

Bogdan Wojtyniak

National Institute of Public Health – National Institute of Hygiene

bogdan@pzh.gov.pl

ORCID: 0000-0002-2135-8226

Jakub Stokwiszewski

National Institute of Public Health – National Institute of Hygiene

jakub@pzh.gov.pl

ORCID: 0000-0002-9328-4924

Contribution of avoidable causes of death to premature mortality in Poland and selected European countries

Abstract

Our study, availing the new, agreed by the OECD and Eurostat lists of preventable and treatable causes of death, seeks to quantify the contribution of avoidable causes to premature mortality and its dynamics in Poland and Central European countries – Czechia, Hungary, Lithuania and Slovenia, in comparison with Sweden serving as a benchmark country in 1999–2017. We calculated age standardised death rates for the broad groups of avoidable causes and more specific ones, which comprised preventable and treatable cancer and diseases of the circulatory system (DCS), preventable injuries and alcohol-related diseases. Deaths from not avoidable causes were also analysed. The analysis of time trends in the death rates and calculation of the Average Annual Percent Change (AAPC) for the overall trend were performed with joint-point models. The contribution of changes in mortality from avoidable causes to increase life expectancy during 1999–2017 and contribution of the difference in mortality from these causes to the difference in life expectancy between the five countries and Sweden were based on the decomposition of temporary life expectancy between birth and age 75 [$e_{(0-75)}$]. For the

calculation of life expectancy, we used the classic Chiang method and the decomposition of life expectancy by the death causes and age was conducted with the Arriaga method. The AAPC of death rates from avoidable causes in 1999–2017 was similar in all the countries but Lithuania, where the decline started later. The decline in the death rates from not avoidable causes is much slower than the rates from avoidable causes. Mortality from treatable causes was decreasing faster than from preventable causes in most populations. In 1999–2017, the average rate of mortality decline for preventable cancer was greater among men than among women, while for treatable cancer the sex-related differences were much smaller and in favour of women. As for preventable and treatable death from DCS, their decrease was faster among women than men in all the countries but Sweden. Improvements in mortality from causes that could be avoided through prevention or treatment made substantial positive contributions to the overall change in life expectancy in all the countries. The differences in temporary life expectancy $e_{(0,75)}$ between the analysed Central European countries and Sweden were much smaller in 2017 than in 1999, due to the reduction of the gap in mortality from avoidable causes. Our results show that among men, and to a lesser extent among women, mortality from preventable causes contributes more than mortality from causes that can be effectively treated to shorter life expectancy in the countries of Central Europe than in Sweden.

This indicates that in reducing the health gap between the inhabitants of Central Europe and Western Europe, the healthcare system should consider disease prevention even to a greater extent than just treating them.

Keywords: avoidable mortality, premature mortality, mortality in Poland, mortality in Central Europe, avoidable cardiovascular mortality, avoidable cancer mortality

Introduction

Assuming as an axiom that the primary objective of the health system is to safeguard and improve the health of society, it is natural to assess this system in terms of its participation in improving the health of the population and assess its contribution to health differences between countries. This task is extremely difficult due to the complexity of the problem and the limitations resulting from the lack of relevant data. It is essential to choose a health indicator that is appropriately specific and sensitive to action and intervention in the area of health. The concept of avoidable deaths as it is commonly understood as a way of measuring the quality of healthcare was developed in the 1970s by a team led by Rutstein (Rutstein, Berenberg, Chalmers, Child, Fishman & Perrin, 1976). They proposed to measure the quality of medical care by counting the cases of unnecessary illnesses and unnecessary premature deaths. The list of avoidable causes of deaths has been changing over the years. As Nolte and McKee (Nolte & McKee, 2004) have shown, almost each study on amenable mortality has had its own list of ‘causes of

deaths amenable to healthcare'. Eurostat started to report avoidable deaths indicators in 2014 (Eurostat, 2014), based on the lists developed by the Office of National Statistics (ONS) in England in 2011 (ONS, 2011). In 2018, the OECD and Eurostat worked together with an expert group to develop new joint lists of preventable and treatable causes of mortality that built on the results of earlier work. These lists were published in 2019 (OECD, Eurostat, 2019). Causes of death are considered preventable if they can be avoided mainly through effective public health and primary prevention interventions (to reduce incidence). The most important specific categories of preventable deaths include those caused by diseases that can be prevented by vaccination, HIV/AIDS, lung cancer, chronic obstructive pulmonary disease, diseases related to the consumption of alcohol and other psychoactive substances, as well as accident injuries and suicide. Causes of death are considered treatable (or amenable, as they were named earlier) if in the scope of the medical knowledge and available technology during death they can be mainly avoided through timely and effective healthcare interventions, including secondary prevention and treatment (to reduce case-fatality). Specific categories of causes of death that can be effectively treated include, but are not limited to, cancer of the breast, colon, rectum and anus, Hodgkin's disease, benign neoplasm, acute and chronic rheumatic heart disease, pneumonia and acute lower respiratory tract infection, asthma, gastric ulcer and duodenal ulcer, diseases of the appendix, hernia. Unlike in the earlier versions, in the current version of the lists the age threshold has been uniformly set to 75 years for all the selected causes of death. Among the set principles there were also following three important ones: "For those causes of death that can be both largely prevented and also treated once they have occurred, these causes of death were attributed to the preventable category on the rationale that if these diseases are prevented, there would be no need for treatment. Causes of death should generally not be fractioned as being partly preventable and treatable given the lack of evidence to do this accurately and systematically, except when there is no strong evidence of predominance, in which case a 50%–50% allocation was used. Any double-counting of the same causes of death between the two lists was avoided, so that the two lists can be used together to provide a broad assessment of the relative importance of prevention and health care interventions in reducing avoidable deaths." (OECD, Eurostat, 2019). The 50–50 allocation was applied to cervical cancer, diabetes mellitus, and most of selected avoidable diseases of the circulatory system (DCS), including ischaemic heart diseases and cerebrovascular diseases. All these principles make the new lists somewhat different than the earlier lists.

As the authors underline, both lists of causes of mortality and the age limits reflect current health expectations, medical technology and knowledge, and developments in health policy, and hence might be subject to future revisions.

Based on earlier classifications, some publication analysed avoidable mortality in European countries (Gay, Paris, Devaux, & de Looper, 2011; Nolte, & McKee, 2011; Velkova, Wolleswinkel-van den Bosch, & Mackenbach, 1997; Nolte, Scholz, Shkolnikov, & McKee, 2002), pointing out differences between countries in Central and Western Europe. The issue of avoidable deaths in accordance with the previous classification in relation to the situation in Poland was presented in two publications by Wróblewska (Wróblewska, 2012; Wróblewska, 2017), who stressed the importance of such an approach which can provide new information that cannot be obtained with the use of classic mortality rates. Recently Karanikolos and colleagues (Karanikolos, Mackenbach, Nolte, Stuckler, & McKee, 2018) investigated trends in amenable and other mortality in the EU since 2000 across 28 EU countries to check if the global financial crisis and its aftermath had an impact upon the performance of health systems in Europe.

Our study, availing the new agreed classifications, tries to quantify the contribution of avoidable causes of death to premature mortality and its dynamics in Poland and Central European countries – Czechia, Hungary, Lithuania and Slovenia, in comparison with Sweden serving as a benchmark country. The estimation of the share of preventable causes of death shows the magnitude of possible yield in health and life expectancy by strengthening and improving public health policy and the healthcare system.

Material and methods

Mortality and population data for all countries but Poland were extracted from the WHO Mortality data base for the years 1999–2017 when causes of death in the analysed countries were coded according to the 10th revision of the International Classification of Diseases – ICD-10 (WHO Health statistics and information systems, 2019). Data for Poland come from databases of Statistics Poland that are made available with some restrictions to the National Institute of Public Health – National Institute of Hygiene to conduct statutory analysis of health status of the Polish population.

The selection of causes of death considered avoidable was based on the above-mentioned OECD/Eurostat lists of preventable and treatable causes of death. In the analysis we considered three aggregated main groups of causes i.e. all avoidable, all preventable, all treatable, and the same categories for cancer and for diseases of the circulatory system (DCS). We also analysed mortality from preventable injuries and preventable alcohol-related causes.

