INEQUALITIES IN PREMATURE MORTALITY FROM ISCHAEMIC HEART DISEASE IN THE WHO EUROPEAN REGION

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SUMMARY

Objectives: Ischaemic heart disease (IHD) is one of the leading causes of premature mortality. Our aim was to analyse standardised premature mortality rates from IHD by geographical groups in the age group 45–59 years.

Methods: We performed a retrospective, quantitative analysis of age-standardized mortality rates from IHD between 1990–2014 per 100,000 population in Western European (WE: N = 17), Eastern European countries (EE: N = 10), and countries of the former Soviet Union (fSU: N = 15) within the European Region of the World Health Organisation (WHO) based on data retrieved from the WHO European Mortality Database. Descriptive statistics, time series analysis and statistical tests were used for the analyses (ANOVA, Kruskal-Wallis test, Mann-Whitney test, paired t-test).

Results: On average, age-standardized death rates (ASDR) from IHD per 100,000 population were the lowest in WE (men 1990: 143.67, 2014: 50.29; women 1990: 29.06, 2014: 9.89), and the highest in fSU (men 1990: 358.69, 2014: 253.25; women 1990: 99.78, 2014: 57.85). Between 1990 and 2014, all three groups experienced significant decrease in ASDR both in men and women (fSU: −29.39%, −42.02%; EE: −49.41%, −50.57%; WE: −64.99%, −65.97%, respectively) ($p < 0.05$). Between 1990 and 2004, ASDR decreased in WE in both sexes ($p < 0.001$), in EE among males ($p = 0.032$). Between 2004 and 2014, ASDR from IHD decreased significantly in both sexes in fSU and WE, in EE only among women ($p < 0.05$).

Conclusions: During the whole period analysed, ischaemic heart disease mortality significantly decreased in both sexes in all the groups.

Key words: epidemiology, ischaemic heart disease, premature mortality

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INTRODUCTION

One of the main forms of cardiovascular diseases (CVD) is ischaemic heart disease (IHD), the International Classification of Diseases (ICD) code range ICD 10: I20-I25, where the blood supply and consequently the oxygen supply to the heart muscle is insufficient. Ischaemic heart disease is among the leading causes of death (1, 2). Classic IHD risk factors include smoking, high cholesterol levels, elevated systolic blood pressure, obesity, diabetes, and sedentary lifestyle. Access to modern health care is also among the risk factors contributing to the development of IHD (3–5). In 2014, 8.17 million people died from IHD worldwide. IHD mortality was 1.14 million in the age group of 45–59 worldwide in 2014 (6). In Europe, IHD accounts for 20% of deaths among women and 19% of deaths among men. IHD is a leading cause of premature mortality as well. Premature mortality can be reduced by avoiding modifiable risk factors and by ensuring access to adequate and effective health care. Premature deaths are deaths which could have been prevented or avoided with the present state of medical knowledge and its proper application. Several experts have developed slightly different sets of indicators for the age at which deaths from certain causes are considered avoidable. One measure of premature mortality is potential years of life lost, which is the number of years not lived out of a commonly agreed life expectancy of 70 years. In addition, premature mortality is also defined as death before the age of 65 and is included as a separate indicator among the indicators calculated from mortality (7). IHD mortality rates show considerable differences according to geographical group. Major manifestation of IHD, acute myocardial infarction has been found to show a decreasing tendency in Western countries contrary to Asian countries (8, 9).

In former Soviet Union (fSU) countries, societal and political changes have had an unfavourable impact upon the state of health of the population which has also manifested in decreasing life expectancy. Health indicators in fSU countries are lagged behind those in other European countries. Data for individual countries varied over time (1). At the end of the 20th century, IHD was mainly prevalent among the elderly in high-income countries. Nowadays, due to changes in lifestyle, increased stress levels and other contributing factors, IHD has been increasingly more common in the middle age population of low- and middle-income

countries (2). Despite the fact that Eastern European countries (EE), including Hungary, have witnessed an improvement in the state of health of their populations in the past decades, health indicators have not moved closer to those of Western European countries (WE) (10).

Our aim was to analyse available mortality data from ischaemic heart disease for the period between 1990 and 2014 in 42 countries of the WHO European Region in the 45–59 age group.

