

TRENDS IN PREMATURE CEREBROVASCULAR DISEASE MORTALITY IN THE POLISH POPULATION AGED 25-64 YEARS, 2000-2016*

Alicja Cicha-Mikołajczyk¹, Aleksandra Piwońska¹, Witold Śmigieński^{1,2}, Wojciech Drygas^{1,3}

¹Department of Epidemiology, Cardiovascular Disease Prevention and Health Promotion, National Institute of Cardiology, Alpejska 42, 04-628 Warsaw, Poland

²Department of Demography, University of Lodz, Rewolucji 1905 r. 41, 90-214 Lodz, Poland

³Department of Social and Preventive Medicine, Faculty of Health Sciences, Medical University of Lodz, Hallera 1, 90-001 Lodz, Poland

Alicja Cicha-Mikołajczyk – <https://orcid.org/0000-0002-5870-6087>; Aleksandra Piwońska – <https://orcid.org/0000-0003-1889-0569>; Witold Śmigieński – <https://orcid.org/0000-0002-5239-2988>; Wojciech Drygas – <https://orcid.org/0000-0002-4351-6459>;

ABSTRACT

Background. Many scientific reports have shown a decrease in total cerebrovascular disease (CeVD) mortality over the past few decades, but too little attention has been paid to premature mortality. CeVD accounted for 22.5% and 17.8% of premature cardiovascular disease deaths in Poland, in 2000 and 2016, respectively.

Objective. The aim of the study was to analyse premature CeVD mortality in the Polish population in the recent years, the dynamics of its changes and the potential factors that may have contributed to the decline in mortality. The main goal of the study was to overview the levels and trends in premature CeVD mortality with an emphasis on haemorrhagic, ischaemic and unspecified (not specified as haemorrhagic or ischaemic) stroke.

Material and methods. The analysis was based on a database of the Central Statistical Office of Poland and included data from 2000-2016 on premature cerebrovascular deaths occurring between 25 and 64 years of age (N=104,786). CeVD and haemorrhagic, ischaemic or unspecified stroke were coded with ICD-10 codes I60-I69, I61-I62, I63 and I64, respectively. The analysis included assessment of CeVD deaths distribution and evaluation of age-specific mortality rates in 10-year age groups and age-standardised mortality rates (SMR) in the age group 25-64 years, separately for men and women. Trends in SMRs have been studied in the period 2000-2016.

Results. The number of CeVD deaths decreased by 32.8% in men and 48.8% in women. There was a two-fold decline in CeVD mortality: from 59 to 29 male and from 30 to 12 female per 100,000. In addition, a 2-year increase in the median age of CeVD death was observed (Men: 56.4 to 58.4 years, Women: 56.4 to 58.7 years, $p < 0.001$). A statistically significant decline in mortality (per 100,000) was also noticed for haemorrhagic stroke (Men: 18.7 to 10.4; Women: 9.6 to 3.8), ischaemic stroke (Men: 11.8 to 8.4; Women: 4.7 to 3.0) and unspecified stroke (Men: 19.7 to 3.5; Women: 9.1 to 1.3).

Conclusions. A substantial decline in premature CeVD mortality was observed in the period 2000-2016. Additionally, the number of deaths that could not be classified as haemorrhagic or ischaemic stroke death decreased significantly. The increasingly widespread use of new post-stroke therapies and their availability make it possible to expect a further decrease in CeVD mortality. However, the necessary actions should be taken to compensate for the disparities in CeVD mortality between men and women.

Key words: *cerebrovascular disease, stroke, premature mortality, Poland, mortality trends*

STRESZCZENIE

Wprowadzenie. W wielu doniesieniach naukowych pokazano spadek umieralności ogólnej z powodu chorób naczyń mózgowych (ChNM) w ciągu ostatnich kilku dekad, ale zbyt mało uwagi poświęcono przedwczesnej umieralności. ChNM odpowiadały za 22.5% i 17.8% przedwczesnych zgonów z powodu chorób układu krążenia w Polsce, odpowiednio w 2000 i 2016 roku.

Cel pracy. Niniejsza praca miała na celu analizę przedwczesnej umieralności z powodu ChNM w populacji polskiej w ostatnich latach, dynamikę jej zmian oraz potencjalne czynniki, które mogły przyczynić się do spadku umieralności. Głównym celem pracy był przegląd poziomów i trendów zmian przedwczesnej umieralności z powodu ChNM

* The part of this work was supported by the Institute of Cardiology grant no. 2.18/I/16 titled "Monitoring and analysis of official statistics data on cardiovascular mortality and morbidity in Poland in 2013-2016".

Corresponding author: Alicja Cicha-Mikołajczyk, National Institute of Cardiology, Department of Epidemiology, Cardiovascular Disease Prevention and Health Promotion, Alpejska 42, Warsaw, 04-628, Poland, Tel: +48 22 8125586, E-mail: acicha@ikard.pl

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ze szczególnym uwzględnieniem udarów krwotocznego, niedokrwiennego i nieokreślonego jako krwotoczny lub niedokrwienny.

Material i metody. Analiza obejmowała dane oficjalnej statystyki państwowej z lat 2000-2016 dotyczące przedwczesnych zgonów z powodu ChNM pojawiających się pomiędzy 25 a 64 r.ż. (N=104,786). Choroby naczyń mózgowych oraz udary krwotoczny, niedokrwienny i nieokreślony jako krwotoczny lub niedokrwienny były kodowane zgodnie z ICD-10 odpowiednio jako I60-I69, I61-I62, I63 i I64. Analiza obejmowała ocenę rozkładu liczby zgonów spowodowanych ChNM, obliczenia współczynników umieralności w 10-letnich grupach wieku i standaryzowanych współczynników umieralności (SMR) w grupie wieku 25-64 lata, osobno dla mężczyzn i kobiet. Badano też trendy zmian standaryzowanych współczynników umieralności w okresie 2000-2016.

