# THE DEVELOPMENT OF CARDIOVASCULAR MORTALITY IN SELECTED EUROPEAN COUNTRIES

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**ABSTRACT**

The article compares the level and the development of cardiovascular mortality in selected European countries from 1968 to 2006. The development of cardiovascular mortality is viewed in connection with the changes of the overall mortality, mortality by other groups of causes of death, as well as mortality by age and sex. The changes of the mortality level and the proportion of the most frequent circulatory diseases are analyzed within the whole group of circulatory diseases. The article also includes cluster analysis based on selected mortality indicators. The analyses conclude that different development of the circulatory diseases mortality was the major cause of divergent trends in the overall mortality between the Western European countries and the post-communist countries. The level of cardiovascular mortality in the first group of countries decreased considerably during the observed period. On the contrary, the cardiovascular mortality in the post-communist countries was characterized by stagnation or even deterioration from the beginning of the studied period until approximately the early nineties. The post-communist countries underwent the decline of the circulatory diseases mortality during the nineties in accordance with the change of political and socioeconomic conditions.

**Keywords:** cardiovascular mortality, diseases of the circulatory system, causes of death, standardized mortality rates, international comparison

## 1. Introduction

Globally, the diseases of the circulatory[1] system represent the most frequent group of causes of death. According to the World Health Organisation estimates, the circulatory diseases were responsible for approximately 30% of all deaths in 2005 (WHO, 2007). Logically, cardiovascular diseases constitute the leading group of causes of death in Europe. An exception is the male population of France and in recent years also the male population of Spain and of the Netherlands where the highest proportion of deaths is due to neoplasms. Circulatory diseases account for about 42% of deaths in the European Union population (Eurostat, 2009).

The main goal of the analysis was to examine the trends of cardiovascular mortality in selected European countries and contextualize them into the development of overall mortality conditions and the development of age-specific and cause-specific mortality. The subject matter is closely linked with medicine, especially in terms of cardiovascular risk factors, prevention and the development of pharmaceuticals, treatment methods as well as the level of Health systems.

### Theories of mortality and the cardiovascular revolution

In agreement with Abdel Omran's theory of epidemiological transition, human societies pass from the stage of infections, epidemics and famines through a period of declining mortality from infections, epidemics and famines to finally reach the stage where degenerative, chronic and man-made diseases predominate. In this epidemiological stage, the growth of life expectancy is significantly decreased (Omran, 1971).

The phenomenon of the circulatory diseases mortality decline has been assigned the name cardiovascular revolution. During this epidemiological change the structure of mortality by age and cause changes considerably. The emergence of the cardiovascular revolution in the seventies brought new possibilities for improving overall mortality conditions and for extending life expectancy (Vallin, Meslé, 2004).

Several authors (Olshansky, Ault, 1986; Rogers, Hackenberg, 1987) argued that the decline of cardiovascular mortality is an additional fourth stage of the epidemiological transition. A more comprehensive concept proposed the theory of health transition which includes several epidemiologic transitions (Frenk et al., 1991). The first of them is the transition described by Omran and the second relates to the cardiovascular revolution (or to the reduction of cardiovascular and man-made diseases). For the future, a possible additional stage has not been excluded (Meslé, Vallin, 2000). The Health transition concept deals with the dynamic range of factors that led to the permanent increase of life expectancy and takes into account the response of the society to the given epidemiological situation.

[1] In this article, circulatory and cardiovascular diseases are used as synonyms.

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| Country \ Year | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | – | – | – | – | – | – | – | – | – |
| Czech Republic | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 |
| Denmark | ICD7 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | – | – | – | – | – | – |
| Finland | ICD7 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 |
| France | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | – | – |
| Irland | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 |
| Italy | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD10 | – | – | – | – | – | – |
| Hungary | ICD7 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | – | – | – |
| Germany | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 |
| Former East Germany | – | – | – | – | – | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | – | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Former West Germany | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Netherlands | ICD7 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 |
| Norway | ICD7 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | – | – |
| Poland | ICD7 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | – | – | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 |
| Portugal | ICD7 | ICD7 | ICD7 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD10 | – | – | – | – | – | – |
| Austria | ICD7 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 |
| Greece | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 |
| Slovakia | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | ICD9 | ICD9 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | – |
| Spain | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | – |
| Sweden | ICD7 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | – |
| Switzerland | ICD7 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | – |
| United Kingdom | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD8 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | ICD9 | – | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 | ICD10 |

**Fig. 1** Data availability in the WHO Mortality Database, 8th–10th revision of ICD, selected European countries, 1968–2006

## 2. Data and Methods

### Data

The set of selected countries includes 18 European Union member states plus Norway and Switzerland (Figure 1). From the New EU member states the central European countries were included, which enabled to observe the position of the Czech Republic. For the period until 1990, both Western and Eastern Germany were included.

The analysis is based on the 8th, 9th and 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD). The time range of application of each of these revisions is not the same in the majority of selected countries, therefore the study period also differs among countries. The longest ran from 1968 to 2006 (Figure 1).

The main data source for the analyses represents the WHO Mortality Database. It supplies the number of deaths by country, sex, age and by the detailed list of causes of death for the ICD revisions in question (raw data files). The WHO Mortality Database also provides age structures and number of life births. The data for the Czech Republic come from The Czech Statistical Office publication – Deaths by detailed list of causes of death, sex and age in the Czech Republic (1919 to 2006). The WHO Mortality Database contains the data for the Czech Republic only for the period 1986–2006.

| *Shortcut* | *Country* | *Shortcut* | *Country* |
|---|---|---|---|
| AUT | Austria | GRC | Greece |
| BEL | Belgium | HUN | Hungary |
| CZE | Czech Republic | CHE | Switzerland |
| DEU | Germany | IRL | Irland |
| DNK | Denmark | ITA | Italy |
| ESP | Spain | NLD | Netherlands |
| FIN | Finland | NOR | Norway |
| FRA | France | POL | Poland |
| FRG | Former West Germany | PRT | Portugal |
| GB | United Kingdom | SVK | Slovakia |
| GDR | Former East Germany | SWE | Sweden |

**Fig. 2** List of shortcuts used in tables and figures

The international comparison of cause-specific mortality encounters many problems and uncertainty. The national statistics take into account only the underlying cause of death. The analysis of mortality by cause is therefore simplified, limited and it does not necessarily express the real causality.

The reliability of data depends on the accuracy in determining the underlying cause of death by physicians and on the coding system. The coding system means the selection method for the underlying cause of death from the death certificate. These methods are defined by WHO rules and guidelines. If it's performed manually and by a large number of employers, the data comparability risks being lower. This problem might be partly resolved by introducing the Automated Coding Systems for causes of death (ACS), under consideration by Eurostat.

### Methods

To perform a more detailed mortality analysis within the group of cardiovascular diseases, the following groups of diseases or separate diagnoses were chosen:

- ischemic heart diseases (further divided into acute myocardial infarction and other forms of ischemic heart disease),
- cerebrovascular diseases,
- other heart diseases,
- hypertension,
- atherosclerosis,
- other diseases of the circulatory system.

To analyse long time-series of cause-specific mortality, the use of shortlists between the concerned ICD revisions is necessary. I used The European Shortlist adapted by Spijker (2004) for the main groups of causes of death and The International Shortlist for Hospital Morbidity Tabulation (2008) for more detailed analysis within the group of cardiovascular diseases.

In spite of the use of shortlists, the categories of ischemic heart disease and other heart diseases couldn't be correctly converted between the 8th and 9th revision of ICD for all countries. Due to these conversion problems, it was only possible to study mortality on cerebrovascular diseases and mortality on other cardiovascular diseases (in this case the difference between cardiovascular and cerebrovascular diseases) for the entire period 1968–2006. Subject literature provides instances of using a similar approach (Habartová 2008, Spijker 2004, Vallin, Meslé, Rychtaříková 1988). For the other selected groups of diagnoses within the frame cardiovascular diseases, the study period mostly matches the application of the 9th and 10th ICD revision (primarily 1979–2006).

The standardized mortality rates by cause of death were used as the basic indicators of the mortality level development. These were founded on the direct standardisation method using the European standard population of WHO (1976).

Using the two-dimensional decomposition method, the change in life expectancy at birth could be expressed as a sum of contributions of separate age groups and causes of death (groups of causes of death). This was achieved by application of the Pollard's discrete formula (1982):

$$e_0^B - e_0^A = \sum_{x=0}^{85+} \sum_{i=0}^{j} [(\acute{u}_x^{(i),A} - \acute{u}_x^{(i),B}) \cdot n \cdot w_s]$$

where

$\acute{u}_x^{(i),A}$ and $\acute{u}_x^{(i),B}$ are the age-specific mortality rates from cause of death ($i$) in the population A and B,

A and B are two arbitrarily chosen populations (e.g. populations of two different countries or one population in two different time periods),
$n$ represents the width of the age interval,
$w_s$ is the weight of the age group x counted towards the center of the interval denoted $s$, the weight is defined as:

$$w_s = \frac{1}{2} \cdot \left[ \left( \frac{l^B_\xi + l^B_{\xi+n}}{200000} \cdot \frac{e^A_\xi + e^A_{\xi+n}}{2} \right) + \left( \frac{l^A_\xi + l^A_{\xi+n}}{200000} \cdot \frac{e^B_\xi + e^B_{\xi+n}}{2} \right) \right]$$

where
$l^A_\xi$, $l^A_{\xi+n}$, $l^B_\xi$, $l^B_{\xi+n}$ are the survivals at exact age $\xi$ and $\xi+n$ from life tables of the population A and B,
$e^A_\xi$, $e^A_{\xi+n}$, $e^B_\xi$, $e^B_{\xi+n}$ are life expectancies at exact age $\xi$ and $\xi + n$ from life tables of the population A and B.

