.6	3.0	13%	5.9	6.6	12%	1.4	3.8	164%
	Undefined causes	13.3	11.2	-16%	24.8	12.1	-51%	15.1	13.8	-8%	21.9	13.4	-39%
	% Total	87.2	88.8	2%	97.2	91.1	-6%	84.6	82.8	-2%	92.9	88.4	-5%

Exceptions to this behavior occur in the Algarve and the Azores regions, with no negative variations on both males and females aged 65-69. These two regions present a cumulative variation different from all the others. There are also differences between the regions of Madeira and those two and the North region, Algarve, the Center region, Alentejo and Lisbon (with small increases).

Regional trends and variations by sex

From Table 2 analysis, we find significant differences in mortality by sex in Portugal: more females than males died, in all regions in both ages 65-69 and 85+, due to diseases of the circulatory system - the main cause of death among the older Portuguese, except for the Algarve region, where the death rates for females stood still in the 2004-2006 period, slightly less than the analogue for males. The other significant difference between males and females is the higher death rates on males than females for diseases of the respiratory and digestive systems – with the exception of the Madeira, where trends differ internally on both males and females (only age 85+ replicates the general trend regarding these causes of death).

Considering the general trend variation, crude death rates have been increasing, for both males and females, on the deaths from neoplasm, endocrine diseases, diseases of the respiratory and digestive, and decreasing, for deaths due to diseases of the circulatory system. Only if we consider deaths attributed to undefined causes, it's clear a distinct variation pattern, by sex and region or age – in Lisbon, for example, among females aged 85+, there's an increase closer to 13%, while in the Algarve or in the Center region (also for females at the same age) reductions occurred at about 21 to 27% respectively; in the islands, this variation is always negative.

Also with a similar trend in all regions, but now with a negative variation, we have the diseases of the circulatory system: The largest reductions, about 30% on both males and females, occurred in North and Center regions. Only in the Azores - a region that experienced the smallest reduction in the country, regarding this cause of death – there is (with a negative balance) a difference in magnitude of variation values in death rates by sex: reduction on

1 females is about one third of males (e.g., 6% in the age 65-69, for 18% in the same age for
2 males), notice that the circulatory system diseases still represent 40 to 50% of causes of death
3 in the region.
4

5 Occasionally, there are also differences within regions, by sex. Therefore, we find that in
6 the North region, deaths from diseases of the digestive system decreased close to 16% on
7 females aged 65 to 69, compared with an increase of 12% on males. In the Algarve region, a
8 similar discrepancy occurs in terms of variation (females: 48%; males: 37%), but now for deaths
9 due to endocrine diseases, and in Lisbon, for diseases of the respiratory system (females: -5%;
10 males: +4%). In the Alentejo region, the previous pattern for deaths due to endocrine diseases
11 is repeated, with a reduction on female and an increase on male, exception to age 85+
12 (females: +36%; males: -28%). In the Azores region, there is a similar trend to that described for
13 the North region, when it comes to diseases of the digestive system, but also, in both age
14 groups considered, a reduction in neoplasm mortality on females and an increase on males. In
15 the Madeira region, it occurs the largest difference by sex observed for all regions (with
16 increase on females and reduction on males, in some death causes, which is contrary to
17 general trend): deaths due to diseases of the respiratory system increased at about 147% on
18 females aged 85 and over, while males, at the same age and for the same death cause,
19 suffered a decrease of only 3%. Contrasting to other regions, the Center region does not have
20 internal differences by sex considering variations by cause of death.
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38 For these reasons, North and Center regions show a similar pattern by sex, which
39 differs from the Alentejo region in the deaths from endocrine diseases and diseases of the
40 digestive system (see Fig. 3). Each of these three regions differs, in turn, from the others, at
41 least for one of the causes of death at age 65-69, whereas, age 85+, the differences between
42 regions are reduced: the North and Center regions have been joined to the Algarve and
43 Madeira, with analogous variations (reduction) on both males and females for diseases of the
44 circulatory system and undefined causes.
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52 To complement the analysis by sex, one calculated the ratio between the number of deaths on
53 males and females, which is presented in Table 3. The ratio, estimated by cause of death and
54 region, shows that, generally, in all regions, there's a higher mortality among males than on
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females. That fact occurs with deaths due to neoplasm, diseases of the circulatory and respiratory system, but only in individuals aged 85 and over.