Wyniki. Liczba zgonów z powodu ChNM obniżyła się o 32.8% u mężczyzn i o 48.8% u kobiet. Zaobserwowano 2-krotne zmniejszenie się umieralności z powodu ChNM: z 59 do 29 mężczyzn i z 30 do 12 kobiet na 100,000. Dodatkowo zaobserwowano wzrost mediany wieku zgonu z powodu ChNM o 2 lata (mężczyźni: z 56.4 do 58.4 lat, kobiety: z 56.4 do 58.7 lat, $p < 0.001$). Statystycznie istotny spadek umieralności (na 100,000) został również odnotowany dla udaru krwotocznego (mężczyźni: 18.7 do 10.4; kobiety: 9.6 do 3.8), udaru niedokrwiennego (mężczyźni: 11.8 do 8.4; kobiety: 4.7 do 3.0) oraz udaru o nieokreślonej jako krwotoczna lub niedokrwienna etiologii (mężczyźni: 19.7 do 3.5; kobiety: 9.1 do 1.3).

Wnioski. Znaczący spadek przedwczesnej umieralności z powodu ChNM został zaobserwowany w okresie 2000-2016. Ponadto istotnie zmniejszyła się liczba zgonów, których nie można sklasyfikować jako spowodowane udarem krwotocznym lub niedokrwiennym. Coraz bardziej rozpowszechnione użycie nowych poudarowych terapii i ich dostępność pozwalają się spodziewać dalszego spadku umieralności z powodu ChNM. Jakkolwiek niezbędne działania powinny zostać podjęte w celu wyrównania różnic pomiędzy przedwczesną umieralnością mężczyzn w stosunku do kobiet.

Słowa kluczowe: choroby naczyń mózgowych, udar, przedwczesna umieralność, Polska, trendy umieralności

INTRODUCTION

Cardiovascular disease (CVD) has been the main cause of death in the Polish population for many years, and although CVD mortality has been declining since the 1990s [15, 38], it still accounts for more than 40% of total deaths annually [2, 37]. A particularly disturbing phenomenon in Poland is premature CVD mortality. According to our calculations, CVD accounted for 31.0% and 25.5% of total deaths in people aged 25-64 years, in 2000 and 2016, respectively. Globally, ischaemic heart disease (IHD) and cerebrovascular disease (CeVD) were the two leading causes of CVD death and years of life lost (YLLs) in 2016 [8]. We calculated that IHD accounted for 30.2% and CeVD for 17.8% of CVD premature deaths in 2016 in Poland.

Many scientific reports have shown a decrease in total cerebrovascular disease mortality over the past few decades [8, 9], but too little attention has been paid to premature mortality. However, in Poland, premature mortality (e.g. from CVD, malignant neoplasm, disease of the respiratory system) is reported annually by the National Institute of Public Health NIH - National Research Institute (formerly Institute of Public Health - National Institute of Hygiene) [37].

The aim of the study was to analyse premature CeVD mortality in the Polish population in the recent years, the dynamics of its changes and the potential factors that may have contributed to the decline in mortality. The main goal of the study was to overview the levels and trends in premature CeVD mortality with an emphasis on haemorrhagic, ischaemic and unspecified (not specified as haemorrhagic or ischaemic) stroke.

MATERIAL AND METHODS

The analysis covered the official state statistics on cerebrovascular deaths in Poland from 2000 to 2016 obtained from Statistics Poland (formerly Central Statistical Office). In this report, to cover the majority of the professionally active population, premature mortality occurring between 25 and 64 years of age was considered (N=104,786).

For the purpose of the study cerebrovascular disease was coded in accordance with the International Statistical Classification of Diseases and Related Health Problems, 10th Revision [ICD-10] by I60-I69 codes. Cerebral haemorrhage (haemorrhagic stroke) included intracerebral haemorrhage (ICD-10 code I61) and other nontraumatic intracranial haemorrhage (ICD-10 code I62), while cerebral infarction (ischaemic stroke) and unspecified stroke (not specified as haemorrhage or infarction) were identified by ICD-10 codes I63 and I64, respectively.

The analysis included assessment of CeVD deaths distribution and evaluation of age-specific mortality rates (MR) and age-standardised mortality rates (SMR). SMRs were calculated using the direct method according to the European Standard Population ESP2013 [7, 23]. Mortality rates were calculated in 10-year age groups (25-34, 35-44, 45-54 and 55-64 years), while SMRs were calculated in the age group 25-64 years, separately for men and women.

Trends were determined by fitting annual SMRs data in the unobserved components model (UCM) and the piecewise polynomial spline model (PPSM). An UCM is widely used in econometrics to analyse time

series as it allows for decomposition the time series into components such as trend, seasonal, cycle, and random, as well as for improving forecast accuracy, especially when there are outliers in the data. Unlike UCM, the spline model can provide an equally good fit to the data, but if there is seasonality and cyclicity, the forecast results are worse. The *Cochran-Armitage* trend test and the *Jonckheere-Terpstra* test were used to determine a statistically significant trend between the number of deaths in subsequent years, while fit statistics based on residuals were applied to test trend significance for SMRs and median age at death.