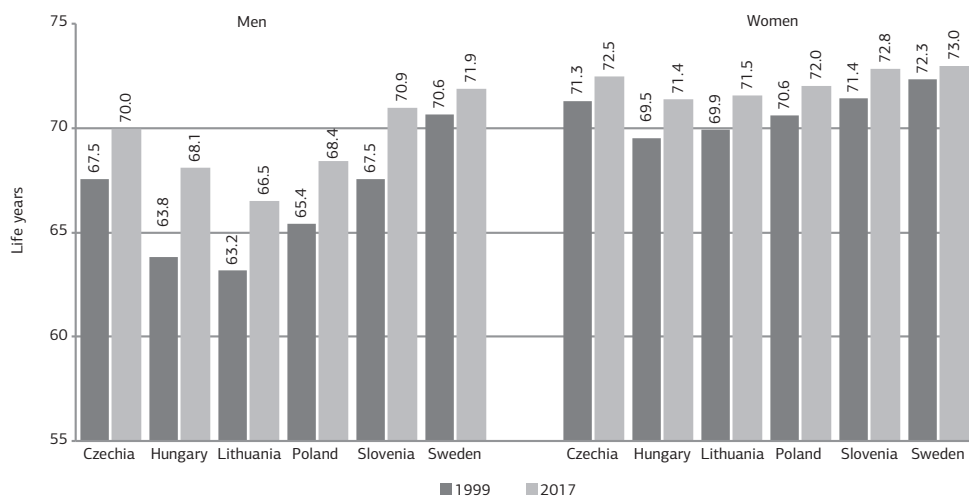
We used the direct method to standardise the mortality rates by age and as a standard we used the European Standard Population developed by Eurostat (Eurostat, 2013), which has the same age structure for men and women.

Since analysis of avoidable mortality is by definition constrained to the population below 75 years of age, the calculation of contribution of changes in mortality from avoidable causes to increase life expectancy is based on temporary life expectancy (partial life expectancy) between birth and age 75 [$e_{(0-75)}$]. For the calculation of life expectancy, we used the classic Chiang method (Chiang, 1984) and the decomposition of the life expectancy in accordance with the death causes and age was conducted with the Arriaga method (Arriaga, 1984). The analysis of time trends in the death rates and calculation of the Average Annual Percent Change (AAPC) for the overall trend and 95% confidence intervals (95% CI) were performed with joint point models and the joint point Regression Program (Version 4.8.0.1 April 22, 2020; National Cancer Institute, USA). The AAPC summarises the rates of change in age-adjusted rates that are not constant over a given time (in our case 1999–2017) but vary among different time partitions. The AAPC is the geometric mean of the annual changes from all the time partitions (Clegg, Hankey, Tiwari, Feuer, & Edwards, 2009).

Results

Unfavourable differences in the temporary life expectancy of men in Poland and other Central European countries compared to the inhabitants of Sweden, although clearly decreasing, are still visible, especially among men (Figure 1).

Figure 1. Temporary life expectancy of men and women in Czechia, Hungary, Lithuania, Poland, Slovenia, and Sweden, in 1999 and 2017



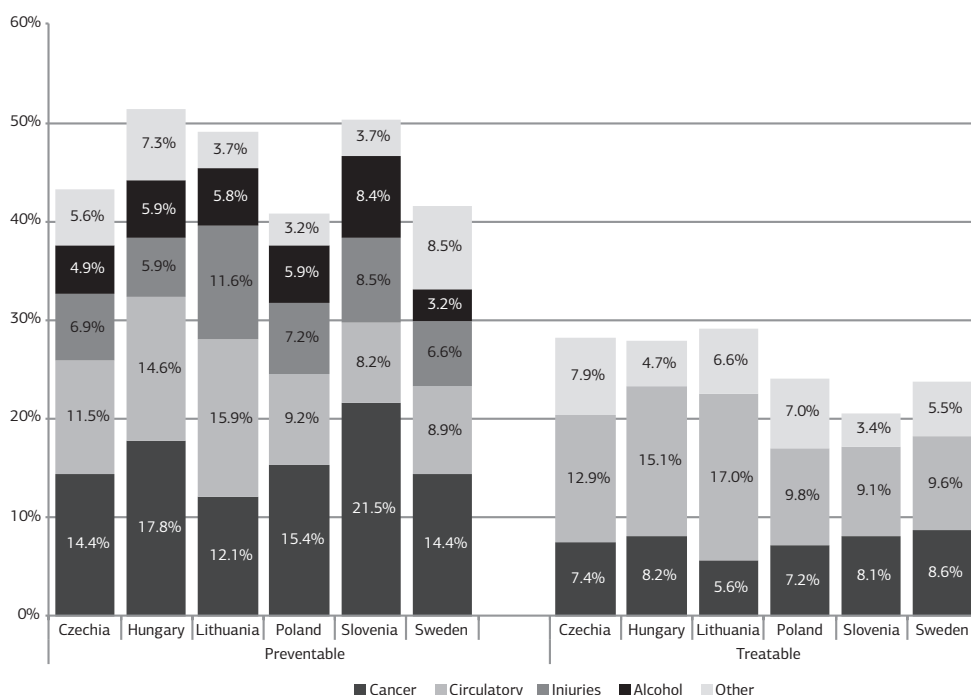
Source: own elaboration.

The increase in temporary life expectancy, resulting from the decline of premature mortality, was not uniform in the analysed countries. If we assume that the maximum possible increase can lead to life expectancy of 75 years, the greatest relative increase in life expectancy occurred in Slovenia – 40% and 33% of the ‘missing’ years of life for men and women, respectively. Among women, a relative increase in temporary life expectancy in all the countries was greater than in Sweden, and among men only in Lithuania it was smaller than in Sweden.

Mortality level and its changes

Deaths from avoidable causes account for as much as 79% and 78% of all death cases in the population below 75 years of age in Hungary and Lithuania, respectively, and about 65% in Poland and Sweden (Figure 2).

Figure 2. Percentage of avoidable deaths by subgroups of causes among all deaths below 75 years of age in Czechia, Hungary, Lithuania, Poland, Slovenia, and Sweden, 2017

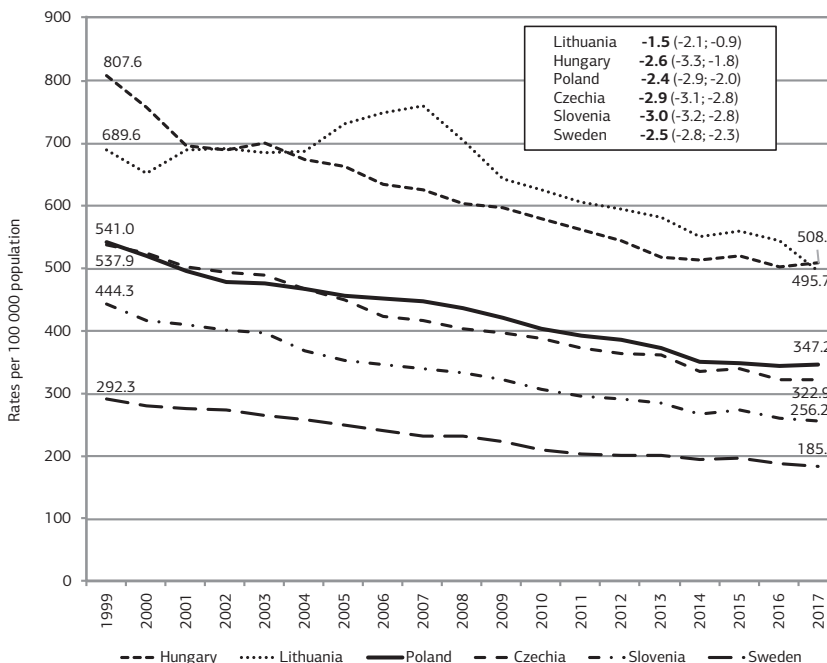


Source: own elaboration.

More than 60% of avoidable deaths is caused by preventable causes, in the range from 60.5% in Czechia to 71.0% in Slovenia. Diseases of the circulatory system contribute more to avoidable deaths than cancer in Czechia, Hungary and especially in Lithuania, while in Slovenia, Sweden, and Poland the situation is opposite. In Lithuania, some 42% of all premature deaths, i.e. below the age of 75, that could be avoided are caused by the DCS and about 23% are caused by cancer. In Slovenia the opposite is true.

In the period of 1999–2017, age-standardised mortality rates from avoidable causes show a clear decline at a similar pace (AAPC) in all the countries except Lithuania, where a decrease started only after 2007 (Figure 3). However, the decline in Lithuania during 2007–2017 was even faster than in other countries during 1999–2017 (–3.8, CI –5.2, –2.4). Overall, the mortality rates have the lowest values in Sweden and are the largest in Lithuania and Hungary – in 2017 2.7 times larger than in Sweden. In the entire analysed period, the avoidable rates for Poland were larger than those for Slovenia and since 2005 also larger than for Czechia.