Table 3 Ratio between the number of deaths on males/ females (multiply by 100), by region and cause of death, to individuals aged 65-59 and 85 and over, from 1994 to 2006

Age group	Time period	Portuguese regions						
		North	Algarve	Center	Lisbon	Alentejo	Azores	Madeira
Neoplasms								
65-69	1994-1996	100	96	94	98	88	101	98
	2004-2006	97	93	96	97	94	127	86
85+	1994-1996	181	158	181	166	190	142	163
	2004-2006	171	193	171	178	171	166	166
Endocrine diseases								
65-69	1994-1996	41	31	56	72	48	28	44
	2004-2006	55	83	62	66	52	35	44
85+	1994-1996	72	66	84	74	63	42	74
	2004-2006	78	64	81	103	68	72	76
Diseases of the circulatory system								
65-69	1994-1996	100	96	94	98	88	101	98
	2004-2006	97	93	96	97	94	127	86
85+	1994-1996	181	158	181	166	190	142	163
	2004-2006	171	193	171	178	171	166	166
Diseases of the respiratory system								
65-69	1994-1996	100	96	94	98	88	101	98
	2004-2006	97	93	96	97	94	127	86
85+	1994-1996	181	158	181	166	190	142	163
	2004-2006	171	193	171	178	171	166	166
Diseases of the digestive system								
65-69	1994-1996	100	140	133	129	114	117	247
	2004-2006	134	126	144	172	143	172	220
85+	1994-1996	98	117	119	116	159	262	54
	2004-2006	112	98	113	112	84	154	126
Undefined causes								
65-69	1994-1996	127	139	139	112	118	156	114
	2004-2006	103	101	113	103	120	133	124
85+	1994-1996	91	79	81	87	75	63	88
	2004-2006	80	76	81	76	73	60	111

This trend also happens with deaths due to diseases of the digestive system and undefined causes, but now in individuals aged 65 to 69 (which, in the first case, we can extend to individuals aged 85 and over, with the exception of deaths occurred in Algarve and Alentejo regions – on the South of the country – from 2004 to 2006, where there was a reversal in the

1 trend over the initial period). As far as endocrine diseases, excepting for Lisbon region (with an
2 average of 103 males deaths for every 100 females from 2004 to 2006, among individuals aged
3 85 and over), the number of deaths on females is higher than on males.
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10 *Regional trends and variations in ages 65-69 and 85+* 11 12 13

14 Some of the differences between selected age groups have already been mentioned
15 when we analyzed trends by sex. Now we present a general description, by cause of death and
16 by sex in order to underline other regional differences.
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20 There is an overall trend in all regions: the variation of crude death rates, by cause of
21 death, it's higher in older individuals (age 85+), on both males and females. As we can observe
22 in Fig. 3 this pattern is most obvious in deaths due to endocrine diseases. If we consider all the
23 causes of death, we find differences between the Madeira and other regions because, unlike
24 the general trend, in this region, the variation is greater for deaths due to diseases of the
25 respiratory system as well as for neoplasm in individuals aged 65 to 69 and 85 and over. Also,
26 the Madeira and Azores regions behave differently, for undefined causes of death – there is, in
27 these regions a tendency for higher variation of the crude death rate on females, instead on
28 male, contrasting with general trends in mainland.
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38 Note that, even within the same age group, occasionally, differences occur at a
39 subnational level but also at a sub-regional level, for example, we point out the reduction in
40 mortality due to endocrine diseases on females aged 65 to 69. This situation is different from
41 the general trend of deaths attributed to this cause in other regions of the country where
42 occurred an increase in that age (for both males and females).
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53 *Regional trends and variations by cause of death* 54 55 56