Additionally, the male to female ratio (MFR) and percentage change (PC) in all mortality indices (number of deaths, MR, SMR) were calculated. The significance level of 0.05 was assumed to verify the statistical hypotheses. The statistical analysis was performed in SAS9.4 (SAS Institute, Cary, North Carolina, USA). The study was in accordance with the ethical standards of the Bioethics Committee at the Institute of Cardiology (approval no.1537/2016).

RESULTS

A substantial decline in premature CeVD mortality has been noticed during the years observed. The number of CeVD deaths decreased by 32.8% in men and 48.8% in women between 2000 and 2016 (Table 1).

The share of CeVD deaths in CVD deaths changed from 19.4% to 16.2% in males and from 31.3% to 22.8% in females in the same period, and although this trend seems to be optimistic, the increase in male towards female deaths is worrying (Men:63.3% MFR=1.7 in 2000, Men:69.4% MFR=2.3 in 2016, $p<0.001$ for trend). An increasing percentages of male deaths or MFR were also observed for cerebral haemorrhage (Men:63.8% MFR=1.8 in 2000, Men:71.5% MFR=2.5 in 2016, $p<0.001$ for trend) and for unspecified stroke (Men:65.8% MFR=1.9 in 2000, Men:71.1% MFR=2.5 in 2016, $p<0.001$ for trend). The same tendency was noticed for ischaemic stroke, but it was not statistically significant (Men:68.5% MFR=2.2 in 2000, Men:72.1% MFR=2.6 in 2016, $p=0.09$ for trend).

The highest decline in the number of stroke deaths was observed for an unspecified stroke (PC=74.8% for men, PC=80.3% for women) that was associated with a more precise diagnosis of the cause of death and resulted in changes of CeVD deaths distribution.

Thus, the greatest changes in the distribution of CeVD deaths took place within unspecified and ischaemic stroke deaths, while the share of haemorrhagic stroke death in CeVD death was almost constant in 2000-2016 (Table 1). Generally, stroke (combined haemorrhagic, ischaemic and unspecified) contributed to 84.5% and 76.4% of male CeVD deaths,

as well as 76.5% and 68.3% of female CeVD deaths, in 2000 and 2016.

Trends in CeVD deaths and in haemorrhagic, ischaemic or unspecified stroke deaths in 10-year age groups are shown in Figure 1. The lowest number of deaths was recorded in the age group 25-34 years. The average number of CeVD deaths was less than 90 and 50 per annum and the average number of haemorrhagic stroke deaths was less than 40 and 20 per annum, respectively for men and women. For ischaemic and unspecified stroke the average number of deaths was less than 10 for both genders. A small number of ischaemic and unspecified stroke deaths was also reported in the age group 35-44 years. For all cerebrovascular diseases the most numerous were deaths in the age group 55-64 years.

These findings were confirmed by observation of MR levels – the lowest mortality rates were in the age group 25-34 years, while the highest in the age group 55-64 years (Table 1). For all 10-year age groups CeVD mortality rates decreased in the period 2000-2016. The detailed information on all MR levels is presented in Table 1, while trends in age-specific mortality rates are shown in Figure 2.

The results of our study revealed a two-fold decrease in age-standardised mortality rate of CeVD in the Polish population aged 25-64 years in the period 2000-2016. SMR of CeVD decreased from 59 to 29 and from 30 to 12 per 100,000 in men and women, respectively. A considerable decrease in mortality was also obtained for cerebral haemorrhage (men: 1.8 times decrease, women: 2.5 times decrease), cerebral infarction (men: 1.4 times decrease, women: 1.6 times decrease) and unspecified stroke (men: 5.7 times decrease, women: 7.0 times decrease).

Trends in CeVD mortality in the years 2000-2016 are shown graphically in Figure 3. There were fitted in two models: unobserved components model and piecewise polynomial spline model, which was defined as a combination of two first degree polynomials (linear polynomials) with joinpoint detected by the model in 2008 (Figure 4). The observed decline in mortality was statistically significant ($p<0.001$). A better fit to the SMR data was found in the piecewise polynomial spline model (higher values of R^2 for PPSM than for UCM indicate a better fit of the model to the sample). However, the use of both models shows that the statistical methods used in econometrics can be applied in the analysis of medical data.

The expected SMR of CeVD in 2020, estimated in the unobserved components model, was 21.0 (95% CI: 16.2-25.8) per 100,000 in men and 7.8 (95% CI: 6.2-9.4) per 100,000 in women, assuming the same dynamics of change.

For indicative purposes, the percentage change of SMRs in two time periods, 2000-2008 and 2008-2016,

Table 1. Cerebrovascular disease (CeVD) mortality in Polish population aged 25-64 years by sex, 2000-2016