In terms of premature deaths from ischaemic heart disease, the predominant age group is 45–59 years. The 45–59 age group is part of the active working population, and therefore, we consider the monitoring of mortality to be of particular importance not only from a healthcare but also from an economic point of view, which is essential for the definition of further interventions and for policy decisions. There are few similar, summarised studies available for this age group. By dividing the above mentioned 42 countries into three groups (Western European countries, Eastern European countries, countries of the former Soviet Union) we aimed to demonstrate differences with regard to mortality data between and within these groups by applying various statistical tests.

MATERIALS AND METHODS

We performed a retrospective, quantitative analysis on standardised premature mortality data from IHD per 100,000 population in the 45–59 age group. Our analysis included selected Western European countries (N = 17; Austria, Belgium, Denmark, Finland, France, Germany, Greece, Netherlands, Ireland, Luxembourg, Norway, Italy, United Kingdom, Portugal, Sweden, Spain, Switzerland), Eastern European countries (N = 10; Bulgaria, Bosnia-Herzegovina, Czech Republic, Croatia, Poland, Hungary, Romania, Serbia, Slovakia, Slovenia), and countries of the former Soviet Union (N = 15; Armenia, Azerbaijan, Estonia, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan) from the European Region of the WHO. The WHO European Region includes 53 countries. Out of 53 countries, 42 countries were selected for our study, and the selected countries were divided into 3 groups for our analysis (Eastern European countries, Western European countries and the successor states of the Soviet Union). Our analysis targeted the period between 1990 and 2014 due to the availability of data, with special focus on the years 1990, 2004 and 2014.

After 1990, EE and fSU countries experienced far-reaching social and economic changes. From 2004, most EE countries and some fSU countries joined the European Union.

Our study investigated gender differences, regional differences, differences occurring over time, and regional inequalities in standard mortality from IHD in the 45–59 age group within and among the groups of countries we established.

Analysed data were retrieved from the WHO European Mortality Database (MDB) (11) for the indicator: standardised death rate (SDR: 45–59), ischaemic heart disease, per 100,000 (ICD 10: I20-I25). Data were retrieved from the databases derived from national registries of the given countries.

Besides descriptive statistical methods (mean, mean MT, standard deviation), time series analysis and statistical tests were used (ANOVA, paired t-test, Kruskal-Wallis test, Mann-Whitney test, Friedman's test), 95% confidence interval was considered as statistically significant ($p < 0.05$). Normality tests were carried out as these were required for ANOVA and paired t-test. While using ANOVA, in order to examine which categories differed from each other while showing the same SD (Levene test $p > 0.05$) or having different case numbers, we decided to perform the Bonferroni test as post hoc test. Upon applying the paired t-test, we excluded countries within a given sample for which no data were available for any of the selected years. When a variable did not give normal distribution ($p < 0.05$) we chose non-parametric versions of parametric tests for our analyses: pairwise comparisons function was used upon performing the Kruskal-Wallis test in order to exactly identify the categories that differed. Furthermore, Friedman's test was used.

Our analyses were performed using MS Excel 2007 (Microsoft Corporation, Redmond, WA, USA) and SPSS 22.0 (IBM Corporation, Armonk, NY, USA) programs.

RESULTS

In 1990, the relative risk of age-standardized mortality from IHD per 100,000 in men was two and a half times higher in fSU countries (358.69, SD = 78.28, min = 220.69 Tajikistan, max = 480.59 Latvia) and more than one and a half times higher on average in EE countries (236.51, SD = 80.68, min = 136.54 Slovenia, max = 348.19 Czech Republic) than in WE countries (143.67, SD = 58.73, min = 64.22 France, max = 262.78 Finland). In 2004, premature mortality due to ischaemic heart disease was 4.6 times higher in fSU countries (355.94, SD = 115.66, min = 193.61 Tajikistan, max = 604.69 Russia) on average, in EE countries it was more than double (171.73, SD = 49.37, min = 92.48 Slovenia, max = 246.42 Hungary) than in WE countries (77.68, SD = 27.85, min = 43.67 France, max = 144.07 Greece). In 2014, premature mortality due to ischaemic heart disease per 100,000 population in men was five times higher in fSU countries (253.25, SD = 89.72, min = 122.42 Georgia, max = 404.24 Belarus), in EE countries it was 2.4 times higher (119.65, SD = 35.12, min = 60.92 Slovenia, max = 179.19 Hungary) than in WE countries (50.29, SD = 22.21, min = 26.62 Netherlands, max = 116.63 Greece). Our analyses revealed significant differences among WE countries, EE countries and fSU countries with regard to mortality due to ischaemic heart disease in men aged between 45–59 ($p < 0.001$) (Fig. 1).