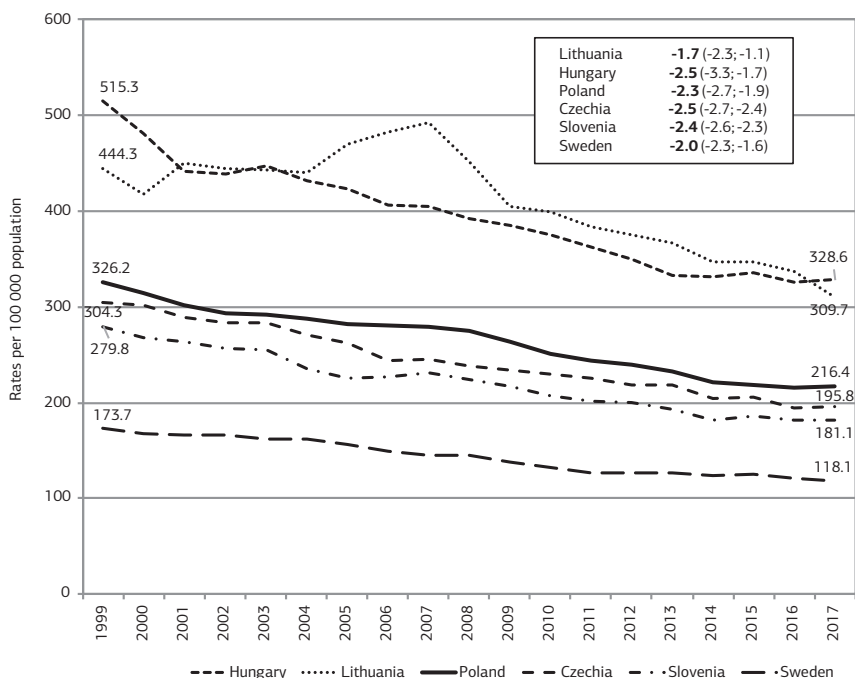
Figure 3. Mortality from avoidable causes of death in Czechia, Hungary, Lithuania, Poland, Slovenia, and Sweden, 1999–2018 – age-standardised rates and the Average Annual Percent Change with a 95% confidence interval (CI)



Source: own elaboration.

A similar situation occurs in the case of preventable and treatable mortality (Figures 4 and 5). As for the former group of causes, the AAPC in Lithuania was significantly smaller than in Czechia and Slovenia, while for the latter the pace of decline of the rates in Lithuania was significantly slower than in all other countries. The treatable mortality decline in Poland was significantly slower than in Czechia and Slovenia. As in the case of total avoidable mortality, also in the case of preventable and treatable deaths the decline in Lithuania during 2007–2017 was faster than in other countries during 1999–2017 (AAPC -4.2, CI -5.3, -3.1 and -2.9, CI -3.6, -2.1, for preventable and treatable mortality, respectively).

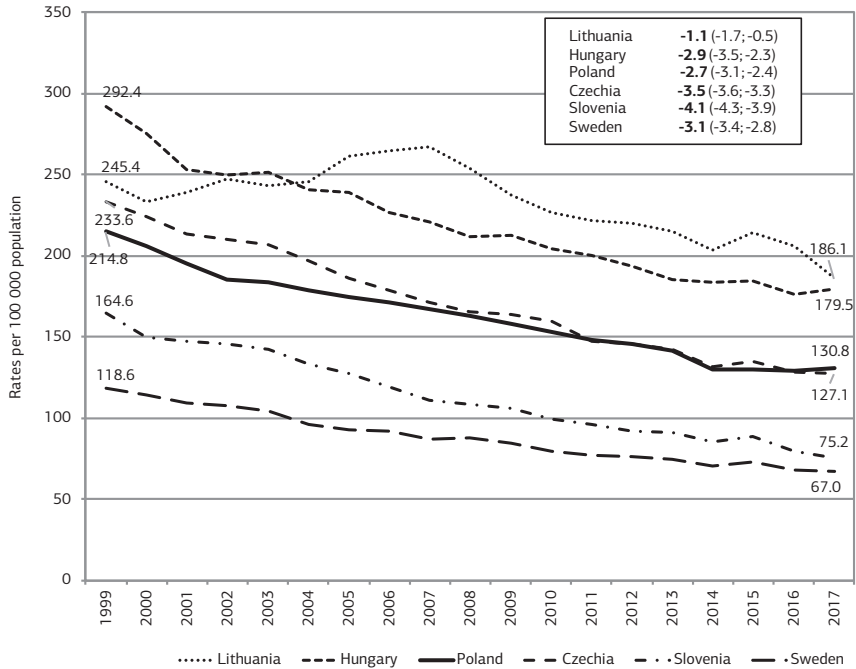
Figure 4. Mortality from preventable causes of death in Czechia, Hungary, Lithuania, Poland, Slovenia, and Sweden, 1999–2018 – age-standardised rates and the Average Annual Percent Change with a 95% CI



Source: own elaboration.

Mortality rates from not avoidable causes display different patterns than the rates from avoidable causes (Figure 6). First, in Poland they are much higher than in other countries and second, in all the countries their decline is much slower than the rates from avoidable causes. The only exception is Slovenia due to the fast decline of the rates that took place in 2003–2008.

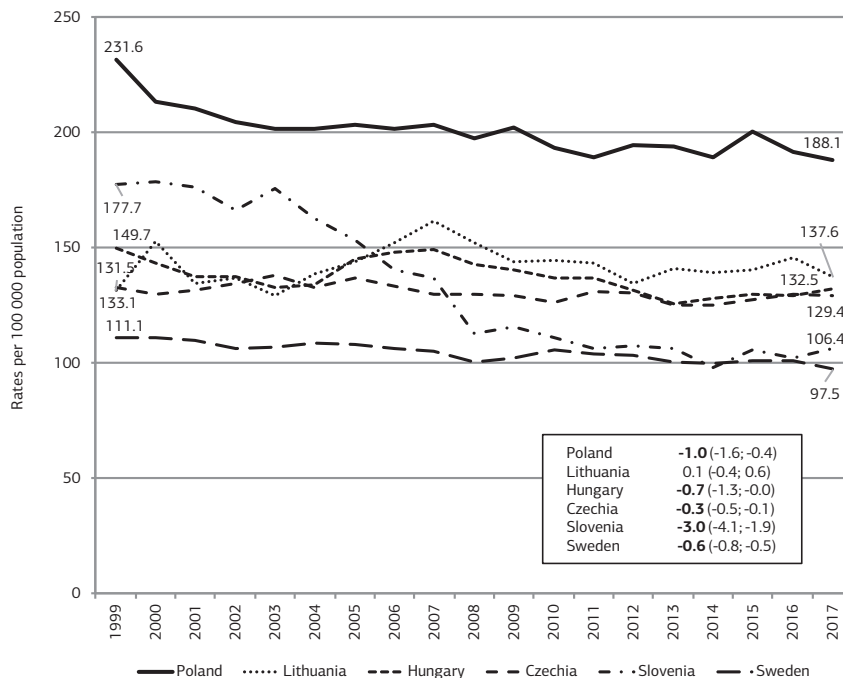
Figure 5. Mortality from treatable causes of death in Czechia, Hungary, Lithuania, Poland, Slovenia, and Sweden, 1999–2018 – age-standardised rates and the Average Annual Percent Change with a 95% CI



Source: own elaboration.

The mortality rates from avoidable causes in 1999 and 2017 and the pace of their decline among men and women in 1999–2017 are presented in Tables 1a and 1b. There are a few observations worth paying attention to. Death rates from preventable and treatable causes are higher in men than in women in all the countries. The decline in the rates in 1999–2017 was faster in the male population than among females for both groups of causes in Sweden and Slovenia. In Lithuania, on the other hand, the rates decreased faster among women than among men. Mortality from treatable causes was decreasing faster than from preventable causes among men and women in all the countries with the exception of men in Lithuania and Hungary. Even though all female mortality rates were lower than those among men, the proportion of deaths from treatable causes as well as not avoidable causes in all premature deaths (below 75 years of age) was greater in the female population.

