

# Sudden cardiovascular death rate and ischaemic heart disease death rate changes during the 5-year period of 2003–2008

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## Abstract

**Background:** A decrease in cardiovascular mortality rates, including deaths due to ischaemic heart disease (IHD), has been observed in Poland since mid-1990s, and at the same time a rapid increase in sudden cardiovascular death (SCD) rate was noted.

**Aim:** To evaluate changes in mortality due to SCD, IHD and SCD+IHD that occurred in 2003–2008 in the Polish population aged 25–64 years.

**Methods:** Individual data from death certificates and demographic data were obtained from the Central Statistical Office and all analyses were performed in the Department of Cardiovascular Disease Epidemiology, Prevention and Health Promotion. SCD was defined as codes I46.1 and R96, and IHD as codes I20–I25 according to the Tenth Revision of the International Classification of Diseases (ICD-10). Calculated mortality rates per 100,000 inhabitants for 5-year age groups were standardised for the European population structure.

**Results:** In 1997–2008, premature mortality due to SCD among adult men and women aged 25–64 years showed only small variations until 2003, and later an upward trend was observed. In 2005–2008, mortality due to SCD increased by 40% among men and 45% among women, but total mortality due to SCD+IHD remained stable. There was no marked variation in the proportion of mortality due to IHD+SCD in total cardiovascular disease (CVD) mortality both in men and in women. The rate of SCD was related to age. A notable finding was the equalisation of mortality rates due to IHD+SCD per 100,000 in nearly all age groups except for the oldest men and women. In the whole adult Polish population, no clear difference in standardised mortality rates could be noted between 2003 and 2008. SCD mortality rate and its proportion in total CVD mortality differed significantly in relation to the region of Poland. SCD mortality rate among men in the Lubusz and Lesser Poland voivodeships decreased by more than 25% (in women only in the Lubusz voivodeship). In the remaining voivodeships, increases in SCD mortality rate were observed (among men, by 171% in the Pomeranian voivodeship, 66% in the Świętokrzyskie voivodeship, and 60% in the Opole voivodeship; among women, by 248% in the Pomeranian voivodeship, 88% in the Silesian voivodeship, and 85% in the Opole voivodeship). No differences in mortality rates due to IHD+SCD in relation to the region of Poland were observed.

**Conclusions:** IHD mortality rates in the Polish population aged 25–64 years were underestimated in the majority of voivodeships. At the same time, SCD mortality rates were overestimated. These results indicate deficiencies in our medical care system regarding the diagnosis and prevention of sudden deaths, and awareness of symptoms of life-threatening conditions.

**Key words:** sudden cardiovascular death, ischaemic heart disease death, classification of causes of death, mortality

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## INTRODUCTION

Mortality rate is one of the most important indicators of the health status of a population. Due to a large proportion of sudden cardiovascular deaths (SCD) among all car-

diovascular deaths, studies on this issue draw much attention among researchers. Numerous papers have been published on the aetiology, epidemiology, prevention, risk factors, and diagnosis and coding of SCD [1, 2]. Autopsy

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studies have also been undertaken to clarify causes of SCD [3, 4].

Epidemiological studies indicate that in Europe, SCD is the cause of 20 to 159 deaths per 100,000 inhabitants per year. In the United States, SCD mortality rate is 84 to 200 per 100,000, and SCD contribute to more than 50% of the overall cardiovascular disease (CVD) mortality [5]. According to other data, sudden deaths constitute 10% to 32% of all natural deaths, but 80–90% of them are SCD.

Sudden cardiac death is a death from cardiac causes, preceded by sudden loss of consciousness occurring soon (several minutes to 1 h) after the onset of acute symptoms in a person with established or preexisting but undiagnosed cardiac disease [6]. The main cause of SCD in middle-aged and elderly subjects is ischaemic heart disease (IHD), identified in 80% of sudden deaths. According to a recent US autopsy study [3], IHD was the cause of sudden death in 34% of patients aged 21–30 years and 42% of patients aged 31–40 years. Thus, it is warranted to analyse both these mortality causes, i.e. SCD and IHD.

An increasing rate of SCD in the Polish population was noted as early as in the 1990s [7, 8]. Until 1997, the diagnosis of IHD as the cause of death was underreported due to overreporting of the diagnosis of atherosclerosis [9, 10]. After 1996, when the Tenth Revision of the International Classification of Diseases (ICD-10) [11] was introduced, diagnostic opportunities increased, and dedicated trained voivodeship physician coders replaced primary care physicians as the healthcare personnel that coded causes of death [10]. At that time, IHD became the most commonly coded cause of CVD mortality. In 2008, 31.8% of all CVD deaths in men and 25.0% of all CVD deaths in women in all age groups, and 37.2% and 26.9% of all CVD deaths, respectively, in the age group 25–64 years were attributed to IHD.