Year	Men			Women		
	2000	2016	PC	2000	2016	PC
Deaths						
CeVD	4582	3077	-32.8	2652	1359	-48.8
haemorrhagic stroke	1530	1083	-29.2	867	431	-50.3
ischaemic stroke	864	896	3.7	397	347	-12.6
unspecified stroke	1474	371	-74.8	765	151	-80.3
Share of CeVD [%]						
haemorrhagic stroke	33.4	35.2	1.8	32.7	31.7	-1.0
ischaemic stroke	18.9	29.1	10.2	15.0	25.5	10.5
unspecified stroke	32.2	12.1	-20.1	28.8	11.1	-17.7
other	15.5	23.6	8.1	23.5	31.7	8.2
Mortality Rate [1/100,000]						
CeVD						
25-34 yrs	3.85	2.32	-39.7	2.18	1.35	-38.1
35-44 yrs	15.79	8.03	-49.1	9.67	2.99	-69.1
45-54 yrs	54.77	29.10	-46.9	29.93	12.13	-59.5
55-64 yrs	167.93	79.36	-52.7	81.91	32.52	-60.3
haemorrhagic stroke						
25-34 yrs	1.85	1.05	- *	1.03	0.67	- *
35-44 yrs	7.98	4.13	-48.2	3.59	1.20	-66.6
45-54 yrs	21.38	12.94	-39.5	11.56	4.17	-63.9
55-64 yrs	44.49	23.76	-46.6	22.85	9.54	-58.2
ischaemic stroke						
25-34 yrs	0.15	0.29	- *	0.08	0.07	- *
35-44 yrs	1.40	0.97	- *	0.91	0.24	- *
45-54 yrs	8.20	6.24	-23.9	3.41	2.65	-22.3
55-64 yrs	39.41	27.11	-31.2	15.16	9.47	-37.5
unspecified stroke						
25-34 yrs	0.54	0.16	- *	0.12	0.00	- *
35-44 yrs	2.66	0.40	- *	1.13	0.24	- *
45-54 yrs	16.10	2.46	-84.7	6.71	1.01	-84.9