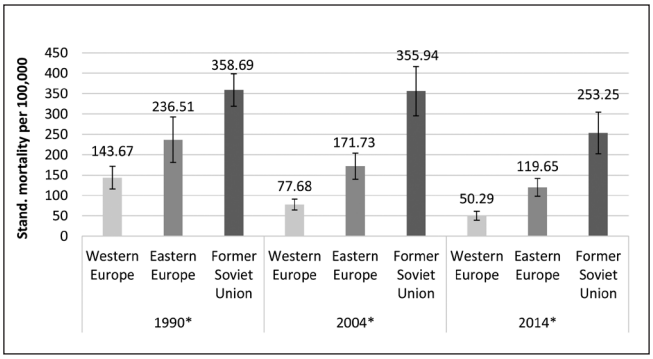

Fig. 1. *Age-standardized death rates per 100,000 from ischaemic heart disease, males.*

*p < 0.001, one-way ANOVA, Kruskal-Wallis test

In 1990, average age-standardized mortality in women was nearly 3.5 times higher in fSU countries (99.78, SD = 27.76, min = 72.66 Armenia, max=164.63 Turkmenistan), and more than one and a half times higher in EE countries (54.67, SD = 20.14, min = 23.96 Slovenia, max=85.50 Hungary) than in WE countries (29.06, SD = 13.37, min = 10.32 France, max = 56.05 United Kingdom). In 2004, premature mortality in women was nearly six times higher in fSU countries (97.90, SD = 30.98, min = 50.27 Estonia, max = 150.8 Turkmenistan), and 2.6 times higher in EE countries (42.29, SD = 16.35, min = 17 Slovenia, max = 65.29 Romania) than in WE countries (16.55, SD = 6.45, min = 6.98 France, max = 31.2 Luxemburg). In 2014, standardised mortality in women was 5.8 times higher in fSU countries (57.85, SD = 27.43, min = 15.48 Estonia, max = 92.98 Ukraine), it was nearly three times higher in EE countries (27.03, SD = 11.02, min = 11.04 Slovenia, max = 47.19 Hungary) compared to WE countries (9.89, SD = 4.02, min = 5.14 Luxemburg, max = 19.93 Greece). Significant differences were found in mortality rates from ischaemic heart disease in women aged 45–59 ($p < 0.001$) upon comparing WE, EE and fSU countries ($p < 0.001$) (Fig. 2).

Analysing age-standardized IHD mortality rates in the years selected and presented in Table 1 (1990, 2004, 2014), significant differences were found in both men and women between WE and fSU countries ($p < 0.05$). Upon comparing mortality rates in EE countries with fSU countries, significant differences were found only in 1990 ($p < 0.05$) (Table 1).

Time series analysis showed that between 1990 and 2014 age-standardised mortality from IHD in men decreased most markedly in selected WE countries (−64.99%), followed by the selected EE countries (−49.41), and then fSU countries (−29.39%). Standardised mortality rate from ischaemic heart disease in men aged 45–59 showed continuous improvement between 1990 and 2013 in WE countries (−66.27%). At the end of the analysed time period, between 2013 and 2014, mortality showed a minimal increase by 3.77%. In EE, between 1990 and 1993, standardised mortality rate from ischaemic heart disease in men increased (+8.51%), and then decreased for more than 10 years until 2004 (−33.09%). Between 2004 and 2011 there was an overall decrease (−24.88%) in premature mortality from ischaemic heart disease in men. Between 2011 and 2012, age-standardized mortality from IHD stagnated and subsequently decreased until the end of the analysed period in EE (−8.76%). In fSU countries, from the beginning of the analysed time period until the mid-1990s mortality from ischaemic heart disease in men aged 45–59 increased continuously (+26.88%), then until 1999 a 19.17% decrease was found. Overall, between 1999 and 2004, there was no significant change (−3.24%). Minimal increase (+1.59%) was found between 2004 and 2008. From 2008 until the end of the analysed period, there was constant improvement in age-standardized IHD mortality in men (−29.97%). During the period analysed, mortality from ischaemic heart disease in men aged 45–59 was found to have been the highest in 1990 in WE countries, in 1993 in EE countries and in 1995 in fSU (Fig. 3).