Because the death during the first year of life is significantly unequal, the weight of the age group 0 is defined as follows:

$$w_{0,5} = \frac{1}{2} \cdot \left[ \left( \frac{0{,}92 \cdot l^B_0 + 0{,}08 \cdot l^B_1}{100000} \right) \cdot (0{,}92 \cdot e^A_0 + 0{,}08 \cdot e^A_1) + \right.$$
$$\left. + \left( \frac{0{,}92 \cdot l^A_0 + 0{,}08 \cdot l^A_1}{100000} \right) \cdot (0{,}92 \cdot e^B_0 + 0{,}08 \cdot e^B_1) \right]$$

Causes of death are not entirely independent. As a result of interactions, the sum of individual contributions doesn't exactly match with the difference in life expectancy at birth.

The values of life expectancies and number of survivals come from life tables calculated by the author. These life tables are in abridged form containing data at 5-year age intervals up to age 85 years and up.

The article also includes results of cluster analysis based on selected mortality indicators. The cluster analysis was carried out using the SAS system. The involved procedures were CLUSTER and TREE. The data were standardized on the mean value 0 and the standard deviation 1 in the procedure CLUSTER. The clustering was based on the Ward method. Ward method is appropriate for smaller number of units as was in this study. It is appropriate for quantitative variables. Ward's method tends to find clusters with roughly the same number of observations in each cluster and it works well for small clusters. It tends to form compact clusters (Pennsylvania State University, 2007, SAS Institute Inc., 2008). The method is based upon the analysis of variance joining clusters with the lowest sum of squares.

In this article, the aim of the cluster analysis was to assemble the European countries to groups with similar mortality conditions and to create arrangements based on the values from the beginning and from the end of the study period, but large variations in the range of time series constrained the analysis. The cluster analysis was performed with use of mortality indicators from 1973 and 2001. These years enabled to encompass the highest number of countries. Indicators for both men and women were included. The cluster analysis was based on 10 following mortality indicators:

- proportion of deaths due to cardiovascular diseases,
- standardized mortality rate on cerebrovascular diseases,
- standardized mortality rate on other cardiovascular diseases (in this case the difference between the whole group of circulatory diseases and the cerebrovascular diseases; only year 1973),
- standardized mortality rate on ischemic heart diseases (only year 2001),
- standardized mortality rate on neoplasms,
- standardized mortality rate on external causes of injury and poisoning,
- standardized mortality rate on diseases of the respiratory system,
- probability of survival to the exact age 40,
- probability of survival from the exact age 40 to the exact age 65,
- probability of survival from the exact age 65 to the exact age 85.

The selection of variables corresponds to the goals of the thesis. The cardiovascular mortality should be viewed in relation to overall, age-specific and cause-specific mortality. These dimensions are inseparable and constitute mortality conditions of a country. So the most important indicators of overall, age-specific and cause-specific mortality should enter the analysis. However, the data availability was restrictive, because the data for some causes of death were not available for some countries for the required time periods (e.g. deaths due to diseases of the digestive system). The above listed variables could be calculated for the highest utmost number of studied countries.

## 3. Discussion of results

### Trends in cardiovascular mortality

In all Western European countries under study, excluding Greece, a significant decline of the circulatory diseases mortality generally occurred over the period 1968–2006 (Figure 3, 4). In some cases, the decrease was practically linear (Finland). On the other hand, the cardiovascular mortality level in the post-communist countries (represented here by the central Europe), underwent an increase or stagnation starting around 1968 until the beginning of the nineties. While female cardiovascular mortality in those countries was typically characterized by stagnation or fluctuations, male cardiovascular mortality was on the rise. Since the beginning of the nineties, with the elimination of the social and political restrictions, the cardiovascular mortality trend began to turn to the decline in this group of countries.

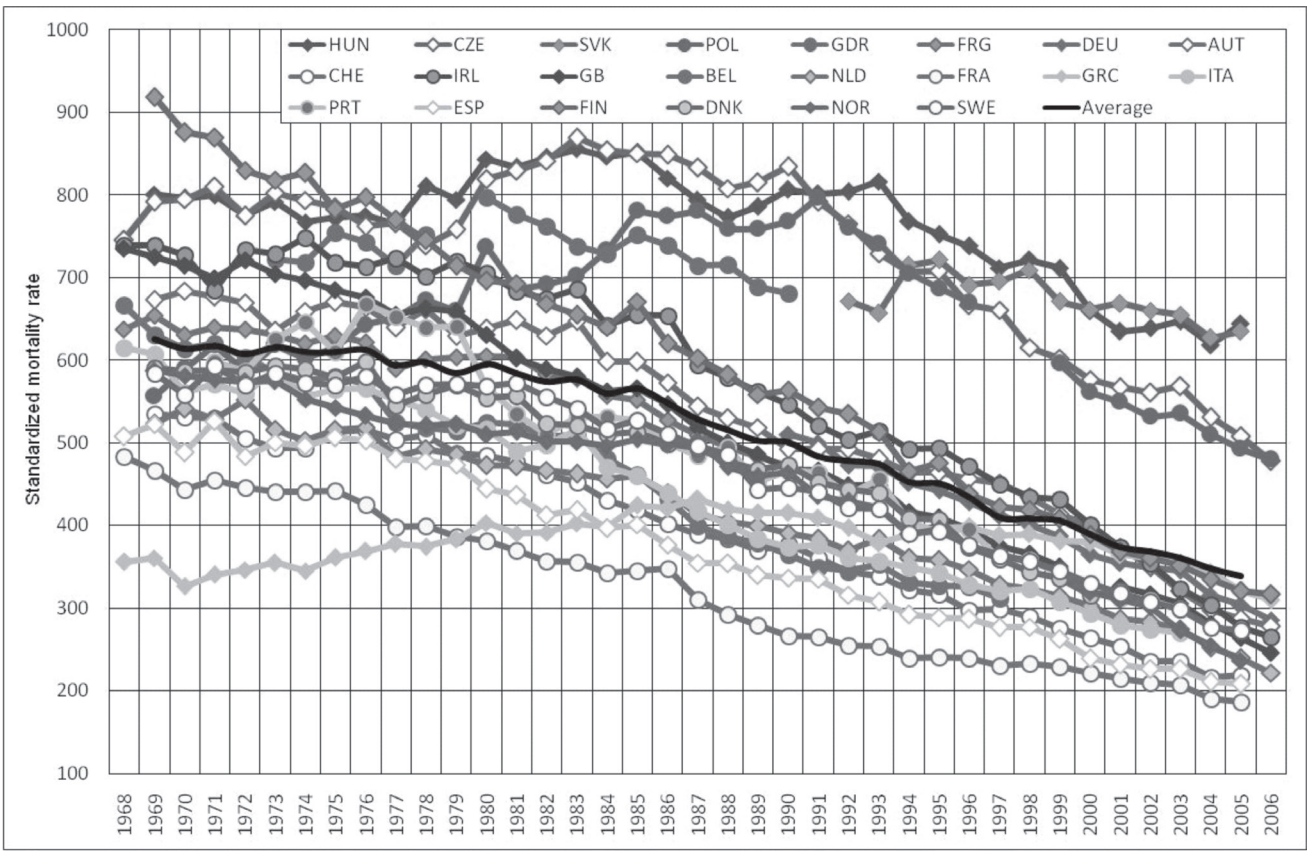


**Fig. 3** Standardized mortality rates for cardiovascular diseases (per 100,000), selected European countries, 1968–2006, men

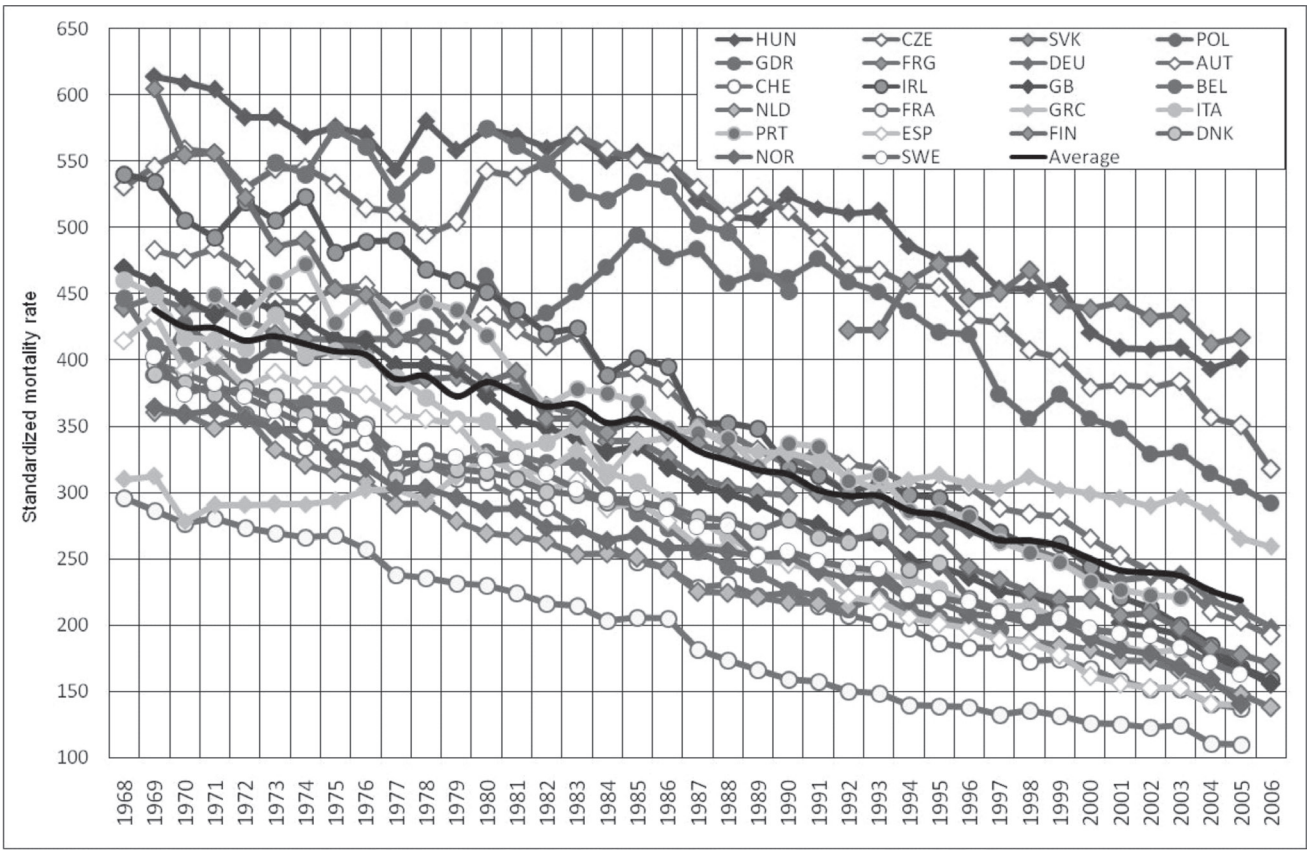


**Fig. 4** Standardized mortality rates for cardiovascular diseases (per 100,000), selected European countries, 1968–2006, women

Overall, the reduction of cardiovascular mortality level appeared earlier in female populations than in male populations (Figure 3, 4). An even more marked decrease of cardiovascular mortality of Western European men took place especially after 1980. Female populations also showed less accentuated difference between Western European and the post-communist countries than male populations.