Figure 6. Mortality from not avoidable causes of death in Czechia, Hungary, Lithuania, Poland, Slovenia, and Sweden, 1999–2018 – age-standardised rates and the Average Annual Percent Change with a 95% CI



Source: own elaboration.

Table 1a. Age-standardised death rates from avoidable and not avoidable causes among men in 1999 and 2017, their average annual percentage change (AAPC, 95% confidence interval CI), and their proportion in all deaths bellow age 75

Causes of death	Year / AAPC	Czechia	Hungary	Lithuania	Poland	Slovenia	Sweden
Avoidable	1999	767.8	1195.3	1086.7	806.8	650.6	386.7
	2017	456.8	730.5	798.6	502.8	358.9	224.0
	AAPC	-3.0	-2.7	-1.3	-2.6	-3.3	-2.9
	95% CI	-3.1; -2.8	-3.3; -2.1	-1.9; -0.7	-2.9; -2.3	-3.5; -3.1	-3.2; -2.6
	%1999	81.7	85.6	85.6	71.0	73.0	74.5
	%2017	73.2	80.6	80.1	65.3	72.5	66.2

Causes of death	Year / AAPC	Czechia	Hungary	Lithuania	Poland	Slovenia	Sweden
Preventable	1999	473.7	821.5	756.5	530.5	449.1	244.3
	2017	294.1	496.8	529.6	335.8	272.2	151.3
	AAPC	-2.7	-2.7	-1.6	-2.5	-2.9	-2.4
	95% CI	-2.9; -2.6	-3.4; -2.1	-2.2; -1.0	-2.9; -2.2	-3.1; -2.6	-2.9; -2.0
	%1999	50.4	58.8	59.6	46.7	50.4	47.0
	%2017	47.1	54.8	53.1	43.6	55.0	44.7
Treatable	1999	294.0	373.8	330.2	276.2	201.5	142.4
	2017	162.7	233.7	269.0	167.0	86.7	72.7
	AAPC	-3.3	-2.6	-0.7	-2.8	-4.5	-3.6
	95% CI	-3.5; -3.2	-3.4; -1.8	-1.3; -0.0	-3.4; -2.2	-4.7; -4.2	-3.9; -3.3
	%1999	31.3	26.8	26.0	24.3	22.6	27.4
	%2017	26.1	25.8	27.0	21.7	17.5	21.5
Not avoidable	1999	171.5	200.8	183.4	328.9	240.7	132.7
	2017	167.3	175.5	198.6	267.6	136.0	114.5
	AAPC	-0.3	-0.8	0.4	-1.0	-3.4	-0.7
	95% CI	-1.5; -0.1	-1.6; 0.1	-0.3; 1.0	-1.7; -0.3	-4.5; -2.2	-0.9; -0.6
	%1999	18.3	14.4	14.4	29.0	27.0	25.5
	%2017	26.8	19.4	19.9	34.7	27.5	33.8

Source: own elaboration.

Table 1b. Age-standardised death rates from avoidable and not avoidable causes among women in 1999 and 2017, their average annual percentage change (AAPC, 95% confidence interval CI), and their proportion in all deaths bellow age 75

Causes of death	Year / AAPC	Czechia	Hungary	Lithuania	Poland	Slovenia	Sweden
Avoidable	1999	348.9	507.3	399.1	327.3	278.5	205.8
	2017	203.7	329.6	273.9	214.4	159.6	146.3
	AAPC	-3.1	-2.6	-1.8	-2.4	-3.0	-1.9
	95% CI	-3.3; -2.9	-3.3; -1.9	-3.3; -0.2	-2.8; -1.9	-3.4; -2.6	-2.3; -1.5
	%1999	77.3	82.0	80.8	68.0	68.7	69.2
	%2017	68.0	77.0	74.7	64.1	66.8	64.5
Preventable	1999	163.1	275.4	211.6	160.4	141.3	108.2
	2017	107.7	192.4	145.9	113.5	94.6	84.9
	AAPC	-2.4	-2.2	-1.8	-2.0	-2.3	-1.3
	95% CI	-2.7; -2.0	-2.9; -1.5	-3.1; -0.5	-2.6; -1.1	-2.8; -1.7	-1.7; -0.9
	%1999	36.1	44.5	42.9	33.3	34.8	36.4
	%2017	36.0	44.9	39.8	34.0	39.6	37.4

Causes of death	Year / AAPC	Czechia	Hungary	Lithuania	Poland	Slovenia	Sweden
Treatable	1999	185.8	232.0	187.5	166.9	137.2	97.6
	2017	96.0	137.3	128.0	100.8	65.0	61.5
	AAPC	-3.8	-2.8	-1.8	-3.0	-3.9	-2.7
	95% CI	-4.0; -3.6	-3.2; -2.5	-2.3; -1.2	-3.4; -2.6	-4.2; -3.5	-2.9; -2.6
	%1999	41.2	37.5	38.0	34.6	33.8	32.8
	%2017	32.1	32.1	34.9	30.2	27.2	27.1
Not avoidable	1999	102.4	111.3	94.7	154.4	127.0	91.7
	2017	95.8	98.4	92.7	119.8	79.2	80.7
	AAPC	-0.5	-0.7	-0.4	-1.3	-2.7	-0.6
	95% CI	-0.8; -0.3	-1.3; -0.0	-0.8; -0.0	-1.8; -0.9	-3.9; -1.4	-0.8; -0.5
	%1999	22.7	18.0	19.2	32.0	31.3	30.8
	%2017	32.0	23.0	25.3	35.9	33.2	35.5

Source: own elaboration.

Table 2a. Age-standardised death rates from subgroups of avoidable causes among men in 1999 and 2017, their average annual percentage change (AAPC, 95% confidence interval CI)

Causes of death	Year / AAPC	Czechia	Hungary	Lithuania	Poland	Slovenia	Sweden
Avoidable cancer	1999	212.1	293.6	212.3	207.5	198.0	88.9
	2017	124.4	216.3	165.8	152.3	130.4	62.7
	AAPC	-3.0	-1.5	-1.1	-1.6	-2.1	-1.7
	95% CI	-3.4; -2.7	-1.7; -1.3	-1.3; -0.9	-1.9; -1.2	-2.4; -1.8	-2.1; -1.4
Preventable cancer	1999	158.2	234.4	178.1	175.6	160.8	66.5
	2017	94.3	167.4	138.7	121.4	109.2	46.2
	AAPC	-3.0	-1.7	-1.1	-1.9	-2.1	-1.8
	95% CI	-3.1; -2.8	-1.9; -1.5	-1.4; -0.9	-2.2; -1.6	-2.4; -1.8	-2.3; -1.4
Treatable cancer	1999	54.0	59.3	34.2	31.9	37.1	22.3
	2017	30.1	48.9	27.1	30.9	21.3	16.6
	AAPC	-3.4	-0.7	-1.1	-0.2	-2.0	-1.6
	95% CI	-4.0; -2.8	-1.0; -0.5	-1.8; -0.4	-0.5; 0.1	-2.8; -1.2	-1.9; -1.3
Avoidable circulatory	1999	374.3	497.3	448.0	352.7	212.9	182.0
	2017	162.9	284.6	348.7	160.5	94.8	72.9
	AAPC	-4.5	-3.1	-1.0	-4.3	-4.5	-4.9
	95% CI	-4.6; -4.3	-4.0; -2.2	-1.6; -0.5	-4.8; -3.8	-5.0; -4.0	-5.2; -4.6
Preventable circulatory	1999	178.3	242.3	217.4	170.0	102.6	88.4
	2017	77.9	140.6	169.7	78.1	45.4	35.3
	AAPC	-4.4	-3.0	-1.0	-4.3	-4.5	-4.9
	95% CI	-4.6; -4.3	-3.9; -2.2	-1.5; -0.4	-4.9; -3.7	-5.1; -4.0	-5.2; -4.6

Causes of death	Year / AAPC	Czechia	Hungary	Lithuania	Poland	Slovenia	Sweden
Treatable circulatory	1999	196.0	255.0	230.6	182.7	110.3	93.6
	2017	85.0	144.1	179.0	82.4	49.3	37.6
	AAPC	-4.5	-3.0	-1.0	-4.4	-4.5	-4.8
	95% CI	-4.6; -4.3	-3.6; -2.4	-1.6; -0.5	-4.9; -3.8	-5.0; -4.0	-5.2; -4.5
Preventable injuries	1999	79.2	130.5	248.8	103.8	105.7	39.4
	2017	51.9	63.9	125.5	62.8	49.2	29.1
	AAPC	-2.5	-3.7	-3.4	-2.7	-4.5	-1.6
	95% CI	-3.1; -1.9	-4.7; -2.7	-4.2; -2.7	-3.1; -1.3	-5.0; -4.1	-2.6; -0.5
Preventable alcohol-related	1999	31.6	154.0	55.8	42.6	34.7	19.6
	2017	33.8	62.3	57.5	48.8	49.6	13.2
	AAPC	0.3	-4.9	0.8	0.7	1.1	-2.1
	95% CI	-0.7; 1.3	-6.1; -3.7	-1.3; 3.1	-0.6; 2.1	-3.3; 5.7	-3.3; -0.8

Source: own elaboration.