Time series analysis revealed that between 1990 and 2014 age standardised mortality from IHD in women decreased most markedly in selected WE countries (−65.97%) similar to men, followed by EE countries (−50.57%), and fSU countries (−42.02%). Mortality from ischaemic heart disease in women decreased most markedly in WE countries between 1990 and 1992 (−12.25%). Slight increase was found with regard to age-standardized

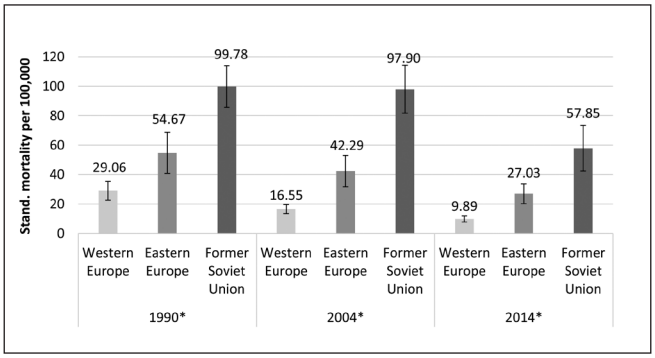

Fig. 2. *Age-standardized death rates per 100,000 from ischaemic heart disease, females.*

*p < 0.001, one-way ANOVA, Kruskal-Wallis test

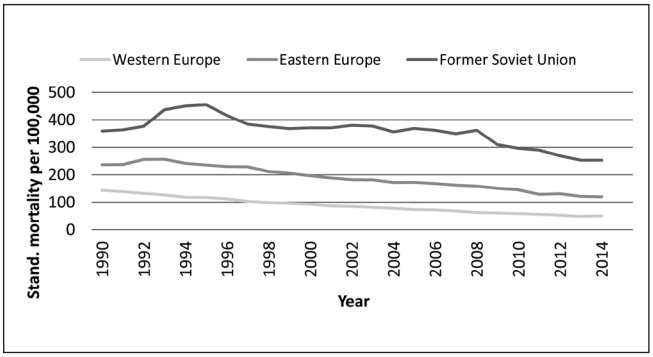

Fig. 3. *Ischaemic heart disease mortality trend in Western Europe, Eastern Europe and former Soviet Union, males, 1990 to 2014.*

Table 1. *Differences of age-standardized death rate per 100,000 population in selected years*

		EE (mean)	WE (mean)	p-value	EE (mean)	FSU (mean)	p-value	WE (mean)	FSU (mean)	p-value
Year 1990	Males	236.51	143.67	0.013	236.51	358.69	0.001	143.67	358.69	< 0.001
	Females	54.67	29.06	0.022	54.67	99.78	< 0.001	29.06	99.78	< 0.001
Year 2004	Males	171.73	77.68	0.027	171.73	355.94	0.070	77.68	355.94	< 0.001
	Females	42.29	16.55	0.086	42.29	97.90	0.120	16.55	97.90	< 0.001
Year 2014	Males	119.65	50.29	0.029	119.65	253.25	0.220	50.29	253.25	< 0.001
	Females	27.03	9.89	0.014	27.03	57.85	0.611	9.89	57.85	< 0.001

EE – Eastern Europe; WE – Western Europe; FSU – Former Soviet Union

mortality between 1992 and 1993 (+2.58%), followed by a subsequent decrease (−32.36%) until the turn of the millennium. Age-standardized mortality due to IHD in women showed an overall improvement between 2000 and 2006 (−14.32%) in WE and then, from 2006 until the end of the time period analysed, a continuous, uninterrupted decrease was observed (−34.75%). In EE countries, standardised age-standardized mortality in women was found to have increased by 9.48% between 1990 and 1993, followed by a decrease in 1994 (−6.23%), and a minimal increase in 1995 (+1.16%). Between 1995 and 2011, female mortality rates in the 45–59 age group showed a continuous, marked improvement in EE (−46.41%). From 2011 until the end of the period analysed, there was an overall 3.4% further decrease in age-standardized IHD mortality in women in EE. Although fSU countries experienced an increase in female standardised mortality from ischaemic heart disease in women aged 45–59 between 1990 and 1995 (+36.68%), there was a subsequent decrease (−25%) until 1999. Between 1999 and 2007 an overall decrease was found (−13.55%). In fSU countries, mortality from ischaemic heart disease among women aged 45–59 was found to have stagnated between 2007 and 2008 and then it decreased until the end of the period analysed (−35.16%). During the period analysed, similar to men, mortality in women aged 45–59 was found to have been the highest in 1990 in WE countries, in 1993 in EE countries, and in 1995 in fSU countries (Fig. 4).