Nevertheless, within the group of West-European countries and within the group of post-communist countries, some differences in circulatory mortality trends were noticeable. In the long run, France, the southern European countries (excluding Greece) and Switzerland were characterized by the lowest cardiovascular mortality level. On the other hand, Finland, the United Kingdom and Ireland resembled the rates of the post-communist countries at the end of the sixties. But these countries underwent the biggest relative decrease of the cardiovascular mortality during the study period (Figure 3, 4).

From the post-communist countries included in the study, the most intensive decline was observed in the Czech Republic and Poland. In Hungary and Slovakia the decrease of mortality due to this group of diseases was considerably milder and started later. At the end of the period 1968–2006 these countries had a significantly higher cardiovascular mortality than the Czech Republic and Poland, especially in the male population. Another particularity concerned Poland where an increase in cardiovascular mortality started at relatively low values at the end of the sixties (Figure 3, 4).

In the group of West-European countries standardized mortality rates on circulatory diseases converged considerably. Since the end of the Sixties, the variability decreased by 50–60% toward the end of the study period. However, an increase of the variability of the standardized mortality rates was conclusive for the entire set of countries included in the study (Figure 3, 4).

Mortality trends of selected groups of cardiovascular diseases often corresponded to the trends of the overall cardiovascular mortality trends described below – for instance in case of ischemic heart diseases, cerebrovascular diseases. Compared to the decrease of overall cardiovascular mortality, the decrease in cerebrovascular mortality in Western European countries during 1968–2006 was milder. As described, for the post-communist countries the cerebrovascular mortality rose at first and started to decrease approximately in the second half of eighties. An exception represented Poland where the cerebrovascular mortality continued slightly rising until 1996.

In the long run, the highest cerebrovascular diseases mortality rates were typical in southern European countries (mainly Portugal) and the post-communist countries except Poland. In the first half of the study period the values for Portugal were extremely high and outlying; in the second half these mortality rates approached and achieved the values of the post-communist countries (Figure 5, 6). On the other hand the lowest rates of cerebrovascular mortality appeared in northern Europe as well as in France and Switzerland.

Ischemic heart diseases mortality development was also very consistent with the cardiovascular mortality trends. But in the group of post-communist countries, a significant lowering occurred only in the Czech Republic. In Hungary, Slovakia and Poland the rates stagnated even toward the end of study period.

The analysis of mortality due to ischemic heart disease revealed diametrically opposed trends for acute myocardial infarction mortality and other forms of ischemic heart disease mortality that mainly represents the chronic ischemic heart disease. The mortality on other forms of ischemic heart disease stagnated or even rose over the years 1968–2006. The decrease of ischemic heart disease mortality was merely enabled by the drop of acute myocardial infarction mortality (Figure 7, 8).

Though lowering mortality caused by acute circulatory diseases patients' survival improves, on the other hand the prevalence of chronic forms of diseases increases and becomes more important in the cause-specific mortality structure (Bruthans, 2000).

During the study period the mortality rates on acute myocardial infarction and cerebrovascular diseases converged significantly in the set of countries. The homogenization of values was more marked for acute myocardial infarction mortality and included all countries under study, not only the Western European (Figure 7, 8).

## Explaining cardiovascular mortality

The cardiovascular risk factors are relatively well described and proven (in comparison to cancer for instance), they are usually divided in two groups – risk factors that can be changed and risk factors that cannot be changed. The first group comprises hypertension, high blood cholesterol and lipid problems, cigarette smoking, diabetes mellitus, obesity, unhealthy diet and physical inactivity. Cardiovascular risk factors that cannot be changed primarily include age, sex, heredity and blood clotting factors.

The decline of circulatory mortality diseases in Western European countries is usually explained by the decrease of classical risk factors (hypertension, hypercholesterolemia and smoking), modifications of diet – lowering the consumption of animal fat, raising the consumption of antioxidant substances (Ginter, 1997 and 2001). There was a fundamental improvement in treatment and prevention methods – especially the availability of effective modern medications.

It is not possible to explain the trends of circulatory diseases mortality in the post-communist countries using only the prevalence of classical risk factors. The socioeconomic context of cardiovascular epidemic which occurred in developed, capitalist Europe after

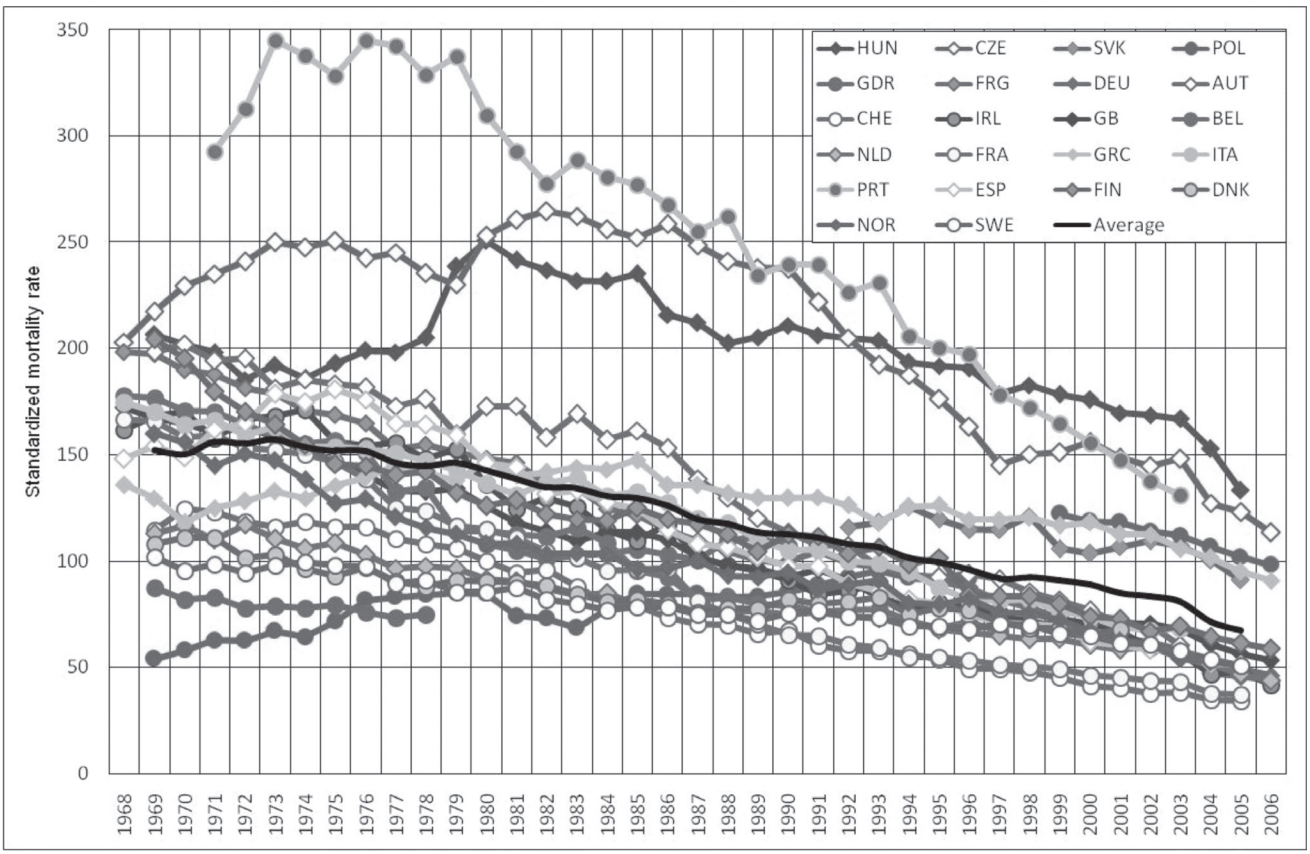


**Fig. 5** Standardized mortality rates for cerebrovascular diseases (per 100,000), selected European countries, 1968–2006, men