Sudden cardiovascular deaths, defined in the present study as codes I46.1 (sudden cardiac death, so described) and R96 (other sudden death, cause unknown) according to the ICD-10 [11], are a difficult and equivocal diagnostic category that lacks a uniform definition. In different studies, deaths were defined as sudden if they occurred within 1, 2, 6, or 24 h after the onset of acute symptoms, or within several seconds without any heralding symptoms [7].

Sudden deaths without preceding clinical symptoms and with no clear morphological abnormalities found in the autopsy study pose significant diagnostic difficulties. According to Chowanec et al. [12], the cause of a sudden death cannot be clearly established if the autopsy was not performed or did not include histopathological examinations.

Reported mortality rates are significantly affected by the following factors: (1) errors made by physicians issuing death certificates and determining the cause of death to be later coded by the Central Statistical Office (GUS) who may, for various reasons, disregard previous patient medi-

cal records and diagnose sudden death; and (2) a low proportion of autopsy studies performed in Poland, which does not allow verification of causes of death and significantly affects the precision of the estimated number of sudden deaths due to IHD [7].

The aim of this study was to evaluate changes in mortality due to SCD, mortality due to IHD, and overall mortality due to SCD and IHD (IHD+SCD) that occurred in 2003–2008 in the Polish population aged 25–64 years.

## METHODS

In this study, we used official governmental statistical data from death certificates which are collected by the Central Statistical Office (GUS) and were made available to the Department of Cardiovascular Disease Epidemiology, Prevention and Health Promotion at the National Institute of Cardiology in Warsaw. Each individual record (not allowing personal identification) included the following information: year of death, voivodeship of residence, gender and age of the deceased subject, and the cause of death according to the ICD-10 classification [11]. For the purpose of this study, IHD was defined as ICD-10 codes I20–I25, and SCD as codes I46.1 and R96.

To calculate mortality rates per 100,000 inhabitants in 5-year age groups (25–29, 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, and 60–64 years) we used data on gender- and age group-specific population structure in Poland and its voivodeships as of June 30 each year. Population structure referred to the number of persons registered for permanent residence.

To calculate standardised mortality rates per 100,000 inhabitants in Poland and its voivodeships, we used 5-year age group rates weighted for the structure of the European population [13]. Standardised mortality rates for voivodeships were calculated similarly to the whole country, but data on gender- and age group-specific population structure in a given voivodeship were used to calculate mortality rates per 100,000 inhabitants in a given age group.

In general, for each category defined by gender, disease group, and age group, mortality rates were calculated for voivodeships and the whole country:  $w = 100,000 \times d/N$ , where  $d$  is the number of deaths in a given category, and  $N$  is mid-year (i.e., as of June 30 each year) population at risk in a given category.

Based on these mortality rates, standardised mortality rates weighted for the structure of the European population in 5-year age groups were calculated for voivodeships and the whole country.

We analysed mortality rates in age groups and standardised mortality rates per 100,000 inhabitants in 2003 and 2008.

In this study, mortality rates due to SCD and IHD were analysed in the Polish population aged 25–64 years.

To verify hypotheses of a null difference in mortality rates between voivodeships, the sign test was used for the diffe-

rence between the mortality rate in a voivodeship and the mortality rate in the whole country.  $P < 0.05$  was considered statistically significant.

## RESULTS

### *Sudden deaths and gender*

In 1997–2008, premature mortality due to SCD among adult men aged 25–64 years (Fig. 1) showed only small variations until 2003, followed by an increase from more than 41 sudden deaths per 100,000 in 2003 to nearly 58 sudden deaths per 100,000 in 2008, or by nearly 40% during the last 5 years.

Even more evident was the absolute increase in the number of SCD, from 3912 among men in 2003 to 5951 in 2008, an increase by 52%.

Overall, a clear downward trend could be noted for mortality due to IHD among men in 1997–2008, but total mortality due to IHD and SCD in 2003–2008 remained stable, which means the decrease in mortality due to IHD was offset by an increase in mortality due to SCD.

In 2003–2008, the absolute number of deaths due to IHD decreased by 8%, from 9464 to 8665 deaths.

