



## Regional variation in coronary heart disease mortality trends in Portugal, 1981–2012



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### ABSTRACT

**Background:** Information is scarce about the geographic variation in time trends of mortality from coronary heart disease (CHD). We aimed to describe trends in death rates, absolute number of deaths and years of life lost (YLL) due to CHD among men and women in Portugal, by region, from 1981 to 2012.

**Methods:** The age-standardized mortality rates from CHD were estimated by sex and region. We used joinpoint regression analysis to calculate the annual percent change (APC) in mortality and to identify points of significant change in the trend. The YLL due to premature mortality for CHD were computed using the Global Burden of Disease method.

**Results:** The age-adjusted mortality from CHD decreased between 1981 and 2012, both in men and women, but with significantly different APC by region. Smaller declines in rates were observed in Alentejo (men: APC 1993–2012: –2.4%; women: APC 1991–2012: –2.4%). The greatest decline was observed in Madeira between 2003 and 2012, in men (APC: –7.6%) and women (APC: –9.7%). The decline in rates in Algarve started only after 2003, whereas it was consistent from 1981 in the North and started in the 1990s in most other regions. A decrease in the number of deaths was only observed after 2000. The YLL from CHD decreased from 1981 to 2012, mainly after 2000.

**Conclusions:** In Portugal, between 1981 and 2012, relative declines of CHD mortality indicators were different by geographic region. Consistent decreases in mortality rates were only observed in the Centre, Lisbon and North, the most populated and urbanized regions.

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### 1. Introduction

Cardiovascular diseases (CVD) are the most common cause of death. In 2012, almost half of non-communicable disease deaths worldwide were caused by CVD (17.5 million deaths), more than double the number of deaths caused by cancers [1,2]. CVD are responsible for close to half of all deaths in Europe (over 4 million deaths per year), with coronary heart disease (CHD) accounting for 20% of all deaths in Europe annually (nearly 1.8 million deaths) [2]. The most up-to-date data on CVD still show disparities in the death rates between European countries, with Central and Eastern Europe having higher rates than Northern,

Southern and Western Europe [2]. Within-country CVD mortality inequalities have been reported in several European countries, by region, socioeconomic characteristics and country of birth [3–5].

CVD and CHD death rates have been consistently falling across most but not all European countries; the timing and magnitude of this decrease also vary [2]. CHD mortality trends may also be different by demographic groups, with young adults, especially women, experiencing smaller decreases in CHD mortality rates in the two last decades [6]. Specific indicators such as years of life lost are needed to capture premature mortality due to CHD.

In Portugal, the age-adjusted mortality from CVD, in 2011, was 174.7/100,000 among men and 126.8/100,000 among women, and the age-adjusted mortality rates from CHD are among the lowest in Europe [2]. There was a decrease in the age-adjusted mortality from CVD between 1980 and 2010 [7], and also from CHD [2], but there is no information about the magnitude of these trends by region. Differences in health status by geographic region, namely in less populated and less urban regions, are among the sizeable inequalities identified

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in the Portugal health system performance assessment in 2010, conducted by the World Health Organization [8]. This report states that it is difficult to assess and monitor the extent of the health inequalities in Portugal, due to the lack of a monitoring system of health indicators by target population groups, owing, at least in part, to a narrow interpretation of the data confidentiality law. A recent ecological study showed geographic variation in hospital admissions and in-hospital mortality of patients admitted with ischemic heart disease in Portugal from 2000 to 2007, with the interior regions showing higher rates, not fully explained by socio-demographic, economical and health resource factors [9]. It is of interest to expand this observation to a longer period and to consider total mortality, in addition to in-hospital mortality.

We aimed to describe time trends in death rates, absolute number of deaths and YLL from CHD among men and women in Portugal, by region, during the period 1981–2012.

## 2. Methods

### 2.1. Sources of data

Estimates of population at risk as well as the number of deaths from CHD [International Classification of Diseases 9th revision clinical modification, (ICD 9 CM) 410–414] were obtained from official statistics [10,11].

All data were obtained from 1981 to 2012 for each sex in age groups (<1, 1–4, 5-year age groups to 80–84 and ≥85 years), by region [Nomenclature of Territorial Units for Statistics (NUTS II): Alentejo, Algarve, Azores, Centre, Lisbon, Madeira and North].

### 2.2. Trends in mortality rates

We calculated age-standardized mortality rates per 100,000 by the direct method, using the European standard population (2013 revision) as reference [12].

To calculate the annual variation in mortality and to identify points of significant change in the log-linear slope of the trend (joinpoints) [13] we performed a joinpoint regression analysis, using Joinpoint® version 3.4 from the Surveillance Research Program of the US National Cancer Institute. The analysis starts with the minimum number of joinpoints, with no joinpoints corresponding to a straight line, testing if one or more joinpoints significantly improve model fit. We set the minimum number of years before the first, after the last and between consecutive joinpoints as five. The best fitting models for the trends are presented for men and women by region. The estimated annual percent change (APC) in mortality for each period was calculated taking the calendar year as the independent variable and assuming a Poisson distribution.