57 Considering the time period under review, circulatory system diseases are, in general,
58 the main cause of death among the older population.
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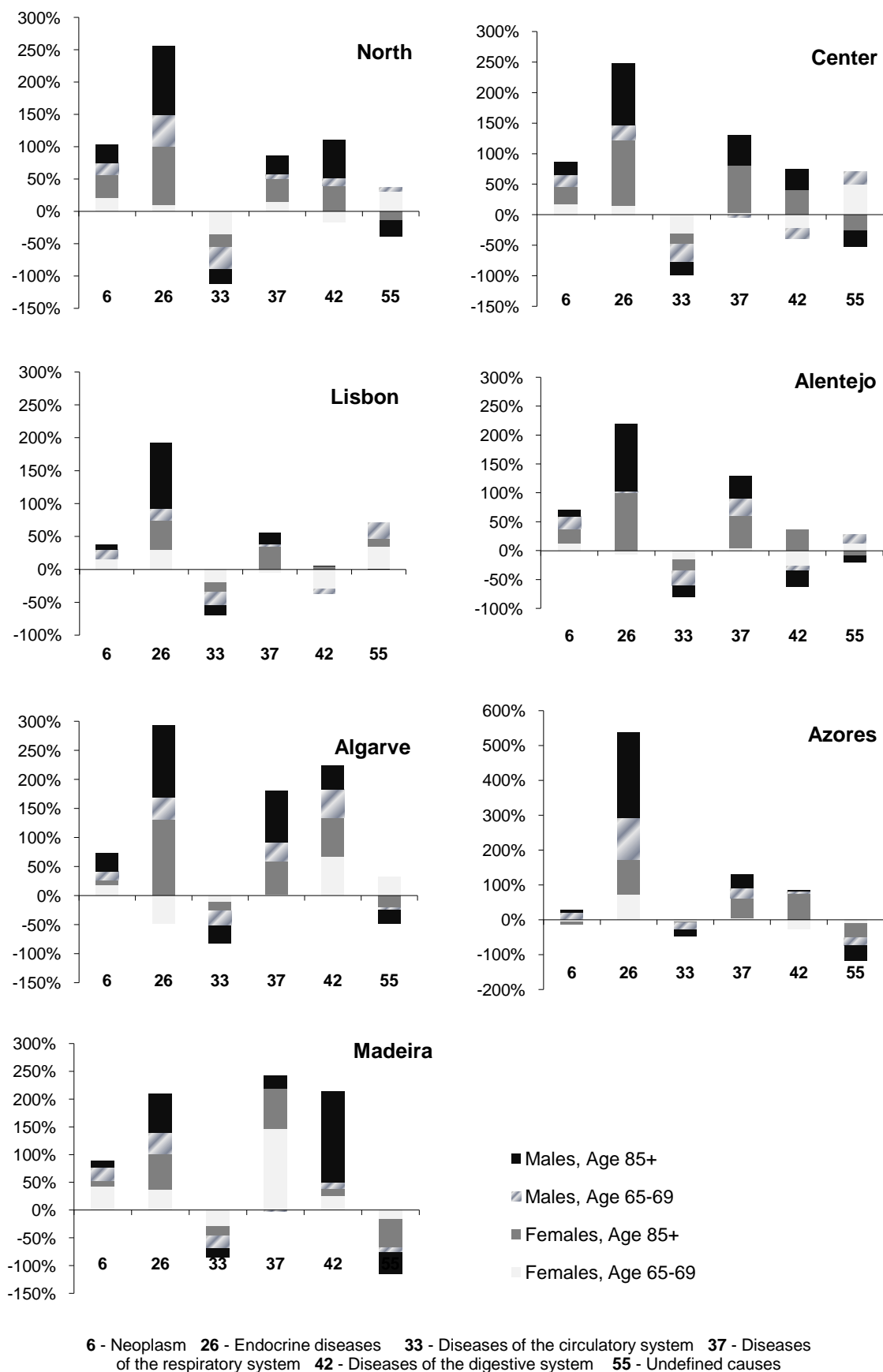


Figure 3 Regional differences in the variation of crude death rates in Portugal, by sex and age (1994-2006)

Deaths due to circulatory system diseases, still represents, from 2004 to 2006, in regions such as Lisbon or the Azores, on females aged 85+, more than 50% of all the deaths (54 and 51%, respectively).