Table 2b. Age-standardised death rates from subgroups of avoidable causes among women in 1999 and 2017, their average annual percentage change (AAPC, 95% confidence interval CI)

Cause of deaths	Year / AAPC	Czechia	Hungary	Lithuania	Poland	Slovenia	Sweden
Avoidable cancer	1999	107.5	137.2	95.2	91.1	99.5	79.1
	2017	76.1	125.7	75.5	95.5	83.7	67.8
	AAPC	-2.0	-0.3	-1.1	0.1	-0.9	-1.0
	95% CI	-2.3; -1.8	-0.7; 0.1	-1.4; -0.8	0.0; 0.3	-1.2; -0.6	-1.3; -0.7
Preventable cancer	1999	42.4	62.4	36.6	41.0	41.1	35.2
	2017	39.1	70.0	32.9	49.1	46.8	35.1
	AAPC	-0.6	0.7	-0.4	0.9	0.7	-0.1
	95% CI	-0.8; -0.3	0.0; 1.3	-1.2; 0.3	0.8; 1.1	0.1; 1.2	-0.7; 0.4
Treatable cancer	1999	65.1	74.8	58.5	50.1	58.4	43.8
	2017	37.0	55.7	42.7	46.5	36.8	32.7
	AAPC	-2.9	-1.5	-1.5	-0.6	-2.3	-1.8
	95% CI	-3.9; -2.0	-1.9; -1.2	-2.0; -1.0	-0.8; -0.3	-2.7; -1.8	-2.1; -1.4
Avoidable circulatory	1999	174.1	233.6	188.9	156.9	93.6	72.2
	2017	63.4	116.7	117.0	59.1	34.3	31.9
	AAPC	-5.6	-3.8	-2.3	-5.3	-5.0	-4.6
	95% CI	-5.9; -5.3	-4.3; -3.4	-2.7; -1.9	-5.9; -4.7	-5.8; -4.2	-5.1; -4.0
Preventable circulatory	1999	79.6	111.7	87.8	74.0	44.2	33.5
	2017	28.8	57.0	56.3	28.3	15.7	15.0
	AAPC	-5.6	-3.6	-2.2	-5.2	-5.1	-4.6
	95% CI	-5.9; -5.3	-4.2; -3.0	-2.6; -1.7	-5.8; -4.6	-5.9; -4.2	-5.1; -4.0

Cause of deaths	Year / AAPC	Czechia	Hungary	Lithuania	Poland	Slovenia	Sweden
Treatable circulatory	1999	94.5	122.0	101.2	82.9	49.4	38.6
	2017	34.6	59.7	60.6	30.8	18.6	16.9
	AAPC	-5.6	-4.0	-2.4	-5.6	-4.9	-4.6
	95% CI	-5.9; -5.3	-4.4; -3.5	-2.8; -2.0	-5.8; -5.3	-5.8; -4.1	-5.2; -4.0
Preventable injuries	1999	21.1	32.5	51.7	21.8	29.3	12.6
	2017	12.4	15.2	26.7	11.7	12.9	9.0
	AAPC	-3.4	-4.3	-3.6	-3.4	-4.5	-2.1
	95% CI	-3.8; -3.0	-4.6; -4.1	-4.6; -2.7	-3.8; -3.0	-5.2; -3.9	-3.1; -1.2
Preventable alcohol-related	1999	9.3	42.1	20.9	9.8	10.9	5.7
	2017	11.5	16.5	17.7	12.7	10.1	5.3
	AAPC	0.9	-4.9	1.0	1.5	-1.0	-1.1
	95% CI	0.2; 1.6	-6.6; -3.2	-2.0; 4.0	-0.9; 3.9	-3.2; 1.3	-1.8; -0.5

Source: own elaboration.

Among men, mortality from avoidable cancer causes is lower than mortality from avoidable DCS in all the countries but Slovenia (Table 2a and 2b). The opposite is true for women, among whom mortality from avoidable cancer causes is higher than mortality from avoidable DCS in all the countries but Lithuania. Death rates from preventable cancer causes are higher than from treatable cancer in all the populations but women in Lithuania and are higher than death rates from preventable DCS in all the populations but men and women in Lithuania. On the other hand, death rates from treatable cancer are lower than from treatable DCS among men in the all countries and women in Lithuania and Hungary.

In 1999–2017, the average rate of mortality decline for preventable cancer was greater among men than among women, while for treatable cancer the sex-related differences were much smaller and in favour of women with the exception of Czechia's residents. As for preventable and treatable death from the DCS, its decrease was faster among women than men in all the countries except Sweden.

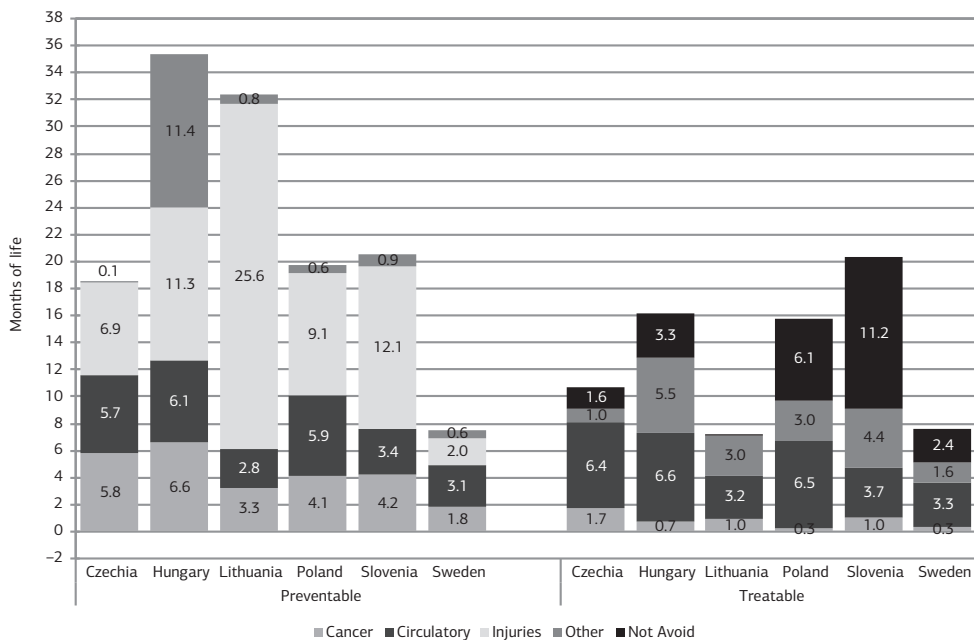
It should be noted that mortality from alcohol-related diseases of the Hungarian population decreased significantly in the analysed period., In the case of Lithuanian residents, on the other hand, the AAPC index showed a slight change in the death rate throughout the period, however, it resulted from opposite trends in the initial years, when the mortality rate increased until 2007 and after 2007, when the mortality rates had a clear, significant downward trend and the average decline rate was -6.7% for men and -6.8% for women.

Improvements in mortality from causes that could be avoided through prevention or treatment made substantial positive contributions to the overall change in life

expectancy in all the countries. Among men, the most important was declining mortality from preventable causes, especially injuries, a slightly smaller contribution was due to the decline in preventable cancer and the DCS (Figure 7a). Among women, the decrease in mortality from causes amenable to medical intervention contributed the most to the increase in life expectancy in four countries and only in Hungary and Lithuania the reduction in the number of death cases from preventable causes played a larger role (Figure 7b). In Hungary, a large role was played by the reduction in mortality from injuries and from alcohol-related causes of death and in Lithuania, the reduction of mortality from injuries played an essential role.