Significant values presented in Table 2 clearly demonstrate that between 1990 and 2014, there were significant changes in SDR from IHD in both sexes during the whole time period in all groups analysed ($p<0.05$). Regarding the time periods 1990–2004 and 2004–2014, we did not find significant changes in all cases in age-standardized mortality from ischaemic heart disease within the groups (Table 2).

Figure 5 shows changes in SDR among men in percentages, in those countries among the groups we established according to geographical location for which data were available for the years 1990 and 2014. Due to lack of data, Azerbaijan, Ireland, Serbia, Slovakia, Switzerland, Tajikistan, and Turkmenistan are not shown on the graph. During the period analysed, average decrease in age-standardised mortality from IHD was 45.50%. In 20 countries the change experienced was above average whereas 15 countries experienced changes below the average. Between 1990 and 2014, standardised mortality from ischaemic heart disease among men aged 45–59 showed an increase in Ukraine (+14.55%), Moldova (+12.29%), Belarus (+7.17%), and Kyrgyzstan (0.89%). Compared to the base year, the most favourable changes were seen in Denmark (−81.52%), followed by the Netherlands (−80.94%), and closely by Norway (−80.67%) (Fig. 5).

Similarly, we analysed changes in age-standardized mortality rates for women between 1990 and 2014 in countries for which data were available. Changes are presented in percentages. Due to lack of data, we could not analyse rates for some countries among the groups we established according to geographical location (Azerbaijan, Ireland, Serbia, Slovakia, Switzerland, Tajikistan, and Turkmenistan). Standardised death rate from IHD in women aged 45–59 decreased by an average of 49.36% in some countries. Above average change was detected in 18 countries while 17 countries showed below average decrease in ASDR from IHD between 1990 and 2014. Except for Ukraine (+9.71%), all countries witnessed a decrease in SDR. Based on data available, standardised mortality rate from ischaemic heart disease showed a similar picture in women to that in men with Denmark showing the biggest decrease (−84.85%) followed by Estonia (−82.30%), and Georgia (−80.76%) (Fig. 6).

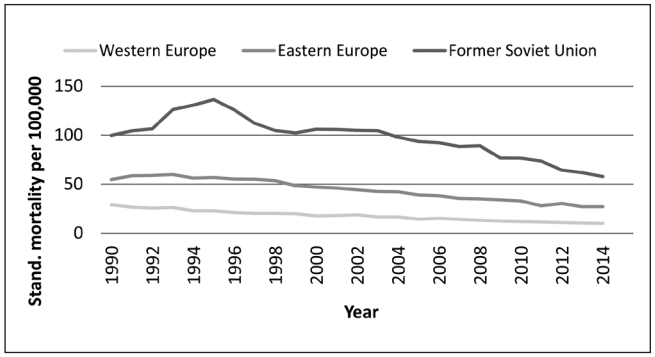

Fig. 4. *Ischaemic heart disease mortality trend in Western Europe, Eastern Europe and former Soviet Union, females, 1990 to 2014.*

DISCUSSION

Our paper presents the results of the analyses of rates of early mortality from ischaemic heart disease in the age group 45–59 years in the WHO European Region based on the WHO European Mortality Database. Mortality from ischaemic heart disease was found to have decreased considerably in both sexes in all the groups during the time period analysed.

Health inequalities have to be taken into account. "The term health inequality generically refers to differences in the health of individuals or groups. Any measurable aspect of health that varies

Table 2. *Differences of age-standardized death rate per 100,000 population according to geographical grouping*

		1990 (mean)	2004 (mean)	p-value	1990 (mean)	2014 (mean)	p-value	2004 (mean)	2014 (mean)	p-value
Eastern Europe	Males	236.51	171.73	>0.05	236.51	119.65	<0.05	171.73	119.65	>0.05
	Females	54.67	42.29	>0.05	54.67	27.03	<0.05	42.29	27.03	>0.05
Western Europe	Males	143.67	77.68	<0.05	143.67	50.29	<0.05	77.68	50.29	<0.05
	Females	29.06	16.55	<0.05	29.06	9.89	<0.05	16.55	9.89	<0.05
Former Soviet Union	Males	358.69	355.94	>0.05	358.69	253.25	<0.05	355.94	253.25	<0.05
	Females	99.78	97.90	>0.05	99.78	57.85	<0.05	97.90	57.85	<0.05