55-64 yrs	62.48	11.29	-81.9	30.04	4.13	-86.3
Age-standardised Mortality Rate [1/100,000]						
CeVD						
haemorrhagic stroke	18.72	10.37	-44.6	9.59	3.80	-60.4
ischaemic stroke	11.77	8.35	-29.1	4.66	2.98	-36.1
unspecified stroke	19.74	3.45	-82.5	9.06	1.29	-85.8
Subperiod I (2000-2008)						
2000	2000	2008	PC	2000	2008	PC
CeVD	58.98	47.59	-19.3	30.05	20.42	-32.0
haemorrhagic stroke	18.72	16.78	-10.4	9.59	6.87	-28.4
ischaemic stroke	11.77	11.89	1.0	4.66	4.29	-7.9
unspecified stroke	19.74	10.11	-48.8	9.06	3.65	-59.7
Subperiod II (2008-2016)						
2008	2008	2016	PC	2008	2016	PC
CeVD	47.59	29.04	-39.0	20.42	11.89	-41.8
haemorrhagic stroke	16.78	10.37	-38.2	6.87	3.80	-44.7
ischaemic stroke	11.89	8.35	-29.8	4.29	2.98	-30.5
unspecified stroke	10.11	3.45	-65.9	3.65	1.29	-64.7

PC – percentage change; for deaths, mortality rates and age-standardised mortality rates percentage change means relative percentage change

* – not reported due to possible errors resulting from too low mortality rates level and too low dynamics of their changes

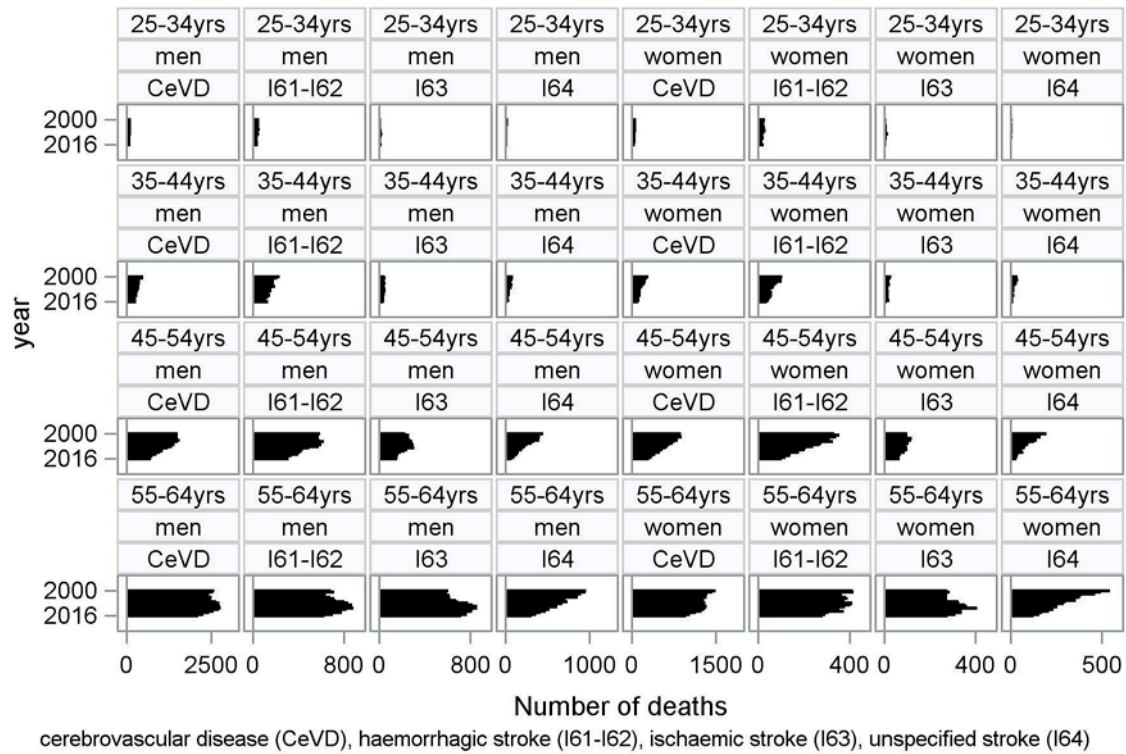
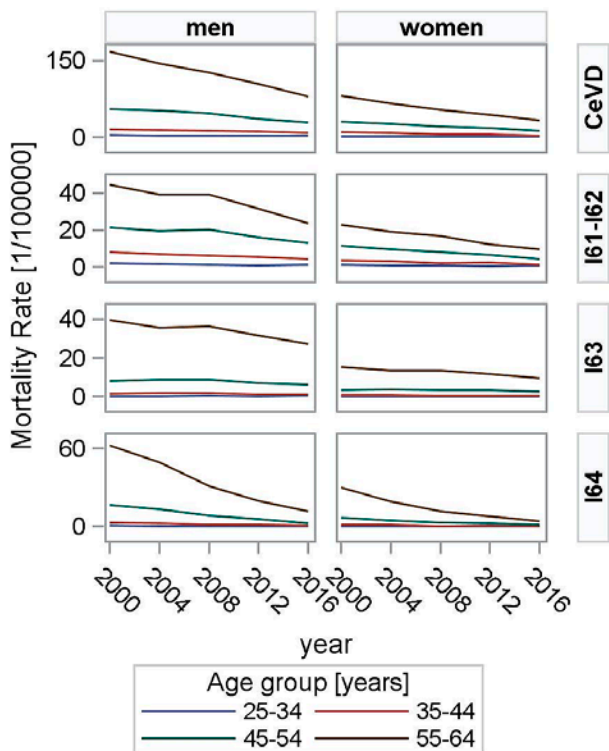
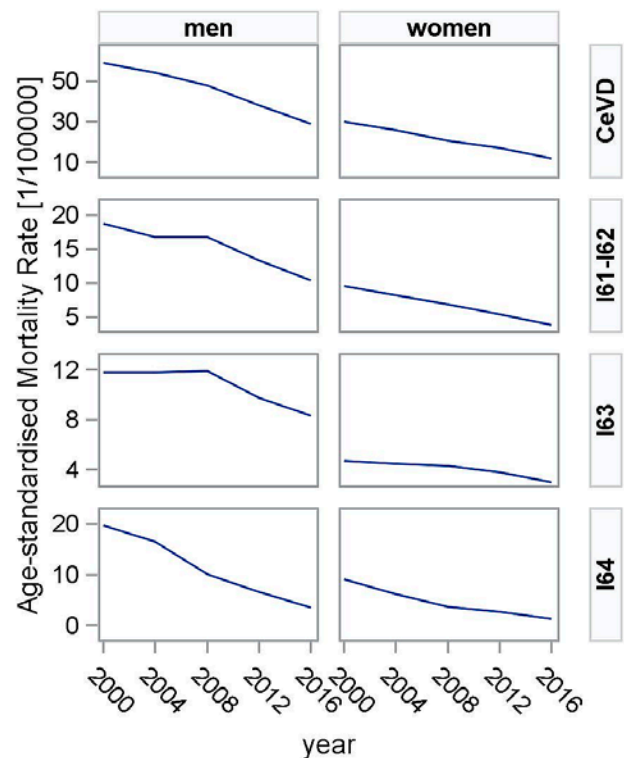