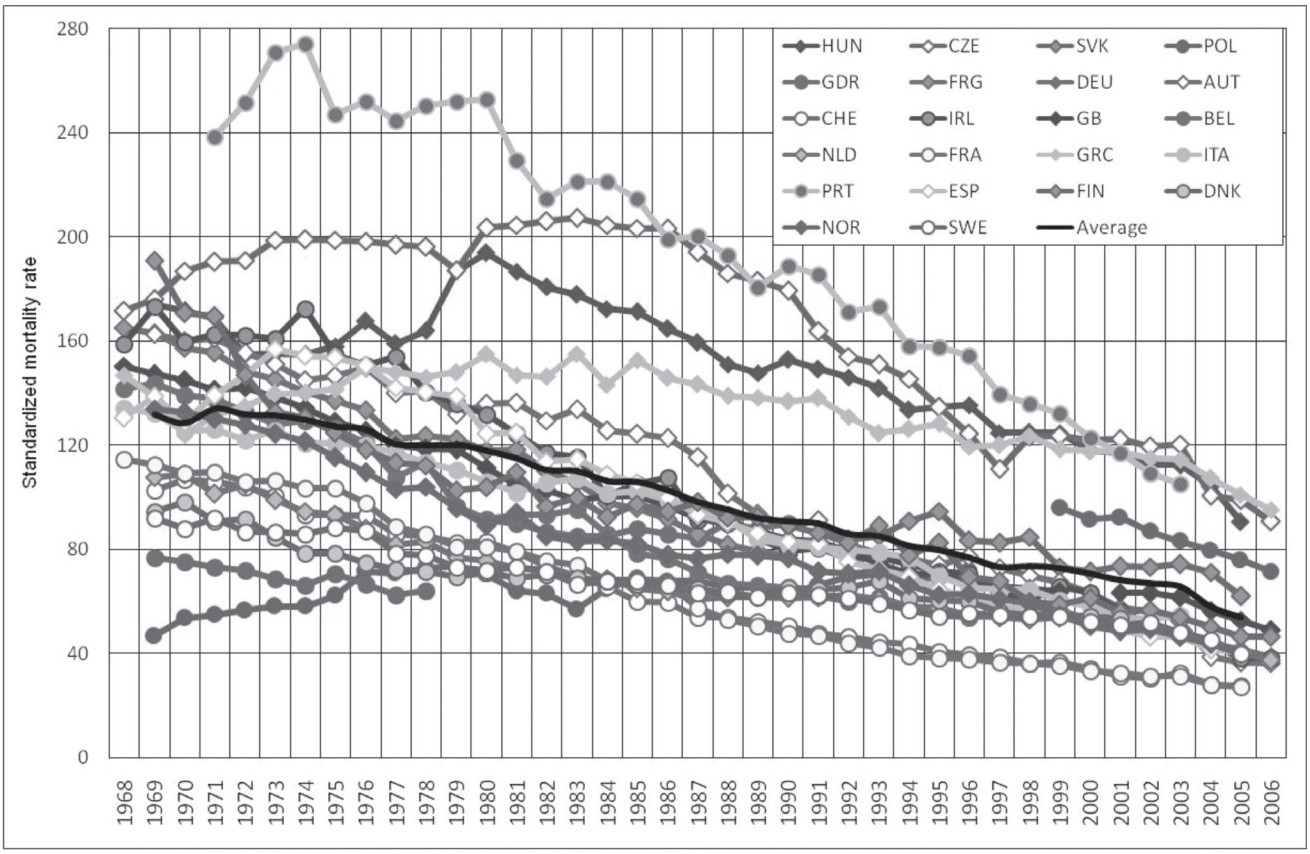


**Fig. 6** Standardized mortality rates for cerebrovascular diseases (per 100,000), selected European countries, 1968–2006, women

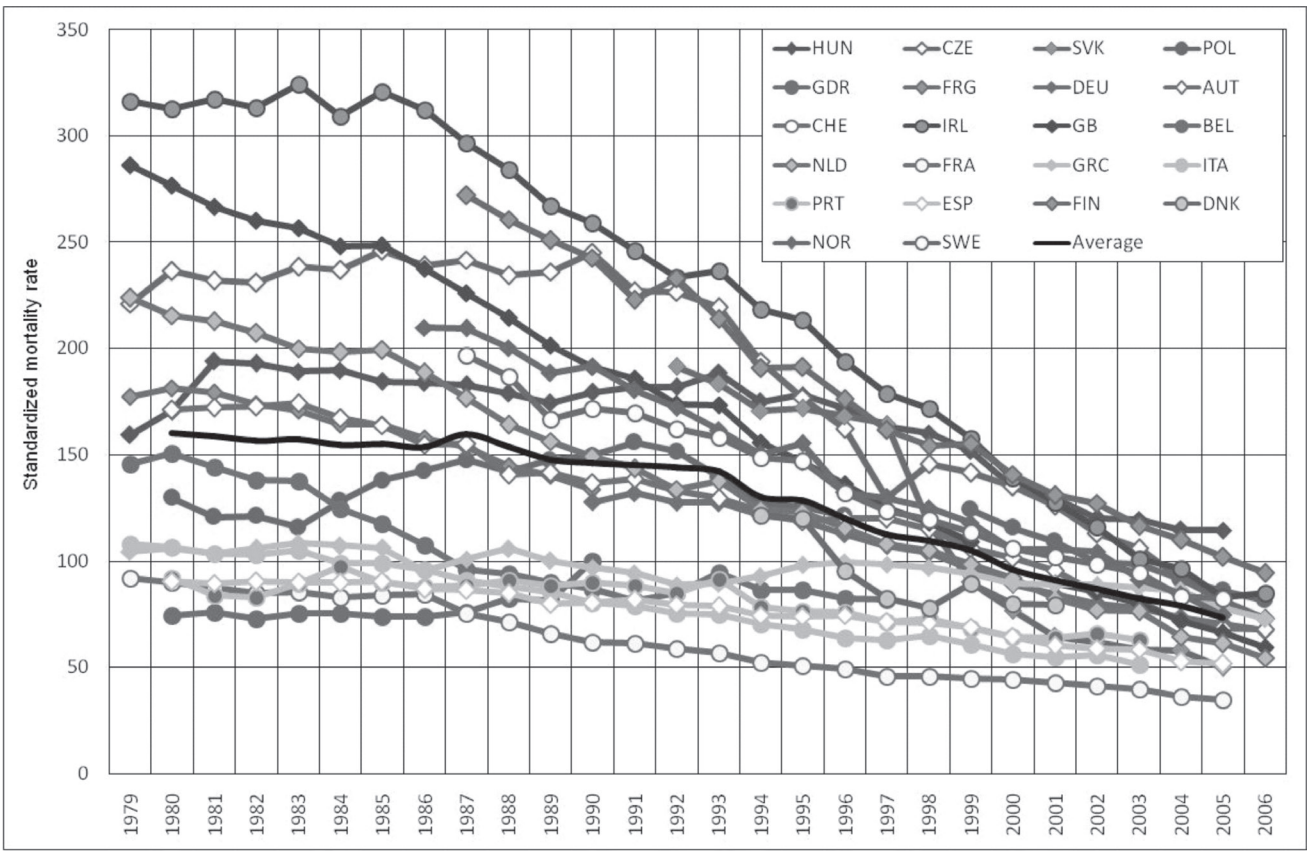


**Fig. 7** Standardized mortality rates for acute myocardial infarction (per 100,000), selected European countries, 1968–2006, men

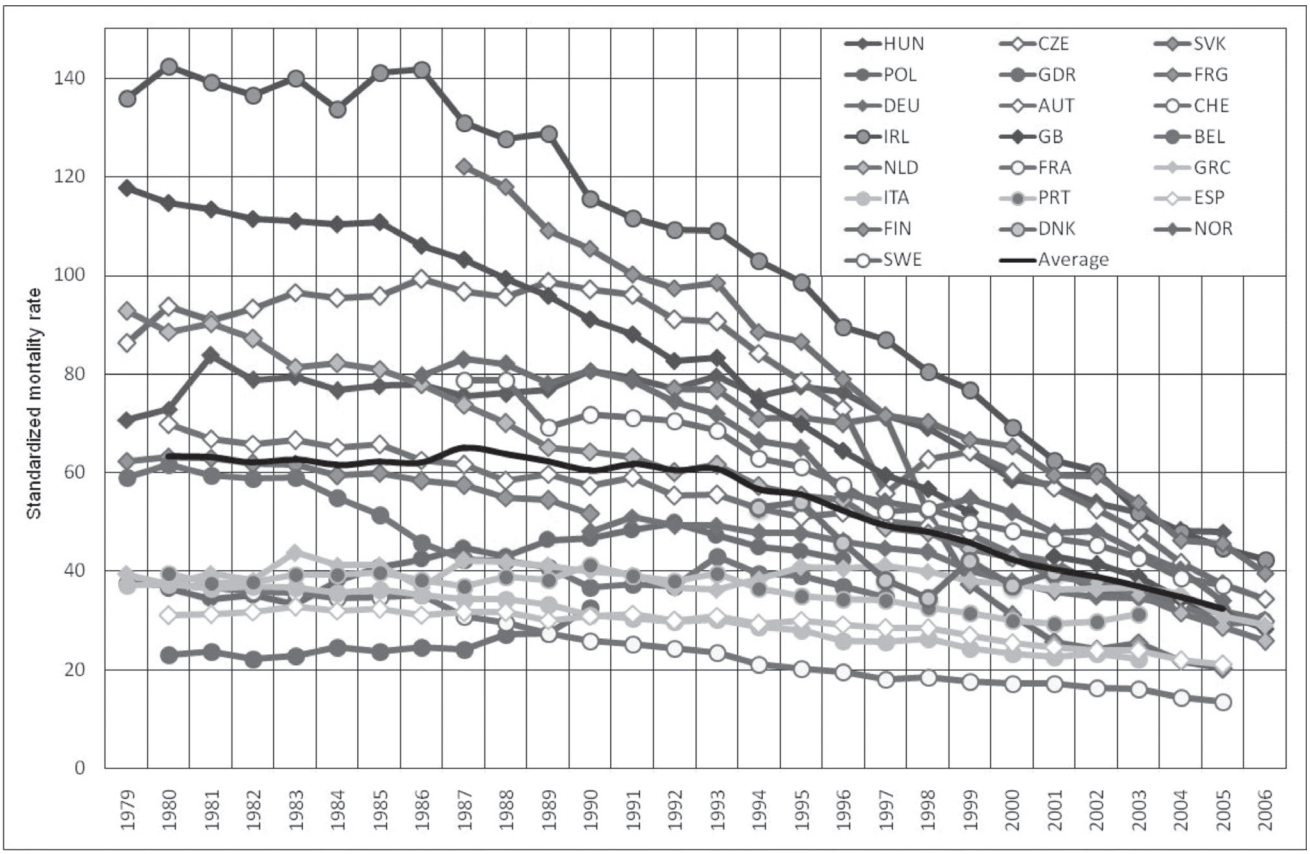


**Fig. 8** Standardized mortality rates for acute myocardial infarction (per 100,000), selected European countries, 1968–2006, women

the Second World War completely differed from the situation of the communist countries during 1960–1990 (Ginter, 1997). Health care in the socialist countries was characterized by obsolete diagnostic and treatment methods – principally by insufficient drug availability. The national health care systems also failed in the domain of prevention, which should convince individuals to put more emphasis on their own health (Vallin, Meslé, 2004). Public health measures and policies, which had been effective in the reduction in infectious disease mortality rates, failed in the fight against cardiovascular diseases (Caselli, Vallin, Wunsch, 2005). Psychosocial factors have also been attributed some role in the development of cardiovascular mortality in the communist countries (Ginter, 2001).