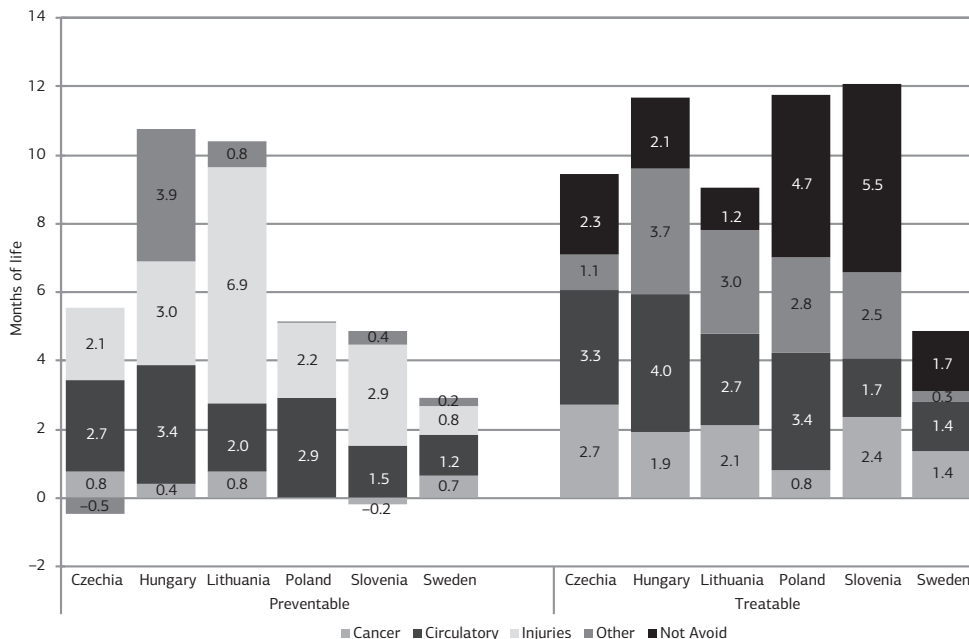
The declining mortality from avoidable DCS contributed to more months of life than the change in avoidable mortality from cancer in both men and women. The contribution of the decrease in mortality from treatable DCS to life expectancy is larger than the contribution from preventable DCS causes in all the populations. However, the situation is different with cancer mortality. Among men, the role of the decrease in mortality from preventable cancer is larger than that of the reduction in treatable cancer mortality, while among women the reverse is true. In Poland and Slovenia, female preventable cancer mortality did not contribute to a life expectancy increase.

Figure 7a. Cause-specific contributions to change in men's temporary life expectancy in Czechia, Hungary, Lithuania, Poland, Slovenia, and Sweden, 1999–2017



Source: own elaboration.

Figure 7b. Cause-specific contributions to change in women’s temporary life expectancy in Czechia, Hungary, Lithuania, Poland, Slovenia, and Sweden, 1999–2017

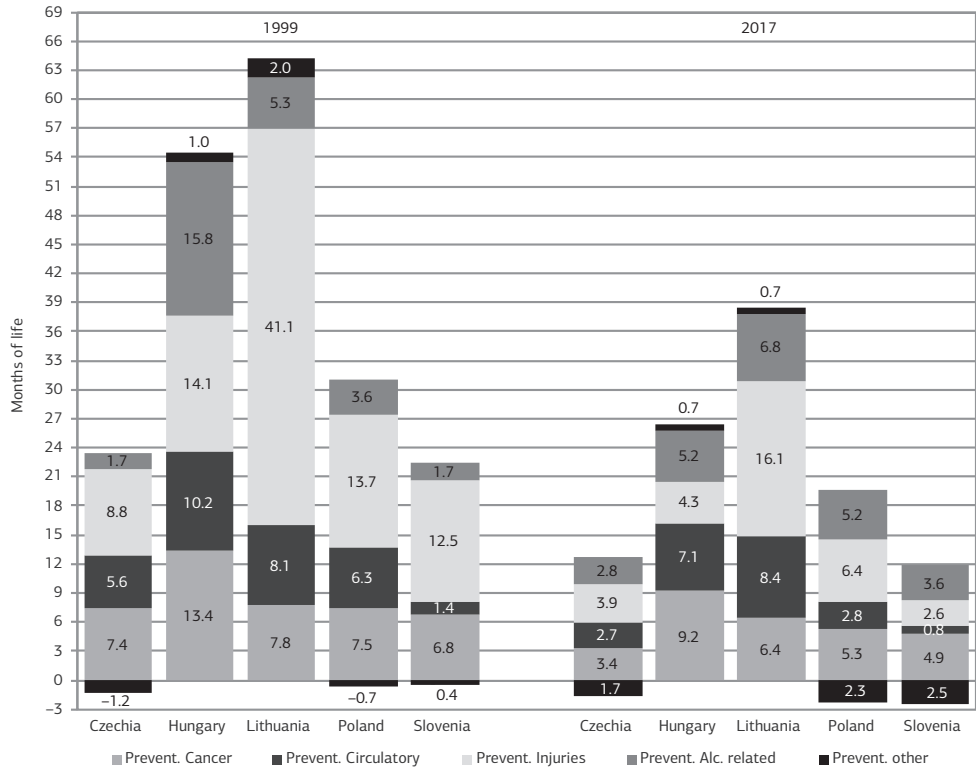


Source: own elaboration.

Differences in temporary life expectancy $e_{(0-75)}$ between the analysed Central European countries and Sweden were much smaller in 2017 than in 1999, due to the reduction of the gap in mortality from avoidable causes (Figures 8a, 8b, 9a and 9b). In four countries apart from Slovenia and Poland, the difference in mortality due to not avoidable causes in 2017 was similar to that in 1999. Among men and, to a lesser extent, among women, mortality from preventable causes is much more detrimental than mortality from causes that can be effectively treated. This is especially true in Lithuania and Hungary. It is worth noting that while in 1999 higher mortality from avoidable deaths due to the DCS contributed more than due to cancer to shorter life expectancy of men and women in Poland than in Sweden, in 2017 cancer played a more negative role among men because of the unfavourable situation in preventable mortality.

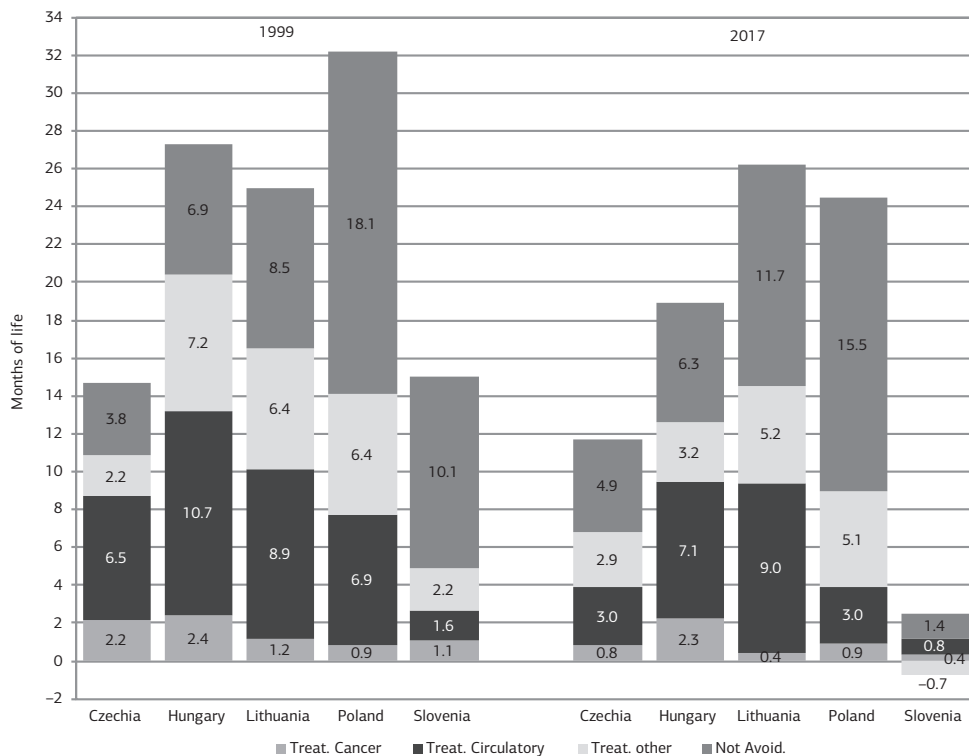
Preventable cancer diseases contribute more to the shorter life span of 0–75 years among men in Central Europe compared to those in Sweden than preventable DCS. The higher mortality due to injuries, especially in Lithuania, as well as alcohol-related diseases also play a noticeable negative role.