There are, however, remarkable regional differences: in individuals aged 65 to 69, the main cause of death, from 2004 to 2006, in the mainland regions, are neoplasm (which were from 1994 to 1996, in the same age group, the second most important cause of death), with deaths due to diseases of the circulatory system taking the second place.

From Table 2 (where one could notice changes on death rates) and Fig. 4 (with present trend) the pattern is similar on both males and females, with differences between the mainland and the islands. According to data from 2004 to 2006, there have been occurring a larger number of deaths due to neoplasm on both males and females aged 65-59 (among less older individuals). It doesn't occur in the islands, where, in the same time period, the death rates associated to diseases of the circulatory system remains dominant on both males and females on selected age groups, despite a reduction in the number of deaths attributed to that cause (as occurred throughout the country).

Considered the main inter-regional difference regarding major causes of death in Portugal, it is noted that respiratory diseases are (instead of the causes undefined) the second leading cause of death among older Portuguese (age 85+).

Moreover (again all over the country) deaths from diseases of the circulatory and respiratory system increase with age, whereas neoplasm seem to decrease. However, at this point, we suppose that deaths due to undefined causes may have their origin, particularly, in certain types of cancer, which would help to increase the percentage due to that major cause.

In fact, there are a moderate proportion of deaths attributed to undefined causes, which does not allow us to conclude about the real phenomena of cause of death. However, the information gathered tells us that (if we do not consider these undefined causes) that the deaths of older population are mostly attributed to diseases of the respiratory system, with corresponding values of death rates increasing from 1994 to 2006 in all Portuguese regions.

Considering now the general variation of causes of death, in the period under review, diseases of the circulatory system have suffered a negative variation – contrary to the general

trend of the other causes in the same time period. With the exception of Madeira (with maximum variation for the diseases of the digestive system), Alentejo and Algarve regions (only among females, aged 65-69, which have decreased), the largest increases, in each region, occurred due the endocrine diseases, followed by diseases of the respiratory and digestive system.

In fact, we assist to a significant increase in deaths due to endocrine diseases, particularly among older individuals (as already observed in Fig. 3), with a higher variation in the Azores – death rate on males, aged 85+, more than doubled (with an estimated variation of 246% from 1994 to 2006). On the other hand, the Madeira or Lisbon regions had globally experienced, for the same age group, the smallest increase in death rate associated to this cause of death (female: 65%, male: 70% in the first region; female: 44%, male: 100% in the second).