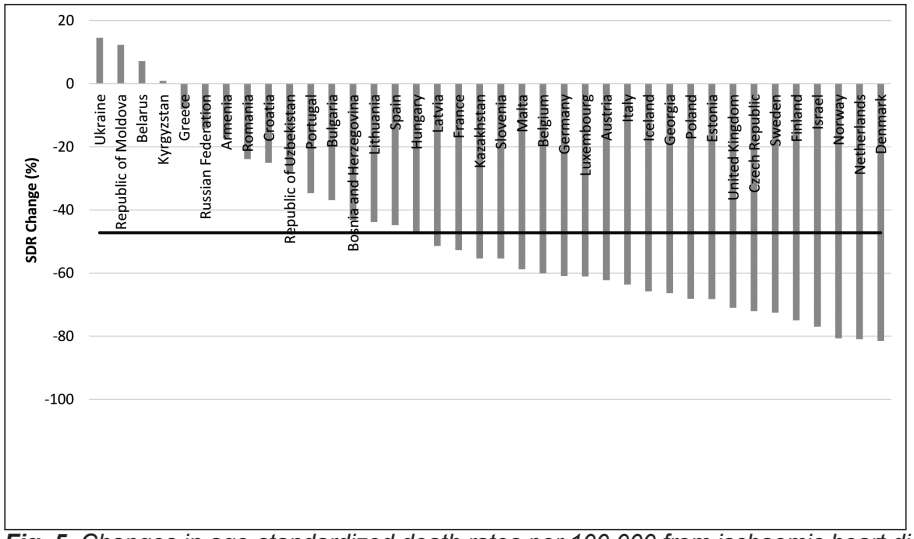

Fig. 5. *Changes in age-standardized death rates per 100,000 from ischaemic heart disease, males, 1990–2014.*

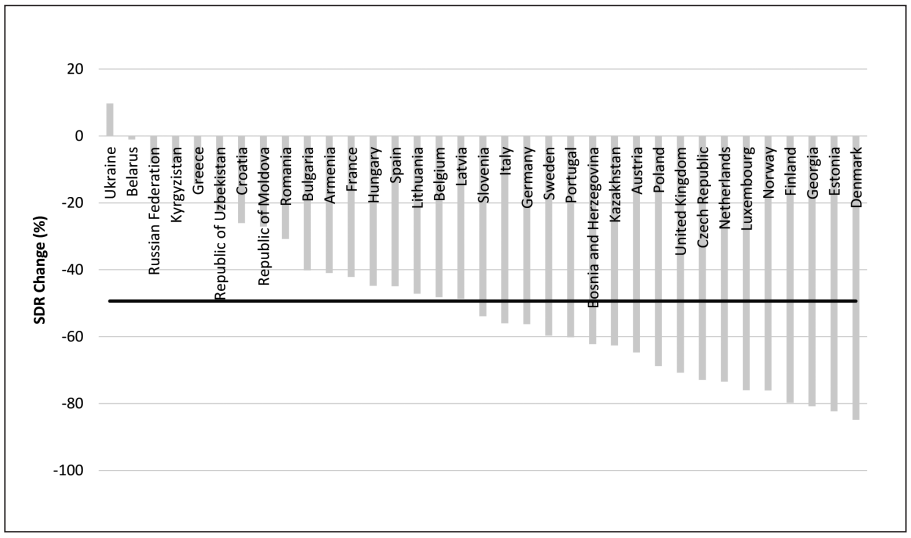

Fig. 6. *Changes in age-standardized death rates per 100,000 from ischaemic heart disease, females, 1990–2014.*

across individuals or according to socially relevant groupings can be called a health inequality. Absent from the definition of health inequality is any moral judgment on whether observed differences are fair or just" (12).

According to a study by Ilic et al., more than half the decrease in mortality rates from IHD in developed countries in both sexes were attributable to favourable changes with regard to cardiovascular risk factors in the population including decrease in the prevalence of smoking, hyperlipidaemia and hypertension (13). Several professional guidelines and population-level preventive strategies have undoubtedly contributed to the above reduction in risk factor prevalence the most significant of which was the Framingham Study (14). The fact that preventive strategies mainly emerged in high-income, developed countries, may be further supported by our findings, that these countries showed the biggest decrease in IHD mortality in the 45–59 age group during the time period we analysed (15).