Figure 8a. Preventable causes specific contribution to the difference in men's temporary life expectancy in Czechia, Hungary, Lithuania, Poland, and Slovenia in relation to Sweden in 1999 and 2017



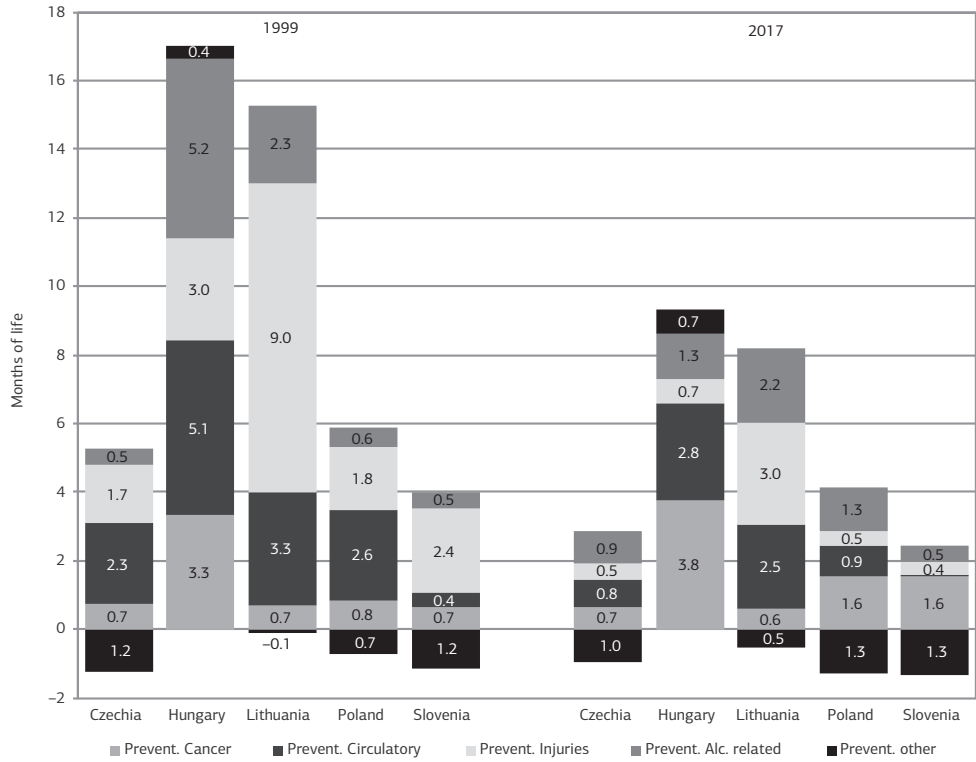
Source: own elaboration.

Figure 8b. Treatable causes specific contribution to the difference in men’s temporary life expectancy in Czechia, Hungary, Lithuania, Poland, and Slovenia in relation to Sweden in 1999 and 2017



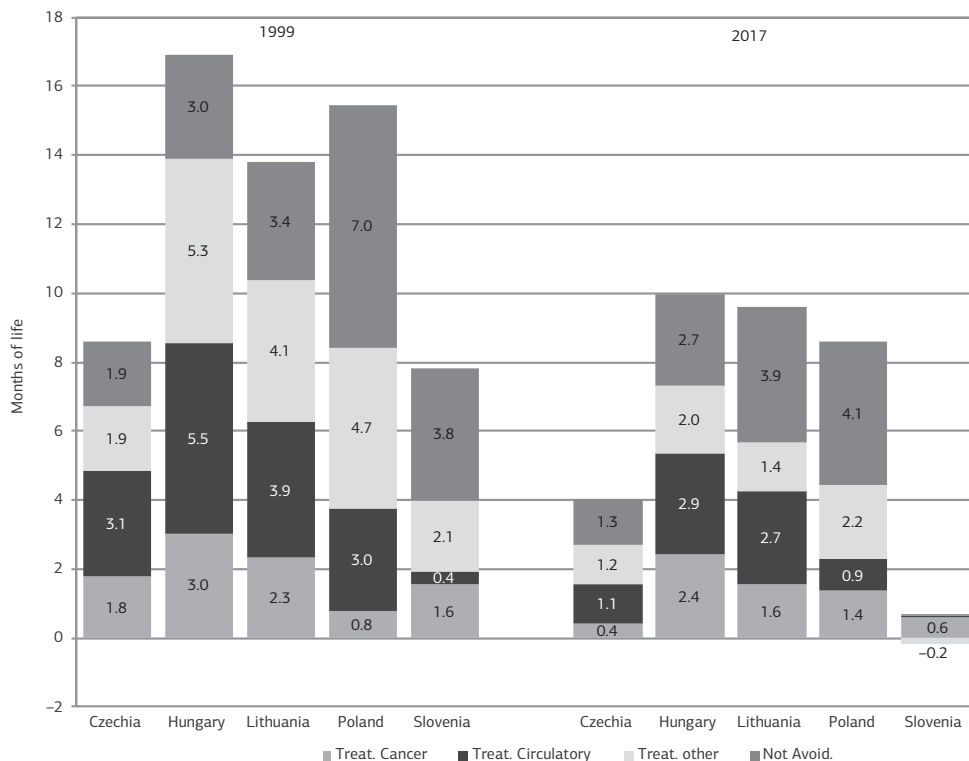
Source: own elaboration.

Figure 9a. Preventable causes specific contribution to the difference in women's temporary life expectancy in Czechia, Hungary, Lithuania, Poland, and Slovenia in relation to Sweden in 1999 and 2017



Source: own elaboration.

Figure 9b. Treatable causes specific contribution to the difference in women's temporary life expectancy in Czechia, Hungary, Lithuania, Poland, and Slovenia in relation to Sweden in 1999 and 2017^{a)}



^{a)} Due to very narrow segments there is insufficient distinction for Slovenia: treatable circulatory causes 0.1 month of life and not avoidable causes 0.1 month of life in 2017

Source: own elaboration.

Conclusion

Improving population health is the primary goal of healthcare systems, therefore, a more precise quantification of healthcare systems performance and contribution to the health of the population is highly desirable. As emphasised by Nolte and McKee (Nolte & McKee, 2003), the concept of amenable mortality, in addition to its attractive conceptual design, provides new information that is not directly reflected in general mortality indicators traditionally used to measure the outcomes of healthcare systems. Korda & Butler (2006), concluding their analysis of trends in avoidable mortality in Australia and comparisons with Western Europe, wrote that the trends

in avoidable mortality in Australia suggested that the Australian healthcare system had been effective in improving population health and Australia's experience compared favourably with that of Europe.

In our study, availing the new, recently agreed by the OECD and Eurostat lists of preventable and treatable causes of death, we tried to quantify the contribution of avoidable causes to premature mortality and its dynamics in Poland and Central European countries – Czechia, Hungary, Lithuania, and Slovenia, in comparison with Sweden serving as a benchmark country in 1999–2017. Publication of the lists agreed by the experts of the OECD and Eurostat gives a new push to comparative analyses of avoidable mortality in the countries and, therefore, assessment of the performance of their healthcare systems. Using different lists may lead to not identical conclusions, as has been shown by Gay and colleagues (Gay et al 2011), so the comparison of the results obtained with the use of the new lists may not be advisable.

Higher premature mortality among men than women, especially strongly marked in Central European countries, is a well-known and documented phenomenon (for example European Commission, 2011; WHO, 2018) yet, it still needs more attention (Baker, Dworkin, Tong, Banks, Shande, & Yameyf, 2014). Our results show that mortality from premature avoidable causes is higher among men than women and the excess of male mortality did not decline in Czechia and Lithuania in 1999–2017 and decreased relatively little in the other countries.