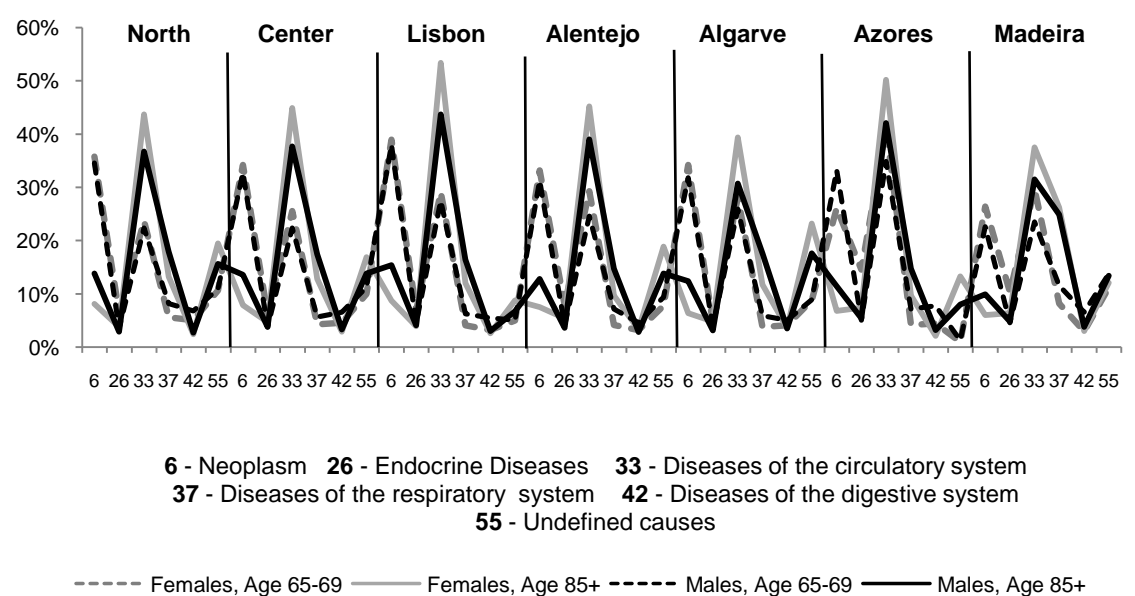


Figure 4 Joint representations of crude death rates by sex, age and main causes of death (2004-2006)

Deaths associated to neoplasm seem to follow a similar trend - positive variation -, and suffered from 1994 to 2006, an increase in ages 65-69 and 85+, on both males and females, in all regions, except to the Azores, on females, where corresponding death rates decreases in both selected ages.

As already mentioned, in Portugal, diseases of the circulatory system – the main cause of death among the older population – have suffered, in the period under review, a negative variation in all regions, on both male and female in selected age groups.

Conclusions

There isn't a consistent pattern reflecting the differences between mortality of older Portuguese population for all selected death causes by age or sex. Considering both trend and variations in the time period under review, one can only identify regional differences for particular causes of death in some age groups (which have its own dynamics).

Nevertheless, we can conclude that mortality varies by sex and also by age group – as expected –, yet we cannot make a sharp distinction between some regions which show similar patterns. In fact, with the exception of undefined causes, it is expected a male-female convergence, by cause of death, in mortality patterns between ages 70 to 84.

Also, in this case study, with the exception of the Center region, the Portuguese mainland regions do not show significant differences in between considering selected death causes. Additionally, the Center and the other mainland regions differ from the Azores and Madeira islands, which are not homogeneous themselves.

Considering the time period under analysis (1992-2006), definitely, from 1998 to 2000, there's a huge change, in the crude death rates levels, on both male and female and for all major causes of death: with the exception of the three mentioned regions (where the largest variations occurred, both in trend and values range) all time series are close to stationary levels.

In fact, it is clear a decreasing mortality trend, associated with diseases of the circulatory system, which goes on opposition to the average values. Instead, endocrine diseases have suffered an important growing trend in most age groups, although with a reduction and (slight) trend reversal, in some cases, from 2001 to 2003 (e.g. females aged 65-69). In the case of neoplasm deaths, overall increasing trend is "masked" by the growth period before the three-year 1998-2000, which influences the estimated range pattern.

As for the time series of deaths from diseases of the respiratory and digestive system, differences remain between the pattern of the Center and the rest of the country (more obvious in diseases of the respiratory system), and also between the islands and regions of the mainland. Still considering those two major causes of death, we notice that, in the first case, a greater regional variability within age groups occurred and, in the second case, there's a more variable pattern over time.

For further research it is our aim to determine possible external causes that may contribute to an explanation of the differences now found. It would also be interesting to disaggregate each major cause of death groups, to understand which one (s) is (are) leading trends or influencing identified variations and point out more differences at a subnational level.

Appendix I. Cause of death major classification according to *International Statistical Classification of Diseases and Related Health Problems (ICD) 10th Revision (Version for 2007)*; available in <http://www.who.int/classifications/apps/icd/icd10online/> [accessed in 28-02-09]