### Relation to overall, age-specific and cause-specific mortality

Cardiovascular mortality trends contributed most significantly to the divergent development of overall mortality between the Western European countries and the post-communist countries. Even currently, the differences due to the described cardiovascular mortality development are perceptible in the level of overall mortality of selected countries.

Circulatory diseases mortality increases with age as well as the proportion of deaths due to this group of diseases. A more significant in cardiovascular mortality rates begins approximately at age of 50 for men and at the age of 60 for women. This occurs roughly 5–10 years earlier in the post-communist countries than in Western European countries. As a result of improvement of the overall mortality conditions these age limits consistently move toward higher age groups.

The decrease of the circulatory diseases mortality is connected with the development of age-specific mortality. From the end of sixties, post-communist countries were lacking in the decline of the middle age and old age cardiovascular mortality, which occurred in the Western European countries. In Hungary, the excess mortality was recognizable even in the relatively young age groups (from the age of 30). The rise or stagnation of the circulatory diseases mortality in these age groups prevented the post-communist countries from keeping on par life expectancy growth in the Western European countries.

In general, the circulatory diseases mortality represented the highest contribution to the life expectancy differential in the majority of countries (Figure 9, 10). The significance of the main groups of causes of death changed during the study period. The detailed analysis of age and cause-specific contributions to life expectancy differential involved 3 sub-periods: 1969–1981, 1981–1992 and 1992–2005.

In the first sub-period, the contributions of other causes of death were predominant in all countries except Finland and the United Kingdom for men and in almost half of the countries for women. This was primarily result of a significant drop in the infant mortality rate. In the second and third period, the contributions of cardiovascular diseases became more prevalent and their proportion rose progressively, whereas the proportion of other main groups of causes of death became less significant. This had to do with other causes of death as well as respiratory and digestive diseases.

In general, it can be concluded that the prevailing contributions of the decline in cardiovascular mortality to the change in life expectancy first appeared in western and northern Europe and in female populations. On the other hand, southern European and the post-communist countries moved to this model later (as well as male populations in general). Change in life expectancy in these countries was influenced over a longer period of time by other causes of death than in western and northern Europe. In the case of post-communist countries, contributions by cardiovascular mortality long remained negative (1969–1981 and 1981–1992).

The reduction of cardiovascular mortality as a whole ICD chapter was primarily enabled because of the decrease of the mortality due to acute myocardial infarction and cerebrovascular diseases. In the majority of selected countries, these groups of circulatory diseases provided the largest component of the cardiovascular diseases contribution to the life expectancy change (Figure 11, 12). Acute myocardial infarction contributed the most in the male population, the contribution of cerebrovascular diseases prevailed at first for women, but gradually the contribution of acute myocardial infarction became predominant also in the female populations. In some countries, the proportions of these two groups of diseases were almost equal (more frequently for women) – Ireland, Italy, Finland.

The age distribution of the contributions of the groups of selected cardiovascular diseases was not equal. The contributions of cerebrovascular mortality were focused on higher age groups than the contributions of acute myocardial infarction (Figure 11, 12).

Other heart diseases, atherosclerosis, hypertension and other diseases of the circulatory system contributed less significantly on the change in life expectancy. The proportion of other heart diseases on the contribution of circulatory diseases was more marked in higher age groups of female populations. More noticeable contributions of atherosclerosis and hypertension in higher age groups were observed in a couple of countries (mostly for women above the age of 65).

The analysis of mortality trends on some narrowly delimited groups of cardiovascular diseases led more to discussion about the quality of data and comparability than to satisfactory results. This especially dealt with hypertension and atherosclerosis in some of the selected countries. Therefore, some countries had to be partly or completely excluded from analysis.

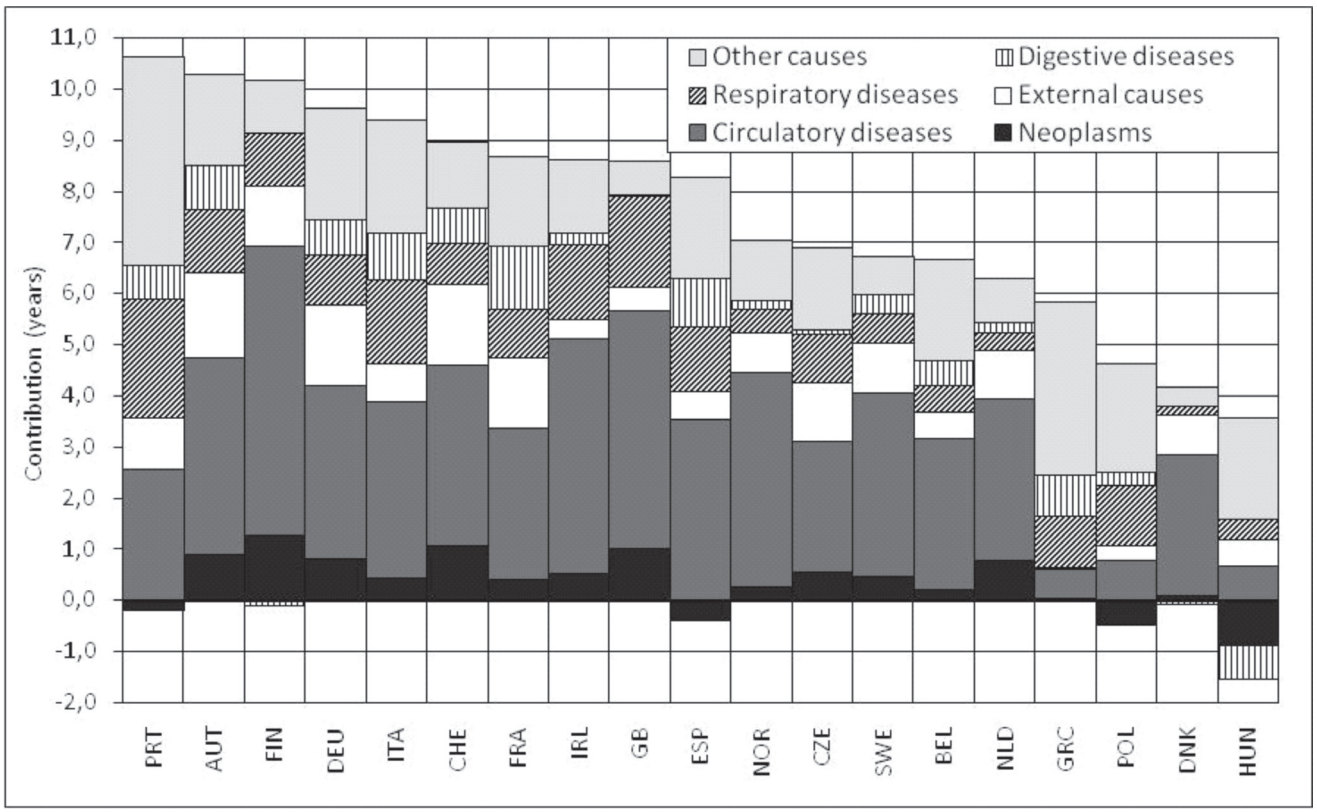


**Fig. 9** Contributions of main groups of causes of death to changes in male life expectancy at birth between 1969 and 2005 (years)