### 2.3. Years of life lost

The years of life lost (YLL) due to premature mortality for CHD, by sex and age group, in each geographic region, were computed using the Global Burden of Disease method [14], by multiplying the number of deaths at each age by the life expectancy at the age at which death occurs. We considered the recommended standard life expectancy at birth of 80 years for men and 82.5 years for women. The average age at death was set to the mid-point of each five-year age group, except for the oldest group in whom it was assumed to be 87.5 years [14]. We applied a 3% time discount rate to assign less weight to the YLL corresponding to the periods more distant from the time of death than to those referring to the first years after death, an age-weighting parameter to weight YLL in the very young and the older ages less than other ages (Global Burden of Disease standard value is 0.04) and an age weighting correction constant so that the introduction of age-weights did not alter the total number of YLL (Global Burden of Disease standard value is 0.1658) [14]. The total YLL for each gender and region was obtained by summing the YLL of all age groups. Moving averages (over 3 years) for YLL were calculated.

## 3. Results

### 3.1. Trends in mortality rates

In Portugal, the age-adjusted mortality rates from CHD decreased between 1981 and 2012, both in men and women, though with different patterns by geographic region, both in magnitude and year of decline onset.

In Portugal, among men, age-standardized mortality rates decreased from 195.6/100,000 in 1981 to 86.7/100,000 in 2012; and among women, from 108.0/100,000 to 50.0/100,000, in the same period.

Among men, Azores and Alentejo were the two regions with the highest standardized mortality rates in 1981 (326.5/100,000 and 250.3/100,000), respectively and also in 2012 (174.9/100,000 and

157.6/100,000, respectively). In the remaining regions, the standardized mortality rates were similar among regions in 1981, ranging from 171.1/100,000 in Algarve to 186.4 in Lisbon, while in 2012 the North showed a lower standardized mortality rate than all other regions (66.4/100,000). Among women, Azores and Alentejo were also the two regions with the highest standardized mortality rates both in 1981 (148.4/100,000 and 164.6/100,000, respectively) and in 2012 (97.4/100,000 for both regions). In the remaining regions, the mortality rates in 1981 ranged from 87.1/100,000 in the Algarve to 139.7/100,000 in Madeira, while the North ranked again as the region with the lowest mortality rate in 2012 (32.6/100,000) (Fig. 1).

When analysing the decreases in standardized mortality rates over the study period, in the whole country 1993 and 2003 mark inflexion points for progressively steeper declines in rates among men, with APC ranging from –0.7% in 1981–1993 to –5.1% in 2003–2012. Among women, inflexion points were observed in 1992 and 2003, with APC ranging from –0.2% in 1981–1992 to –5.5% in 2003–2012 (Table 1).

Among men, the decline in rates in Algarve and Madeira started later, only after 2003, whereas it was consistent from 1981 in the North and started in the nineties in the other regions. Among women, Algarve also started to experience a decrease in rates only after 2004, whereas the North and Centre had consistent decreases in rates from 1981, and from the nineties in the remaining regions, except for Madeira where a fluctuating pattern was observed (Table 1, Fig. 1).

Among men, smaller relative declines in CHD mortality rates were observed in Alentejo and in the Centre region (APC 1993–2012: –2.4% and –3.3%, respectively), while among women the region with the smallest decline was Alentejo (APC 1991–2012: –2.4%) (Table 1, Fig. 1). The greatest relative decline was observed in Madeira for the period 2003 to 2012, both in men (APC: –7.6%) and in women (APC: –9.7%) (Table 1, Fig. 1).

The declines in mortality rates had similar magnitude over time between men and women, when analysing the country as a whole. However, in most regions, greater declines were observed among women compared to men, with larger sex differences in the Centre (APC: –5.7% vs –3.3%; women vs men), followed by Madeira (APC: –9.7% vs –7.6%) and the North (APC: –6.2% vs –4.3%) (Table 1).

### 3.2. Number of deaths and YLL

Although the decrease in the age-adjusted mortality rates from CHD started in the nineties in the majority of the Portuguese regions, the decrease in the number of deaths was only observed after 2000 (Fig. 2).

All over the country, the YLL from CHD were significantly higher in men. The YLL from CHD decreased from 1981 to 2012, both among men and women, ranging from a 23.9% decrease in Alentejo to a 64.5% decrease in Madeira, among men, and from a 4.8% decrease in Alentejo to a 57.8% decrease in Madeira, among women (Table 2). This decrease was mainly observed after the year 2000, and Lisbon and the North were the two geographic regions with lowest YLL, both in men and women, during the majority of the period studied (YLL in 2012, among men: 7.09/1000 population in Lisbon and 4.43/1000 population in the North; and among women: 4.91/1000 population in Lisbon and 2.70/1000 population in the North) (Table 2, Fig. 2).

## 4. Discussion

CHD mortality rates decreased in Portugal over the last 30 years, but with geographic disparities, meaning that cardiovascular health inequalities persisted in the country throughout this period. Azores and Alentejo started with the highest rates in 1981, and despite the decrease, still showed higher rates in 2012, although the difference from the other regions was attenuated. The North, on the other hand, had a mortality rate that was dissimilar to other regions, which began to diverge early in the nineties but maintaining the lowest rates until 2012.

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