1	<i>Infectious and parasitic diseases (A00-B99)</i>
2	<i>Tuberculosis (A15-A19,B90)</i>
3	<i>Meningococcal infection (A39)</i>
4	<i>AIDS (HIV-disease) (B20-B24)</i>
5	<i>Viral hepatitis (B15-B19)</i>
6	<i>Neoplasms (C00-D48)</i>
7	<i>Malignant neoplasm (C00-C97)</i>
8	<i>Malignant neoplasm of lip, oral cavity, pharynx (C00-C14)</i>
9	<i>Malignant neoplasm of oesophagus (C15)</i>
10	<i>Malignant neoplasm of stomach (C16)</i>
11	<i>Malignant neoplasm of colon (C18)</i>
12	<i>Malignant neoplasm of rectum and anus (C19-C21)</i>
13	<i>Malignant neoplasm liver and the intrahepatic bile ducts (C22)</i>
14	<i>Malignant neoplasm of pancreas (C25)</i>
15	<i>Malignant neoplasm of larynx and trachea/bronchus/lung (C32-C34)</i>
16	<i>Malignant melanoma of skin (C43)</i>
17	<i>Malignant neoplasm of breast (C50)</i>
18	<i>Malignant neoplasm of cervix uteri (C53)</i>
19	<i>Malignant neoplasm of other parts of uterus (C54-C55)</i>
20	<i>Malignant neoplasm of ovary (C56)</i>
21	<i>Malignant neoplasm of prostate (C61)</i>
22	<i>Malignant neoplasm of kidney (C64)</i>
23	<i>Malignant neoplasm of bladder (C67)</i>
24	<i>Malignant neoplasm of lymphatic/haematopoietic tissue (C81-C96)</i>
25	<i>Diseases of the blood(-forming organs), immunological disorders (D50-D89)</i>
26	<i>Endocrine, nutritional and metabolic diseases (E00-E90)</i>
27	<i>Diabetes mellitus (E10-E14)</i>
28	<i>Mental and behavioural disorders (F00-F99)</i>
29	<i>Alcoholic abuse (including alcoholic psychosis) (F10)</i>
30	<i>Drug dependence, toxicomania (F11-F16,F18-F19)</i>
31	<i>Diseases of the nervous system and the sense organs (G00-H95)</i>
32	<i>Meningitis (other than 03) (G00-G03)</i>
33	<i>Diseases of the circulatory system (I00-I99)</i>
34	<i>Ischaemic heart diseases (I20-I25)</i>
35	<i>Other heart diseases (I30-I33,I39-I52)</i>
36	<i>Cerebrovascular diseases (I60-I69)</i>
37	<i>Diseases of the respiratory system (J00-J99)</i>
38	<i>Influenza (J10-J11)</i>

39	<i>Pneumonia (J12-J18)</i>
40	<i>Chronic lower respiratory diseases (J40-J47)</i>
41	<i>Asthma (J45-J46)</i>
42	<i>Diseases of the digestive system (K00-K93)</i>
43	<i>Ulcer of stomach, duodenum and jejunum (K25-K28)</i>
44	<i>Chronic liver disease (K70, K73-K74)</i>
45	<i>Diseases of the skin and subcutaneous tissue (L00-L99)</i>
46	<i>Diseases of the musculoskeletal system/connective tissue (M00-M99)</i>
47	<i>Rheumatoid arthritis and osteoarthritis (M05-M06, M15-M19)</i>
48	<i>Diseases of the genitourinary system (N00-N99)</i>
49	<i>Diseases of kidney and ureter (N00-N29)</i>
50	<i>Complications of pregnancy, childbirth and puerperium (O00-O99)</i>
51	<i>Certain conditions originating in the perinatal period (P00-P96)</i>
52	<i>Congenital malformations and chromosomal abnormalities (Q00-Q99)</i>
53	<i>Congenital malformations of the nervous system (Q00-Q07)</i>
54	<i>Congenital malformations of the circulatory system (Q20-Q28)</i>
55	<i>Symptoms, signs, abnormal findings, ill-defined causes (R00-R99)</i>
56	<i>Sudden infant death syndrome (R95)</i>
57	<i>Unknown and unspecified causes (R96-R99)</i>
58	<i>External causes of injury and poisoning (V01-Y89)</i>
59	<i>Accidents (V01-X59)</i>
60	<i>Transport accidents (V01-V99)</i>
61	<i>Accidental falls (W00-W19)</i>
62	<i>Accidental poisoning (X40-X49)</i>
63	<i>Suicide and intentional self-harm (X60-X84)</i>
64	<i>Homicide, assault (X85-Y09)</i>
65	<i>Events of undetermined intent (Y10-Y34)</i>

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