Figure 1. Number of cerebrovascular disease (CeVD), cerebral haemorrhage (I61-I62), cerebral infarction (I63) and unspecified stroke (I64) deaths in men and women aged 25-64 years by 10-year age groups, 2000-2016



cerebrovascular disease (CeVD), haemorrhagic stroke (I61-I62), ischaemic stroke (I63), unspecified stroke (I64)

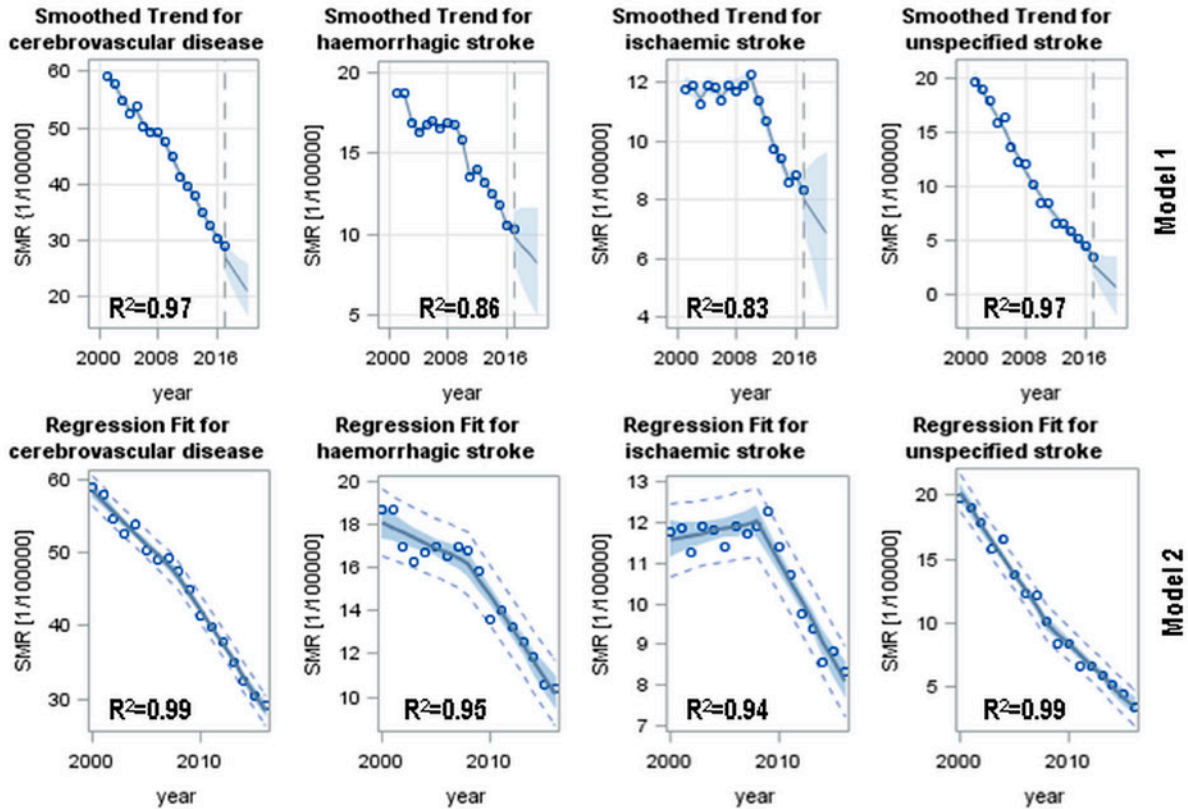


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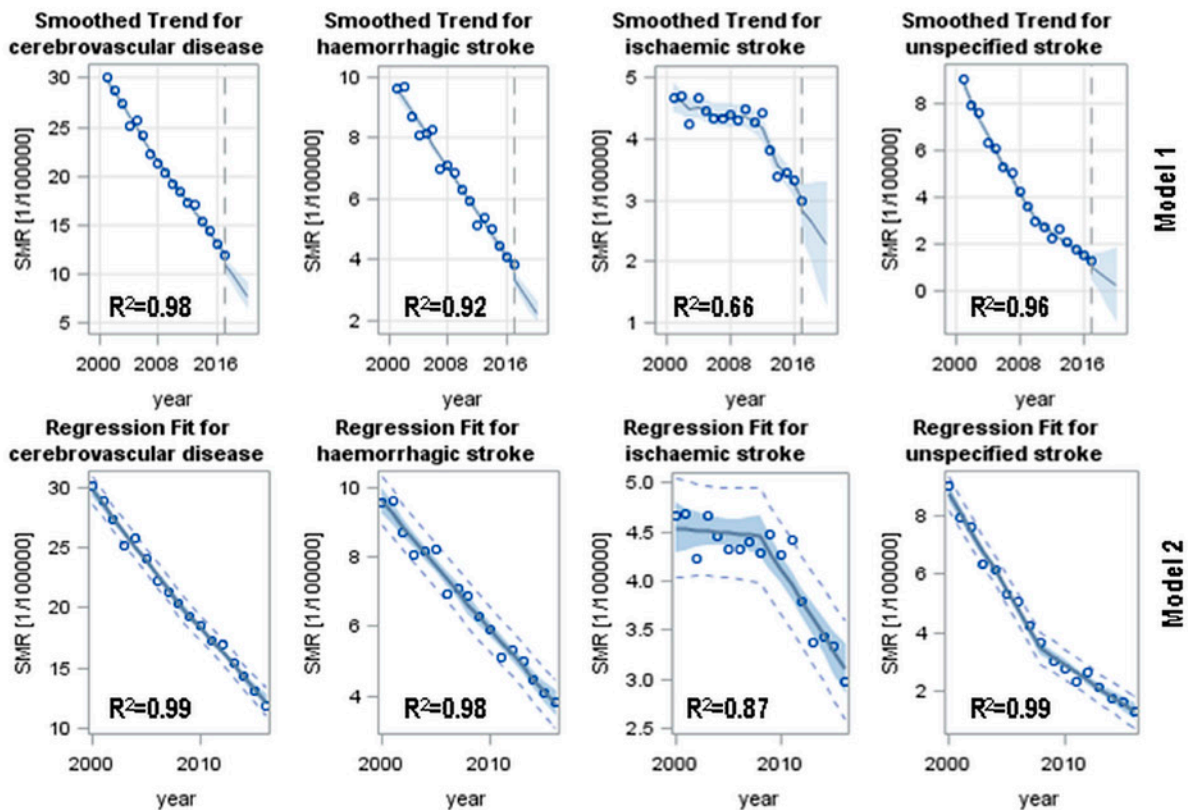
Figure 2. Age-specific mortality rates of cerebrovascular disease (CeVD), cerebral haemorrhage (I61-I62), cerebral infarction (I63) and unspecified stroke (I64) in men and women aged 25-64 years, 2000-2016

Figure 3. Age-standardised mortality rates of cerebrovascular disease (CeVD), cerebral haemorrhage (I61-I62), cerebral infarction (I63) and unspecified stroke (I64) in men and women aged 25-64 years, 2000-2016

A. men aged 25-64 years



B. women aged 25-64 years



SMR – age-standardised mortality rate (per 100 000)

Model 1 – Unobserved Components Model, Model 2 – Piecewise Polynomial Spline Model

◊ Actual, — Fit, ■ 95% Confidence Limits, - - 95% Prediction Limits, | Start of multi-step forecast

Figure 4. Trends of age-standardised mortality rates of cerebrovascular disease (CeVD), haemorrhagic stroke (I61-I62), ischaemic stroke (I63) and unspecified stroke (I64) in men and women aged 25-64 years, 2000-2016

was also estimated. In general, the lower decrease in CeVD mortality was observed in the period 2000-2008 ($PC_{Men}=19.3\%$, $PC_{Women}=32.0\%$), while the higher in 2008-2016 ($PC_{Men}=39.0\%$, $PC_{Women}=41.8\%$). The detailed information referred to all types of stroke is summarized in Table 1.

An additional finding of our study was a clear shift toward an older median age at CeVD death (Men: 56.4 to 58.4 years, $p<0.001$; Women: 56.4 to 58.7 years, $p<0.001$). The same tendency was observed for cerebral haemorrhage (Men: 53.6 to 56.6 years, $p=0.007$; Women: 54.4 to 57.8 years, $p<0.001$), ischaemic stroke (Men: 59.5 to 60.2 years, $p=0.013$; Women: 58.9 to 60.4 years, $p=0.001$) and unspecified stroke (Men: 58.2 to 60.2 years, $p=0.001$; Women: 59.8 to 60.1 years, $p=0.046$).