Similar relationships between the analysed causes of mortality could be noted in women. Since 2003, the number of SCD increased by 45%, the number of deaths due to IHD

decreased by 21%, and total mortality due to IHD and SCD remained nearly unchanged.

Among women aged 25–64 years, 819 SCD and 2174 deaths due to IHD occurred in 2003, compared to 1306 and 1976 deaths, respectively, in 2008. The absolute number of SCD increased by 59%, and the absolute number of deaths due to IHD decreased by 9%.

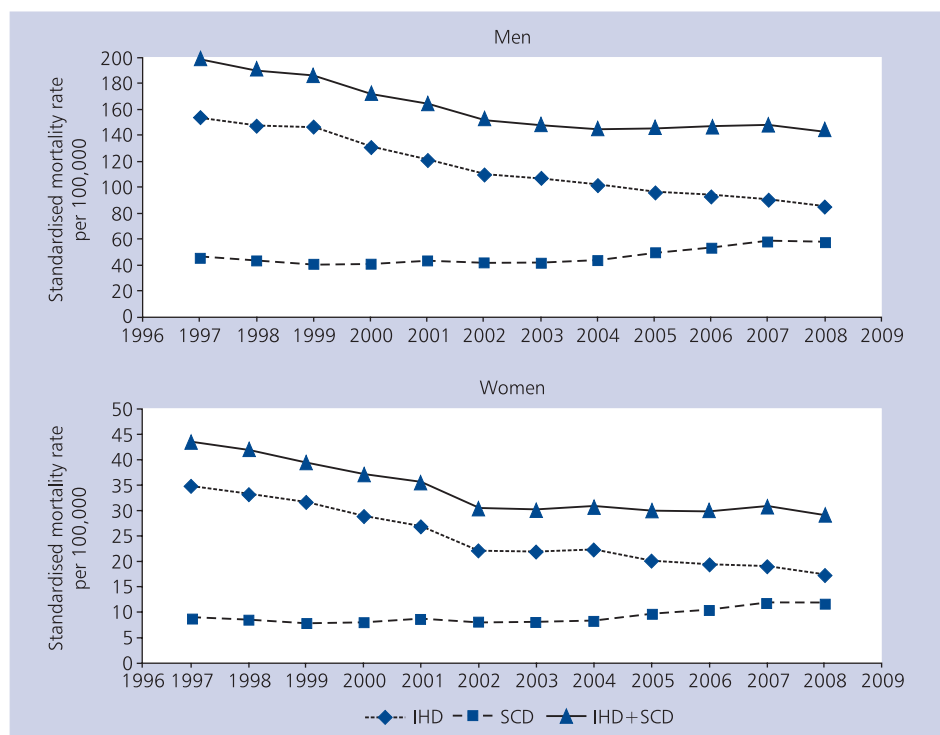
### *Sudden deaths and age*

Mortality due to SCD, IHD, and IHD+SCD was related to age. Figures 2, 3 and 4 show mortality rates due to SCD, IHD, and IHD+SCD per 100,000 in 5-year age groups in the Polish population, and proportions of these deaths in total CVD mortality.

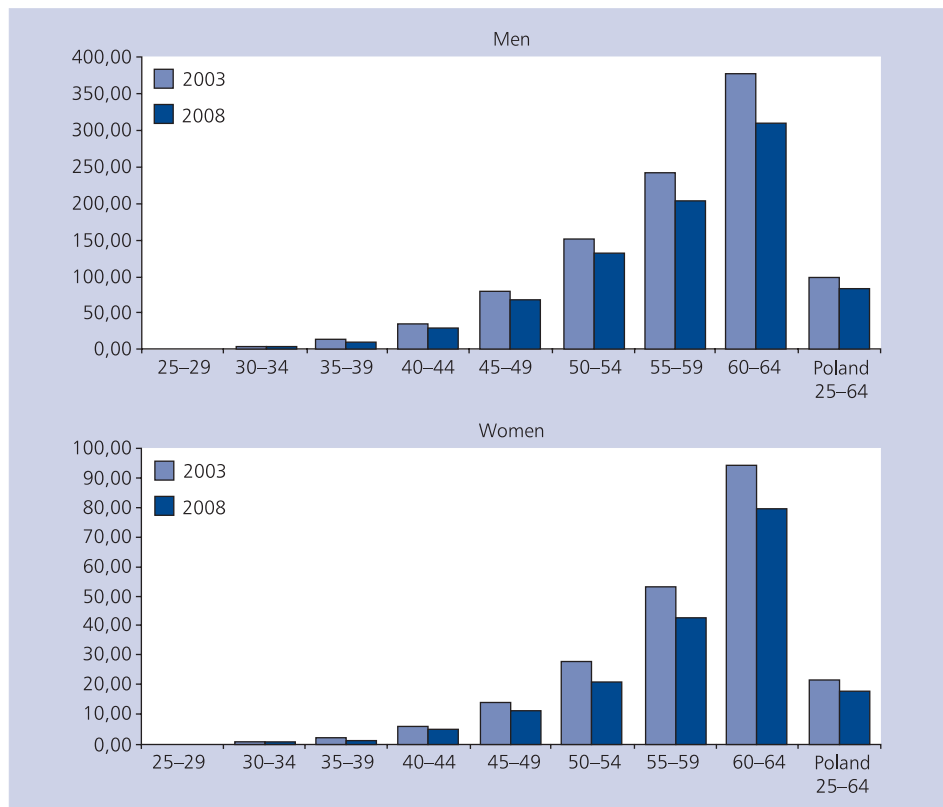
In all age groups both in men and in women, mortality rates due to IHD decreased, and these changes increased with age (Fig. 2). The opposite trend was noted for mortality due to SCD (Fig. 3).