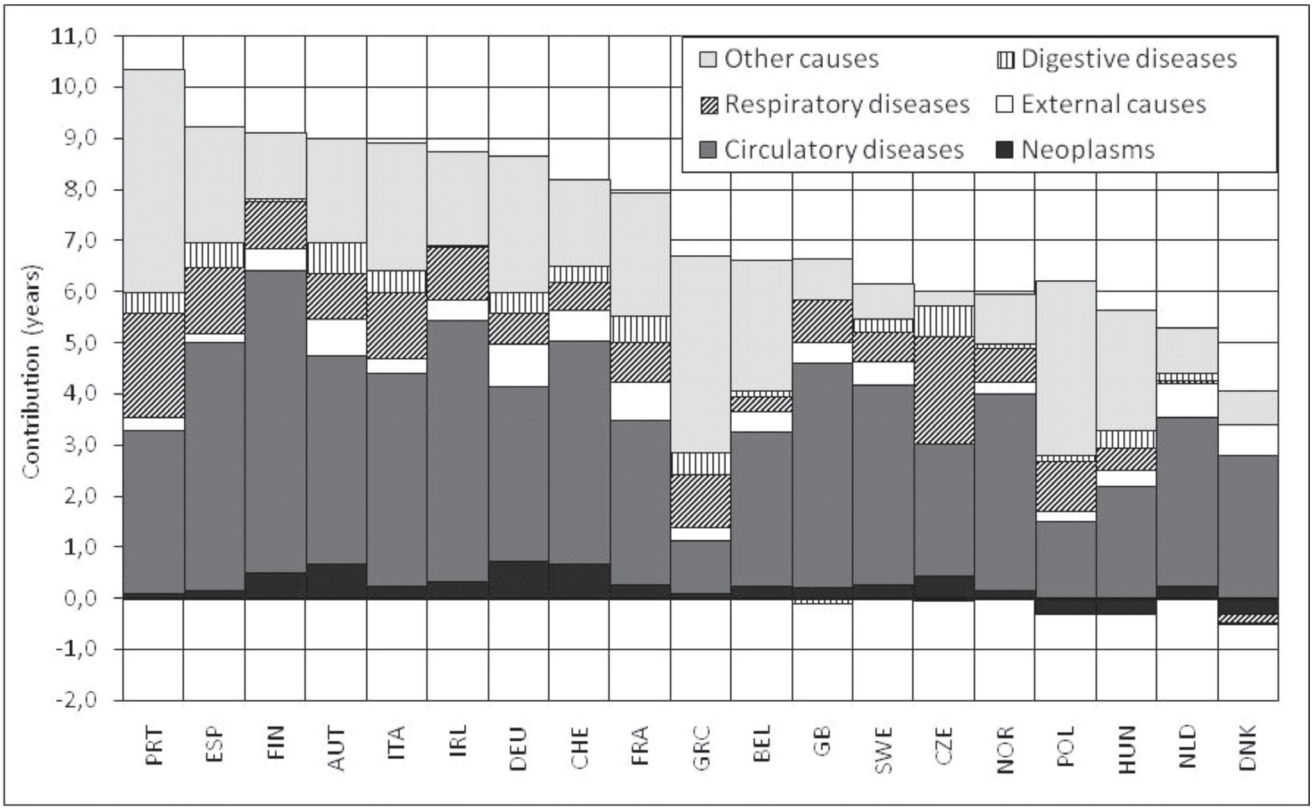


**Fig. 10** Contributions of main groups of causes of death to changes in female life expectancy at birth between 1969 and 2005 (years)

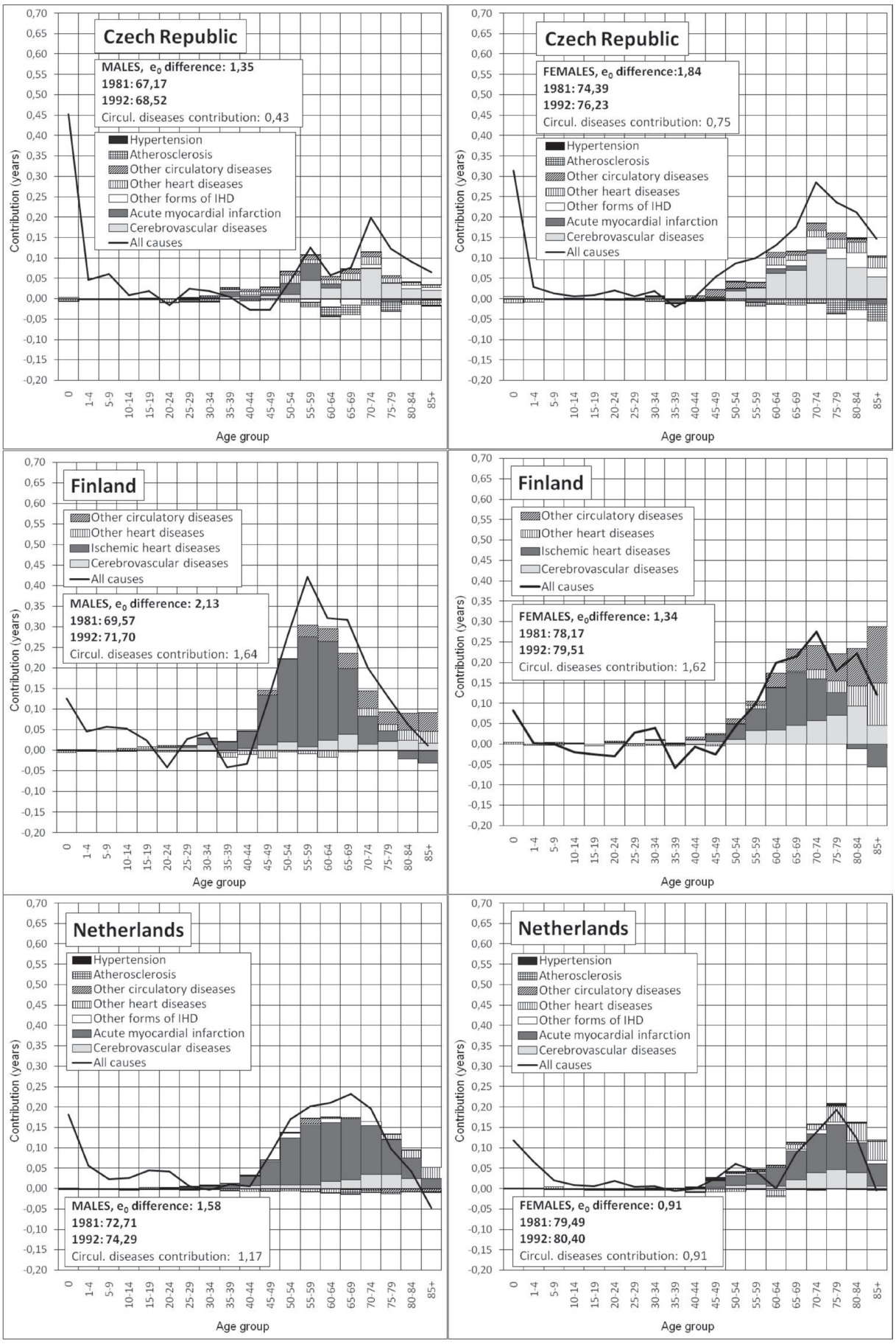


**Fig. 11** Contributions of age groups ages and causes of death to changes in life expectancy at birth between 1992 and 2005 (years), Czech Republic, Finland, Netherlands

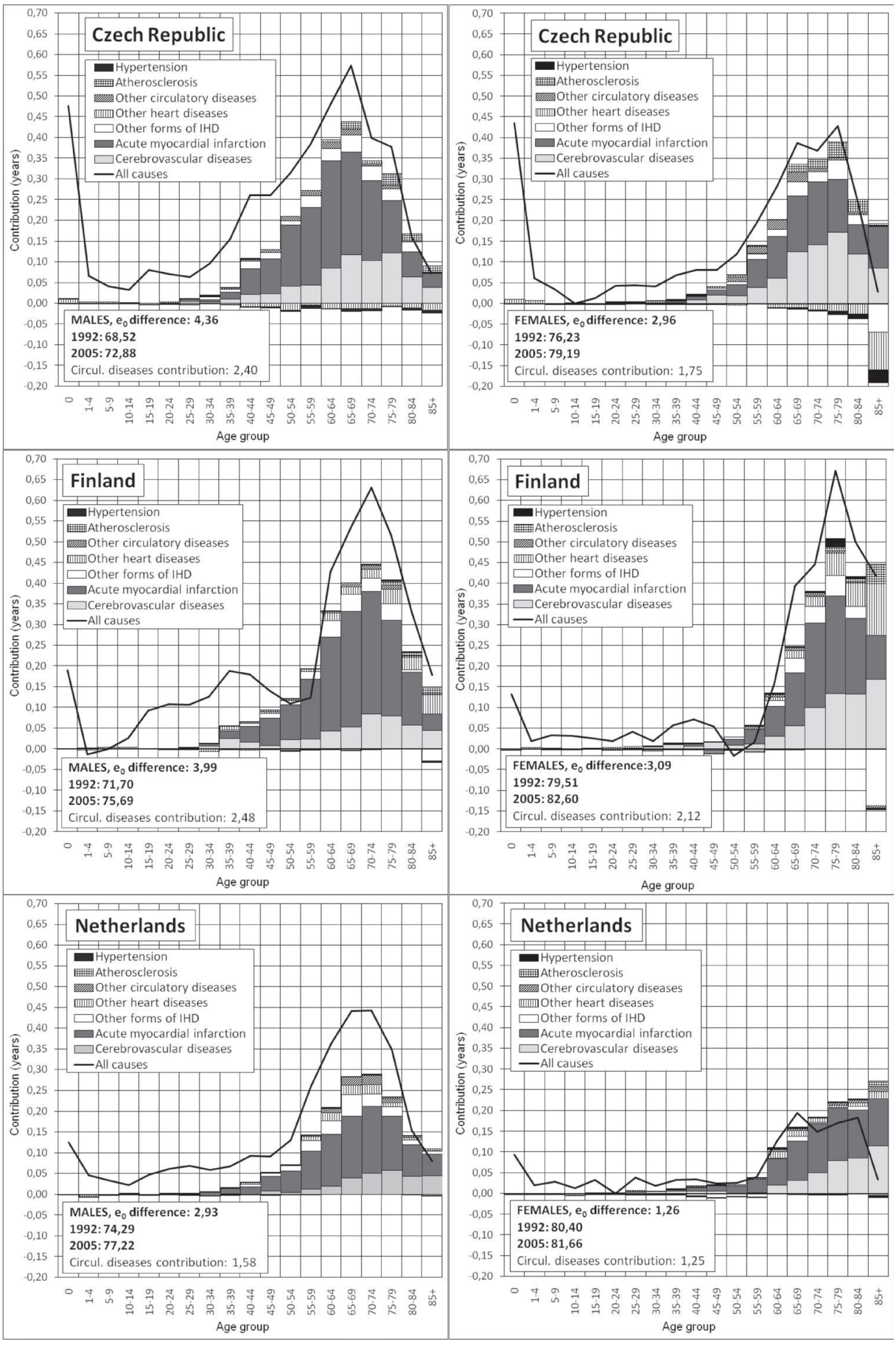


**Fig. 12** Contributions of age groups ages and causes of death to changes in life expectancy at birth between 1981 and 1992 (years), Czech Republic, Finland, Netherlands

## Cluster analysis

The cluster analysis aspired to group the European countries under study in clusters associating states with closer mortality conditions. This should be achieved with the use of most important mortality indicators (as mentioned in methods). Some of selected mortality indicators faced the problem of intercorrelation, it is their nature as the mortality components are not independent on each other. The correlation analysis preceded the cluster analysis. The most correlated variables were excluded or replaced by more appropriate variables. This concerned e.g. the standardized mortality rate on cardiovascular diseases (whole chapter), which was excluded, then life expectancy at birth and life expectancies at the exact ages 40 and 65, which were replaced by probabilities of survival between these ages.