Analysing the decline of avoidable mortality in Europe in 1955–1994 (however, without then socialist countries) Simonato and colleagues (Simonato, Ballard, Bellini, & Winkelmann, 1998) found that the decline in mortality from causes amenable to medical treatment had the most pronounced impact, while much smaller was the impact of the decline in preventable causes. They emphasised that a further reduction in avoidable mortality could be achieved through implementation of primary and secondary prevention. We also have observed that the pace of the decline in death rates from treatable causes was greater than the death rates from preventable causes in all the analysed countries but Lithuania. One may conclude, therefore, that the two-decade old plea for prevention by Simonato and colleagues is still timely and very relevant. Wróblewska (2012) drew a similar conclusion while analysing the situation in Poland in 1999–2008. This problem is particularly pressing in the case of cancer. Among men, preventable cancer mortality is much higher than mortality due to treatable cancer, but their pace of decline is quite similar. Among women, both groups are of similar magnitude, however, there was no significant progress of improvement in female preventable cancer mortality in the analysed countries (including Sweden) except Czechia. In fact, in Poland, Hungary, and Slovenia the rates had a significant upward trend. Finally, it is worth emphasising that among men

and, to a lesser extent, among women, mortality from preventable causes is more responsible for shorter temporary life expectancy in Czechia, Hungary, Lithuania, Poland, and Slovenia than in Sweden, as compared to mortality from causes that can be effectively treated. Finally, it is worth emphasising that mortality from preventable causes is more responsible than mortality from causes that can be effectively treated for the shorter temporary life expectancy of men, and, to a lesser extent, of women, in the analysed Central European countries than among the inhabitants of Sweden.

While amenable mortality may be a relevant indicator, it has several limitations and one of those important is related to the quality and comparability of data. Different practices in assigning ICD codes as an underlying cause of death across countries and across time may reduce cross-country comparability. This problem, however, is present in any study using mortality data to make comparisons over time or across countries. From the Polish perspective, one of the important issues is the use of so called 'garbage codes' for coding deaths from diseases of the circulatory system. The frequent use of the heart failure (ICD-10 I50) as the underlying cause leads to underestimation of ischemic heart disease as a cause of death in Poland, which equally reduces the rates of preventable and treatable mortality equally split between the two categories. In 2016–2017 age standardised death rates from heart failure among men below 75 years of age (per 100,000 population) were 52.4 in Poland, while 20.1, 10.3, 0.8, 0.2, 2.8 and 2.6 in Czechia, Hungary, Lithuania, Slovenia, and Sweden, respectively. Deaths from ill-defined conditions (ICD-10 R96-R99) could exert a similar influence (among Polish men 77.6, while among men in Czechia, Hungary, Lithuania, Slovenia, and Sweden 12.4, 1.4, 27.3, 19.1 and 11.2, respectively).

Some limitation related to the concept of treatable mortality results, among others, from the fact that mortality from treatable causes depends on the prevalence of disease and its case fatality. Therefore, it is possible that the observed differences between the countries' treatable mortality rates or their changes over time are affected by the differences or changes in disease prevalence rather than its treatment (see for example Gierlotka et al., 2015).

Considering various weaknesses and limitations of the concept of avoidable deaths, the obtained results of the analysis should be interpreted with caution. Nevertheless, several of our observations may be helpful in assessing the problem of premature mortality and the operation of the healthcare system in Poland and other analysed countries. Undoubtedly, the healthcare system in Poland can still do a lot to reduce the premature mortality of Polish residents and extend their life expectancy to diminish the distance in relation to many other European countries. Reduction in the excess male mortality in relation to women is also very much expected and needed.

References

- [1] Arriaga, E.E. (1984). Measuring and Explaining the Change in Life Expectancies. *Demography*, 21(1), 83–96.
- [2] Baker, P., Dworkin, S.L., Tong, S., Banks, I., Shande, T., & Yameyf, G. (2014). The men's health gap: men must be included in the global health equity agenda. *Bull World Health Organ* 92, 618–620.
- [3] Chiang, C.L. (1984). *The Life Table and its Applications*. Malabar, Florida: Robert E. Krieger Publishing Company, Inc.
- [4] Clegg, L.X., Hankey, B.F., Tiwari, R., Feuer, E.J., & Edwards, B.K. (2009). Estimating average annual percent change in trend analysis. *Statist. Med.*, 28, 3670–3682.
- [5] European Commission (2011). *The State of Men's Health in Europe: Extended Report 2011*, Luxembourg. Retrieved from: https://ec.europa.eu/health/sites/health/files/state/docs/men_health_extended_en.pdf (accessed: November 14, 2015).
- [6] Eurostat (2013). *Revision of the European Standard Population – Report of Eurostat's task force*. Methodologies and Working papers, 2013 edition. Eurostat, European Commission. Luxembourg: Publications Office of the European Union.
- [7] Eurostat (2014). *Amenable and preventable deaths statistics*. Retrieved from: http://ec.europa.eu/eurostat/statisticsexplained/index.php/Amenable_and_preventable_deaths_statistics (accessed: January 15, 2017).
- [8] Gay, J., Paris, V., Devaux, M., & de Looper, M. (2011). Mortality Amenable to Health Care in 31 OECD Countries: Estimates and Methodological Issues. *OECD Health Working Papers*, 55, OECD Publishing.
- [9] Gierlotka, M., Zdrojewski, T., Wojtyniak, B., Poloński, L., Stokwiszewski, J., Gąsior, M., Kozierekiewicz, A., Kalarus, Z., Wierucki, Ł., Chlebus, K., Zembala, M., Wysocki, M., & Opolski, G. (2015). Incidence, treatment, in-hospital and one-year outcomes of acute myocardial infarction in Poland in 2009–2012 – nationwide database AMI-PL. *Kardiologia Polska*, 73(3), 93–109.
- [10] Karanikolos, M., Mackenbach, J.P., Nolte, E., Stuckler, D., & McKee, M. (2018). Amenable mortality in the EU – has the crisis changed its course? *The European Journal of Public Health*, 28(5), 864–869.
- [11] Korda, R., & Butler, J.R.G. (2006). Effect of healthcare on mortality: Trends in avoidable mortality in Australia and comparisons with Western Europe. *Public Health*, 120(2), 95–105.
- [12] Nolte, E., Scholz, R., Shkolnikov, V., & McKee, M. (2002). The Contribution of Medical Care to Changing Life Expectancy in Germany and Poland. *Social Science and Medicine*, 55, 1905–1921.
- [13] Nolte, E., & McKee, M. (2004). *Does Health Care Save Lives? Avoidable Mortality Revisited*. London: Nuffield Trust.

- [14] Nolte, E., & McKee, M. (2008). Measuring the Health of Nations: Updating an Earlier Analysis, *Health Affairs*, 27(1), 58–71.
- [15] Nolte, E., & McKee, M. (2011). Variations in amenable mortality—Trends in 16 high-income nations. *Health Policy* 103(1), 47–52.
- [16] OECD, Eurostat (2019, November). *Avoidable mortality: OECD/Eurostat lists of preventable and treatable causes of death* (November 2019 version). Retrieved from: <http://www.oecd.org/health/health-systems/Avoidable-mortality-2019-Joint-OECD-Eurostat-List-preventable-treatable-causes-of-death.pdf> (accessed: April 24, 2020).
- [17] ONS (2011). *Definition of avoidable mortality*. Retrieved from: <http://www.ons.gov.uk/ons/about-ons/getinvolved/consultations/archived-consultations/2011/definitions-of-avoidable-mortality/definitionof-avoidable-mortality.pdf> (accessed: May 9, 2016).
- [18] Rutstein, D., Berenberg, W., Chalmers, T.C., Child, C.G., Fishman, A.P., & Perrin, E.B., (1976). Measuring the Quality of Medical Care. A Clinical Method, *New England Journal of Medicine*, 294(11), 582–588.
- [19] Simonato, L., Ballard, T., Bellini, P., & Winkelmann, R. (1998). Avoidable mortality in Europe 1955–1994: a plea for prevention. *J Epidemiol Community Health*, 52, 624–630.
- [20] Velkova, A., Wolleswinkel-van den Bosch, J.H., & Mackenbach, J.P. (1997). The east-west life expectancy gap: Differences in mortality from conditions amenable to medical intervention. *Int J Epidemiol*, 26, 75–84.
- [21] WHO Regional Office for Europe (2018). *The health and well-being of men in the WHO European Region: better health through a gender approach*. Retrieved from:
- [22] <https://www.euro.who.int/en/health-topics/health-determinants/gender/publications/2018/the-health-and-well-being-of-men-in-the-who-european-region-better-health-through-a-gender-approach-2018> (accessed: April 28, 2019).
- [23] WHO (2019). WHO Health statistics and information systems. Retrieved from: https://www.who.int/healthinfo/statistics/mortality_rawdata/en/ (accessed: May 7, 2020).
- [24] Wróblewska, W. (2012). Zgony możliwe do uniknięcia – opis koncepcji oraz wyniki analizy dla Polski. *Studia Demograficzne*, 1(161), 129–151.
- [25] Wróblewska, W. (2017). Territorial variation in mortality from causes amenable to medical care in Poland. *Ann Agric Environ Med.*, 24(3), 489–495.