A 2-year increase in the median age of any CeVD death was considered clinically relevant. This result was achieved for haemorrhagic stroke and total CeVD.

DISCUSSION

The overall trend of decreasing the number of premature CeVD deaths was in accordance with the trend of premature CVD deaths decline, although according to our calculations the reduction in premature CVD deaths was smaller (men: 19.7%, women: 29.7%) in 2000-2016.

Declining premature CeVD mortality trend is consistent with the general trend in decreasing CeVD mortality in the total Polish population by 21% in the period 1990-2015 [22], despite the high number of total CeVD deaths (above 29 thousands in 2016). These results are also in line with our earlier reports [5, 13].

As mentioned previously, the decline in the number of premature CeVD deaths between 2000 and 2016 was over 32% in men and over 48% in women. A similar decrease was observed in the United Kingdom (31.3%) and Switzerland (34.3%) in men and in Bulgaria (43.8%) and Portugal (54.1%) in women (Figure 5) [6, 12]. In turn, the highest percentage change in CeVD deaths was observed in Estonia (men: -72.4%, women: -82.0%), the lowest for Lithuania in men (-3.8%) and for France in women (-19.9%), while for Slovakia, after an initial period of declines until 2006, an increase in cerebrovascular deaths was revealed (men: 25.1%, women 31.8%). Among the countries featured in the paper, Switzerland had the lowest percentage of premature CeVD deaths in all premature deaths and they remained almost unchanged in the observed period (men: 2.4% to 2.1%, women: 2.9% to 2.5%). In turn, the percentage of premature CeVD deaths in all premature deaths in Poland changed from 5.9% to 4.3% and from 8.1% to 4.6%, for men and women, respectively. The highest reported shares of CeVD

deaths were in Bulgaria and Romania in 2000, as well as in 2016.

Noteworthy is a better diagnosis of stroke type as a cause of CeVD death, in the observed 17 years unspecified stroke deaths reduced from about 30% to slightly above 10%. Developing earlier and more precise CeVD diagnostics also resulted in better choice and early application of treatment, that could reduce mortality.

The last two decades brought a new approach to stroke treatment options. In 1997 in Poland the network of stroke specialised units started to be built, and in 2000 there were 23 such units [3]. Furthermore, the principle that “time is brain” was adopted. The most effective method of ischaemic stroke acute phase treatment is a thrombolytic intravenous therapy with recombinant tissue plasminogen activator (rtPA), which was started in Poland in 2003, initially in selected centres within the framework of the National Programme of Prevention and Treatment of Stroke (Polish abbreviation POLKARD), and from 2009 in all stroke treatment units. There were 686 (1.8%) and 7568 (15.7%) hospitalizations with thrombolytic treatment, in 2009 and 2016, respectively, of which 228 (2.8%) and 1538 (17.9%) in the age group 18-60 years [19]. Currently about 20% of patients with ischaemic stroke are treated with rtPA [10, 14].

In addition, a substantial decrease in ischaemic stroke mortality after 2008 could be a consequence of better medical management following the introduction of new recommendations of the European Stroke Organization for treating ischaemic stroke and transient ischaemic attack in 2008 [32].

Based on current knowledge driven by a series of randomised controlled trials, an opinion exists that mechanical thrombectomy (MT) is the most effective method of treatment in selected patients with acute ischaemic stroke [4, 31, 35]. However, it seems not plausible that MT influenced the results of our analysis significantly because this new invasive procedure was not reimbursed by public resources and the number of MT procedures performed up to 2016 in Poland was very minimal, 585 in the period 2012-2016 [21, 25, 36].

There are still disparities in CeVD mortality trends between men and women. These results are consistent with previous studies and surveys [16, 26, 30]. A higher CeVD mortality rate for men than for women is observed in many countries, although not all differences are as large as in Poland [1, 11, 17, 33, 39].

The average life expectancy in Poland in 2016 was estimated to be 45.0 and 52.5 years, respectively, in 30 year old men and women [27]. In this context, it seems important to lead a healthy life without the burden of a past stroke. The previous studies in the Polish population revealed that CeVD was one of the leading single disease entities resulting in life lost years, for