The clustering history is represented by corresponding table (Figure 13). Working with the data from 1973, the clustering begins with joins of west European and north European countries. To a certain extent, it corresponds with the geographical distribution of countries as well as the linking of Italy and Spain and the linking of the Czech Republic and Hungary in next steps. On the other hand, linking of Finland with Former East Germany and Poland as well as the linking of the Czech Republic and Hungary with the cluster of 3 west European countries was, perhaps, less expected. Greece and France joined the southern European cluster, but because of later phase of clustering and higher loss of variability for France, the similarity within this cluster should be lower (Figure 14).

| *Cluster History* | | | | | |
|---|---|---|---|---|---|
| *NCL* | *Clusters Joined* | | *FREQ* | *SPRSQ* | *RSQ* |
| 19 | FRG | BEL | 2 | 0,0044 | 0,996 |
| 18 | CHE | NLD | 2 | 0,0057 | 0,99 |
| 17 | IRL | GB | 2 | 0,0095 | 0,98 |
| 16 | CL19 | AUT | 3 | 0,0101 | 0,97 |
| 15 | DNK | SWE | 2 | 0,0103 | 0,96 |
| 14 | ITA | ESO | 2 | 0,0149 | 0,945 |
| 13 | CL15 | NOR | 3 | 0,0187 | 0,926 |
| 12 | CL18 | CL13 | 5 | 0,0223 | 0,904 |
| 11 | HUN | CZE | 2 | 0,0236 | 0,88 |
| 10 | GDR | FIN | 2 | 0,0279 | 0,852 |
| 9 | POL | CL10 | 3 | 0,0332 | 0,819 |
| 8 | CL11 | CL16 | 5 | 0,037 | 0,782 |
| 7 | GRC | CL14 | 3 | 0,0379 | 0,744 |
| **6** | **FRA** | **CL7** | **4** | **0,0452** | **0,699** |
| 5 | CL8 | CL9 | 8 | 0,0632 | 0,636 |
| 4 | CL12 | CL6 | 9 | 0,0817 | 0,554 |
| 3 | CL5 | CL17 | 10 | 0,0979 | 0,456 |
| 2 | CL3 | PRT | 11 | 0,1738 | 0,283 |
| 1 | CL2 | CL4 | 20 | 0,2825 | 0,000 |

**Fig. 13** Clustering history based on selected mortality indicators, 1973 (SAS Output)

**NB.:**
NCL – number of clusters
FREQ – frequency of objects in the emerging cluster
SPRSQ – Semi-Partial R-Squared, proportion of loss of explained variability
RSQ – R-Squared, proportion of explained variability

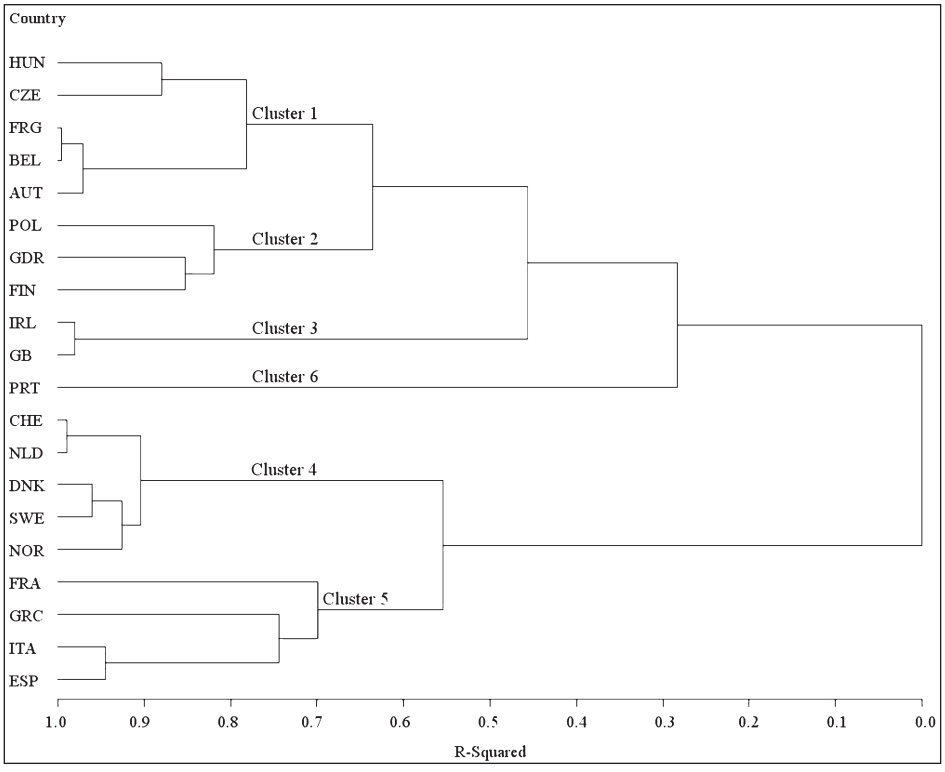


**Fig. 14** Dendrogram showing emerging clusters of European countries on the basis of similarity of selected mortality indicators for the year 1973

The variability preserved by the data decreases quite evenly during the clustering procedure. Higher loss of preserved variability happens with the reduction to 5 clusters, this percentage is considerably higher (40%) than in the previous steps. Therefore, grouping countries into 6 clusters seems to be appropriate and it preserves about 70% of variability of the initial data (Figure 13). In the subsequent steps, the joins of quite large clusters occur. That is why the lost variability reaches extensively higher values in these phases.

Using the indicators from 1973, the analysis created 6 clusters which assemble European countries with similar mortality characteristics. These groups are identifiable on the dendrogram (Figure 14) and include following countries:

1. Hungary, the Czech Republic, Belgium, former German Federal Republic, and Austria. These countries had a lower probability of survival in the middle and older age in common (especially for men), high mortality on neoplasms and external causes as well as mean or higher level of mortality on cerebrovascular diseases. This cluster doesn't express much similarity with respect to some indicators as it was fused after the halfway mark of the cluster history.
2. Finland, former German Democratic Republic, Poland. This trio displayed very high mortality on other cardiovascular diseases, lower probability of survival from the age 40 to 65 and from the age 65 to 85, as well as high mortality on external causes of death. For some indicators this cluster does not express much similarity due to the same reason as the cluster 1 does not.
3. Ireland and the United Kingdom. This pair of countries was distinguished mostly by very high mortality due to respiratory diseases. Other characteristics included rather high proportion of deaths due to circulatory diseases, low intensity of mortality on external causes, and mortality on neoplasms of women above average.
4. Switzerland, the Netherlands, Denmark, Sweden, Norway. These west and northern European countries had high survival in the middle and older age groups (more marked for men) in common, lower mortality on cerebrovascular diseases and a mortality on other cardiovascular diseases around the mean. We can also mention a low mortality on respiratory diseases and a higher mortality of women on neoplasms (except Norway).
5. Italy, Spain, Greece, France. The Mediterranean countries expressed a high probability of surviving in the middle and older age, a low mortality on other cardiovascular diseases, and a very low proportion of cardiovascular deaths, low intensity on women's neoplasms mortality.
6. Portugal remained separate, which resulted from a very low probability of survival, especially in young age groups and from very high level of mortality on cerebrovascular diseases and a low mortality on neoplasms.

With regard to some traits, the results of cluster analysis performed with the data from 2001 do not much differ from the previous one. In this second analysis, Belgium has not been included because its time-series terminates in 1997 (Figure 1). The cluster formation is represented by corresponding table and dendrogram (Figure 15, 16). The clustering starts with the joining of Germany and Austria, Italy and Switzerland, the United Kingdom and Norway. These cores of countries are progressively extended to future clusters.

| *Cluster History* | | | | | |
|---|---|---|---|---|---|
| *NCL* | *Clusters Joined* | | *FREQ* | *SPRSQ* | *RSQ* |
| 18 | DEU | AUT | 2 | 0,0043 | 0,996 |
| 17 | CHE | ITA | 2 | 0,0059 | 0,99 |
| 16 | GB | NOR | 2 | 0,0088 | 0,981 |
| 15 | CL18 | SWE | 3 | 0,009 | 0,972 |
| 14 | CL17 | ESP | 3 | 0,0091 | 0,963 |
| 13 | CL16 | NLD | 3 | 0,0104 | 0,953 |
| 12 | IRL | DNK | 2 | 0,0157 | 0,937 |
| 11 | CR | POL | 2 | 0,0185 | 0,918 |
| 10 | CL12 | CL13 | 5 | 0,0227 | 0,896 |
| 9 | CL14 | FRA | 4 | 0,027 | 0,869 |
| 8 | CL15 | GRC | 4 | 0,027 | 0,842 |
| 7 | CL11 | SVK | 3 | 0,0318 | 0,81 |
| 6 | CL8 | FIN | 5 | 0,0431 | 0,767 |
| **5** | **HUN** | **CL7** | **4** | **0,0487** | **0,718** |
| 4 | CL6 | CL9 | 9 | 0,0692 | 0,649 |
| 3 | CL4 | PRT | 10 | 0,0723 | 0,577 |
| 2 | CL3 | CL10 | 15 | 0,1065 | 0,470 |
| 1 | CL5 | CL2 | 19 | 0,4700 | 0,000 |

**Fig. 15** Clustering history based on selected mortality indicators, 2001 (SAS Output)

**NB.:**
NCL – number of clusters
FREQ – frequency of objects in the emerging cluster
SPRSQ – Semi-Partial R-Squared, proportion of loss of explained variability
RSQ – R-Squared, proportion of explained variability

The Northern European countries are split into two clusters – Norway and Denmark join the states of western Europe as before, whereas Sweden and Finland unite with German-speaking countries and Greece. That seems to generate quite heterogeneous cluster. The position of Finland is specific. Similar to year 1973, it most differs significantly from other north European countries. Finland joins the mentioned cluster in two thirds of the clustering procedure.