Besides implementing preventive measures and strategies, decrease in mortality rates is also due to the development of the healthcare system including advanced diagnostic methods, the more widespread availability of cardiac catheterisation, and the establishment of haemodynamic labs. Easier access to medications and the improvement of therapeutic procedures have also considerably contributed to more advanced medical and surgical therapies being available for patients suffering from ischaemic heart disease (16).

Our results demonstrate that average mortality from ischaemic heart disease was the lowest in the selected WE countries and the highest in fSU in both sexes. During the period analysed, the decrease observed was not continuous in the three groups. At the beginning of the 1990s, EE countries and fSU countries were still seeing an increase in this respect, most probably due to the economic decline, societal and political changes experienced after the change of the regime. In the second half of the 1990s, all groups showed a decrease in age-standardized mortality from IHD, which partly correlates with findings of other studies (17). Nonetheless, in countries of the fSU, age-standardized mortality from IHD did not show considerable changes between 1990 and 2004 in either of the sexes. During the 2008 crisis, these countries experienced even further increase among men. During the time period analysed, countries of the fSU were the last to experience a peak in ischaemic mortality rates. Contributing factors may have

included low socio-economic status, unstable employment and a lack of social capital (1, 18–20). Although we found a decrease in average age-standardized mortality from IHD in all the groups we analysed, in the case of men from fSU countries Ukraine, Moldova, Belarus and Kyrgyzstan, they had increased rates. With regard to women, only Ukraine reported an increase. Other studies found similar tendencies in Ukraine and Kyrgyzstan (2).

Increase in age-standardized IHD mortality could be due to the fact that the percentage of GDP spent on public health expenditures remained below the recommended 5% in Belarus, Kyrgyzstan and Ukraine in 2014 (1, 21). Similar to other studies, we found considerable, continuous improvement in IHD death rates in WE countries (2). Our results showed that age-standardized IHD mortality rates in EE did not differ markedly from those in fSU countries in the years 2004 and 2014 in either of the sexes. This is further supported by our findings that between 2004 and 2014 in EE mortality in males and females did not change significantly. Similar to fSU countries, changes in mortality rates in EE after the change of the regime correlated with changes in the GDP and income inequalities (22–24).

We found that age-standardized mortality from IHD decreased considerably in both men and women similar to other studies (1, 10). Meslé et al. report significant differences in mortality between Eastern and Western European countries. They describe significant differences in average life expectancy at birth between the worst and best mortality performers in Western and Eastern European countries. The researchers attribute the variations found mainly to non-communicable chronic diseases and discuss the possible risk factors involved in their development (25).

With regard to the sexes, ischaemic heart disease mortality was better in women than in men in the 45–59 age group. However, other studies suggest that more women lose their lives in complications of ischaemic heart disease than men. Presumably, the disease is underdiagnosed in women due to atypical pain, which increases the hesitation time. It would be important to involve a higher number of women in clinical trials and increase their health awareness through various media platforms (26).

A strength of our study is that we have performed a comprehensive analysis of premature ischaemic heart disease mortality data from countries of the WHO European Region in the 45–59 age group.

Limitations of our study include a lack of availability of data from the WHO database (lack of IHD mortality data expressed in absolute numbers, occasional lack of standardized mortality data). Validity of our results may have been influenced by differences in mortality statistics used in different countries. Comparability of our results is also limited by the fact that different studies have grouped countries of analysed groups differently, diagnoses have been combined and different codes have been used.

CONCLUSIONS

Our analysis clearly shows that there is considerable variation in mortality data from ischaemic heart disease both within and between the countries/areas analysed. It is assumed that health inequalities may contribute to these differences. Reducing mortality in the 45–59 age group analysed would be particularly important as they are part of the working age population and therefore it may have not only healthcare but economic significance as well. Our results may assist policy makers in their efforts to develop health policy interventions aimed to reduce mortality and in making the necessary policy decisions for improving the organisation of care.

Implementation and facilitation of primary prevention strategies, mainly within the framework of national public health programmes, is crucial for the reduction of mortality rates from ischaemic heart disease in developing countries, primarily strategies targeting cardiovascular risk factors. In order to reduce risk factors, we consider it particularly important in health policy-making to encourage the concept of healthy foods with low tax-rate.

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Conflicts of Interest

None declared

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