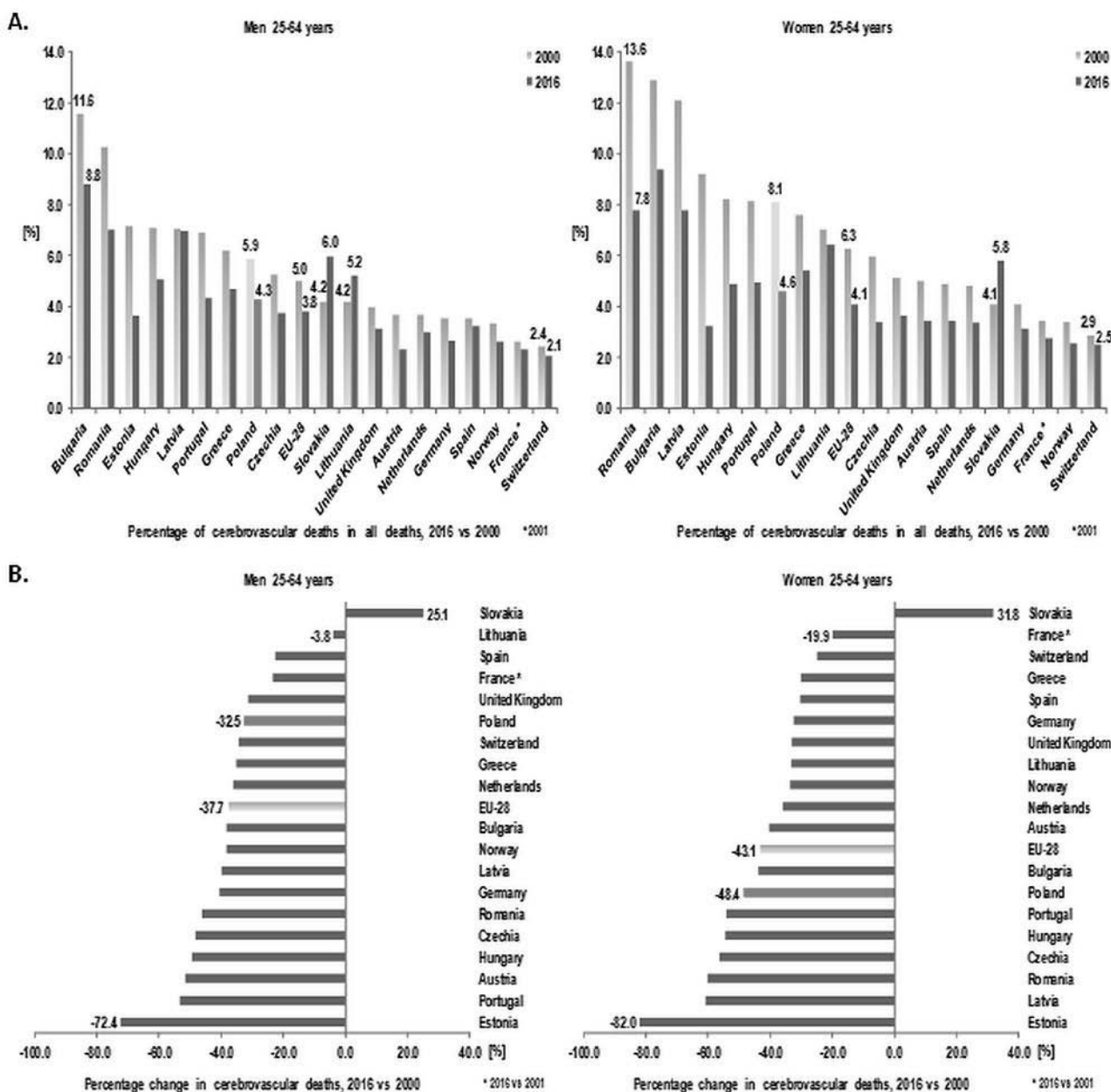


Figure 5. Comparison of cerebrovascular deaths in men and women aged 25-64 years in selected European countries, 2000 versus 2016. (Source: own calculation on Eurostat data)

instance in 2011, CeVD accounted for 4.6 YLLs per 1000 men (fourth position, after IHD, lung cancer and suicide) and 3.8 YLLs per 1000 women (first position, before IHD and heart failure) [18].

Our finding related to the significant shift towards older median ages of CeVD deaths is consistent with the decreasing trend for life years lost due to CeVD for both genders in 2000-2014 [24].

A survey conducted by the World Stroke Organization revealed that the burden of stroke should be reduced simultaneously in several domains: stroke diagnostics, stroke management, stroke care services, stroke rehabilitation, and stroke prevention [28]. The latter one gives the widest scope for further action.

In conclusion, although our study showed a progressive reduction in premature CeVD mortality

in both sexes, every effort should be made to increase awareness of stroke prevention, especially among men, because in 2017 stroke was still the second cause of mortality and the fifth cause of disability in the European Union countries, and in Poland mortality and disability due to stroke were definitely higher than the corresponding average indices for the European Union [29]. In fact, primary prevention of stroke ought to be related to modifiable lifestyle risk factors and aimed at tobacco smoking cessation, healthy nutrition, increase in physical activity, avoiding obesity, and chronic stress.

Of course, population-wide detection and effective treatment of hypertension is of particular importance for reducing CeVD morbidity and mortality [20].

In conclusion, a stroke prevention framework (e.g. awareness-raising programs) should be continued, developed and improved as soon as possible because despite the general declining trend in stroke mortality, the mean global lifetime risk of stroke increased from 22.8% in 1990 to 24.9% in 2016 due to accumulation of risk factors and the aging of the population, and further growth is expected in the coming years [34].

CONCLUSIONS

The results of our study revealed an expected decrease in premature CeVD mortality in the period 2000-2016. They have also shown an acceleration in the decline in premature ischaemic stroke mortality after 2008 possibly related to the introduction of thrombolytic intravenous therapy as an effective and widely available therapy in all stroke treatment units all over the country. A further decrease in CeVD mortality is expected after the implementation of mechanical thrombectomy as a standard procedure in specialised stroke units. Additionally, this report indicated that the number of cerebrovascular deaths that could not be classified as haemorrhagic or ischaemic stroke deaths decreased significantly.

Although a substantial decline in premature CeVD mortality is a positive phenomenon, the necessary actions should be taken to compensate for the disparities in CeVD mortality between men and women.

Funding

The part of this work was supported by the Institute of Cardiology grant no. 2.18/I/16 titled "Monitoring and analysis of official statistics data on cardiovascular mortality and morbidity in Poland in 2013-2016". All results based on official data from Central Statistical Office, that is not responsible for conclusions presented in the publication.

Conflicts of interest

None.

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Received: 24.11.2021

Accepted: 03.01.2022

Published online first: 11.01.2022