Southern European states seem to be even more disunited than in the previous analysis.

The post-communist countries form a single cluster. Nevertheless, while the pair of the Czech Republic and Poland expresses many common traits, Slovakia and Hungary join the cluster much later in the clustering history (Figure 16).

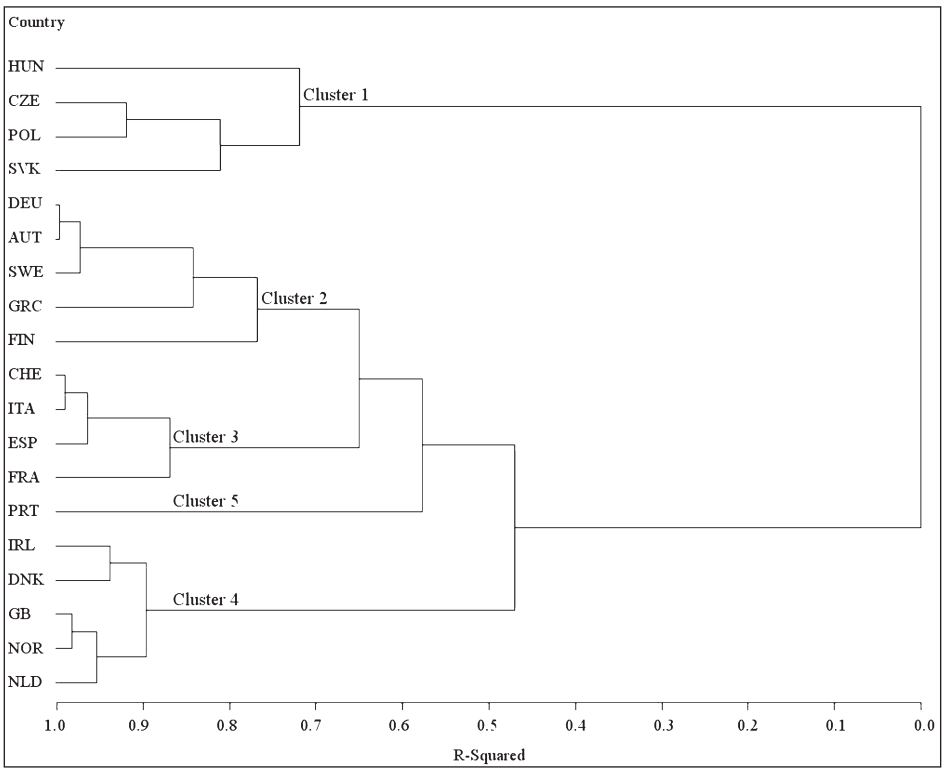


**Fig. 16** Dendrogram showing emerging clusters of European countries on the basis of similarity of selected mortality indicators for the year 2001

In this case, the arrangement of 5 clusters is chosen as optimal. The loss of variability is about 42% higher when reducing the grouping to 4 clusters than in the previous step. The 5 clusters preserve about 72% of the initial data variability (Figure 15). It is remarkable that a lower number of clusters and a slightly higher proportion of preserved variability in comparison with the first cluster analysis appeared. This could be linked to the fact that numbers of countries contained in each cluster are more similar (excluding Portugal). The arrangement include following groups of countries:

1. Hungary, the Czech Republic, Poland, Slovakia. For the post-communist countries higher values of almost all mortality indicators are typical. The low probability of surviving in the higher and middle age categories (especially for men), high level of all included cardiovascular mortality indicators, very high mortality rates on neoplasms and external causes for men can be mentioned. Hungary attains the most extreme values even in comparison with other post-communist countries.
2. Germany, Austria, Sweden, Greece, Finland. High probability of survival in the middle and older age, low mortality due to neoplasms, high proportion of male deaths caused by circulatory diseases. Excluding Finland or Greece, some more common traits could be found in this group – lower mortality on cerebrovascular diseases, mean level of ischemic heart disease mortality.
3. Switzerland, Italy, Spain, France. These countries are characterised by very high probability of surviving for all ages (especially for women), low or lowest values of indicators linked with cardiovascular mortality, low mortality on neoplasms of women. France sometimes reaches the lowest or outlying values in this cluster (analogical situation with Finland in cluster 2).
4. Ireland, Denmark, the United Kingdom, Norway, the Netherlands. This cluster displays mean or slightly lower probability of surviving in the middle and older ages, higher or very high mortality on neoplasms of women, mean mortality on neoplasms for men, lower cerebrovascular mortality and proportion of cardiovascular deaths.
5. Portugal. Its isolation is almost the same as in 1973, but it joins the other clusters a bit earlier (Figure 14). The specific traits of Portugal are, for instance, very high mortality on cerebrovascular diseases and, on the contrary, very low mortality due to ischemic heart diseases.

These results of cluster analysis represent only one of many possible applications of this method. They depend on the choice of input variables and computation methods.

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## SUMMARY

The aim of the article was to analyse the development of cardiovascular mortality in selected European countries in connection with the development of overall, age-specific and cause-specific mortality. The study period was primarily defined as 1968–2006 with respect to differences of time range applications of the revisions of International Classification of Diseases and Related Health Problems. The mortality trends on the most frequent groups of cardiovascular diseases were studied within the whole chapter of circulatory diseases. Some conversion and data quality related problems restrained the analysis.

The analyses showed that in almost all Western European countries (geopolitically), the cardiovascular mortality decline throughout the entire study period. However, the intensity of the decrease considerably differed among countries. The standardized mortality rates from circulatory diseases of Western European countries underwent considerable homogenisation from the end of the sixties until 2006.

On the contrary, the cardiovascular mortality in post-communist countries represented here by the central European countries rose for men and stagnated for women from the beginning of the study period until around the early nineties or the second half of the eighties. Afterwards, the cardiovascular mortality decline successively appeared in the post-communist countries – first and most intensive in the Czech Republic and in Poland, followed by milder and later lowering in Slovakia and Hungary.

The different cardiovascular mortality trends mostly influenced the overall mortality development throughout the study period and led to its divergence. Circulatory diseases mortality represented the highest contribution to the life expectancy differential in the majority of countries even if the proportion of contributions of the main groups of causes of death changed during the study period. In the first section, the influence of the decline in mortality due to other causes of death was predominant in many countries, but progressively the cardiovascular contributions gained the largest significance. In general, the prevailing contributions of the decline in cardiovascular mortality to the life expectancy difference first appeared in the western and northern Europe and in female populations.

In terms of age-specific mortality, the most important cardiovascular mortality decline occurred in the middle and older age groups – approximately above 40 years for men and above 50 years for women. Reserves for its reduction for some countries were also concerned with these age groups. Circulatory diseases mortality is characterized by shifting contributions to life expectancy differential in increasingly higher age groups, which can also be expected in the future.

Mortality development on studied groups of cardiovascular diseases often corresponded to the trends of circulatory mortality as a whole ICD chapter (with slight differences). The reduction of circulatory diseases mortality was mainly enabled by the drop of mortality on acute myocardial infarction and on cerebrovascular diseases. These groups of diagnoses usually provided the highest portion of the cardiovascular contribution to change in life expectancy. During the study period the mortality rates on acute myocardial infarction and cerebrovascular diseases converged significantly in the set of countries.

The lowering of ischemic heart disease mortality merely resulted from the significant decline of acute myocardial infarction mortality, which occurred in all countries under study (even in the post-communist countries). Because the mortality due to other forms of ischemic heart diseases stagnated or even increased.

The results of cluster analysis confirm the conclusions of the previous analyses of mortality trends – geopolitical differentiation i.e. the dissociation of post-communist countries from Western European countries. The cluster analysis also shows the higher tendency of clustering in accordance with geographical distribution (parts of Europe). However, differences which cannot be neglected may exist within the groups formed, mainly for countries joining the clusters in later phases of clustering history.

The divergent development of mortality level between capitalist and post-communist Europe and indication of its slight convergence in recent years confirmed the fundamental impact of socio-economic conditions on mortality.


## RÉSUMÉ

### Vývoj úmrtnosti na nemoci oběhového systému ve vybraných evropských zemích

Článek si klade za cíl porovnat vývoj úrovně a struktury úmrtnosti na nemoci oběhového systému ve vybraných evropských zemích v období 1968–2006 (8.–10. revize MKN). Vývoj úmrtnosti na nemoci oběhové soustavy je zasazen do kontextu změn celkové úmrtnosti a je chápán v souvislosti se strukturálními změnami úmrtnostních poměrů daných zemí, tedy s vývojem úmrtnosti podle věku a pohlaví a s vývojem úmrtnosti na jiné třídy příčin smrti. V rámci třídy nemocí oběhové soustavy jsou analyzovány změny intenzity úmrtnosti a zastoupení vybraných skupin onemocnění, či konkrétních diagnóz. Samostatnou část článku představuje shluková analýza na základě hodnot vybraných ukazatelů úmrtnosti. Z analýz vyplývá, že vývoj úmrtnosti na nemoci oběhové soustavy se ze všech tříd příčin úmrtí nejvýznamněji podílel na diferenciaci vývoje celkové úmrtnosti mezi postkomunistickými a západoevropskými zeměmi. V západoevropských zemích se intenzita úmrtnosti na nemoci oběhového systému ve sledovaném období významně snižovala. V postkomunistických zemích docházelo od počátku sledovaného období přibližně do počátku 90. let ke zvyšování či ke stagnaci úrovně úmrtnosti na nemoci oběhové soustavy. Pokles úmrtnosti na tuto třídu příčin úmrtí nastává v těchto zemích až v 90. letech se změnou politické situace a společenskoekonomických podmínek.



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