A notable finding was the equalisation of mortality rates due to IHD+SCD per 100,000 in nearly all age groups except for the oldest men and women (Fig. 4). In the whole adult Polish population, no clear difference in standardised mortality rates could be noted between 2003 and 2008.

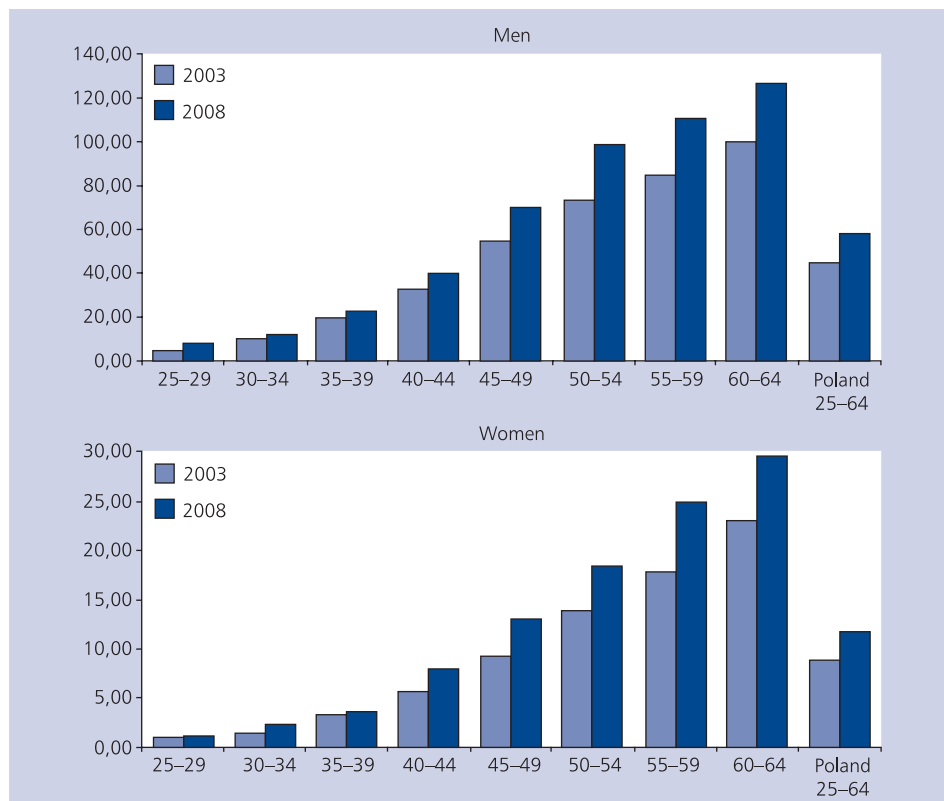
The proportion of mortality due to SCD in total CVD mortality (Fig. 5) showed a downward trend both in men and



**Figure 1.** Standardised mortality rates due to ischaemic heart disease (IHD), sudden cardiovascular death (SCD), and IHD+SCD in the Polish population aged 25–64 years in 1997–2008



**Figure 2.** Mean age-specific mortality rates due to ischaemic heart disease in 5-year age groups and standardised mortality rates in the Polish population aged 25–64 years in 2003 and 2008



**Figure 3.** Mean age-specific mortality rates due to sudden cardiovascular death in 5-year age groups and standardised mortality rates in the Polish population aged 25–64 years in 2003 and 2008

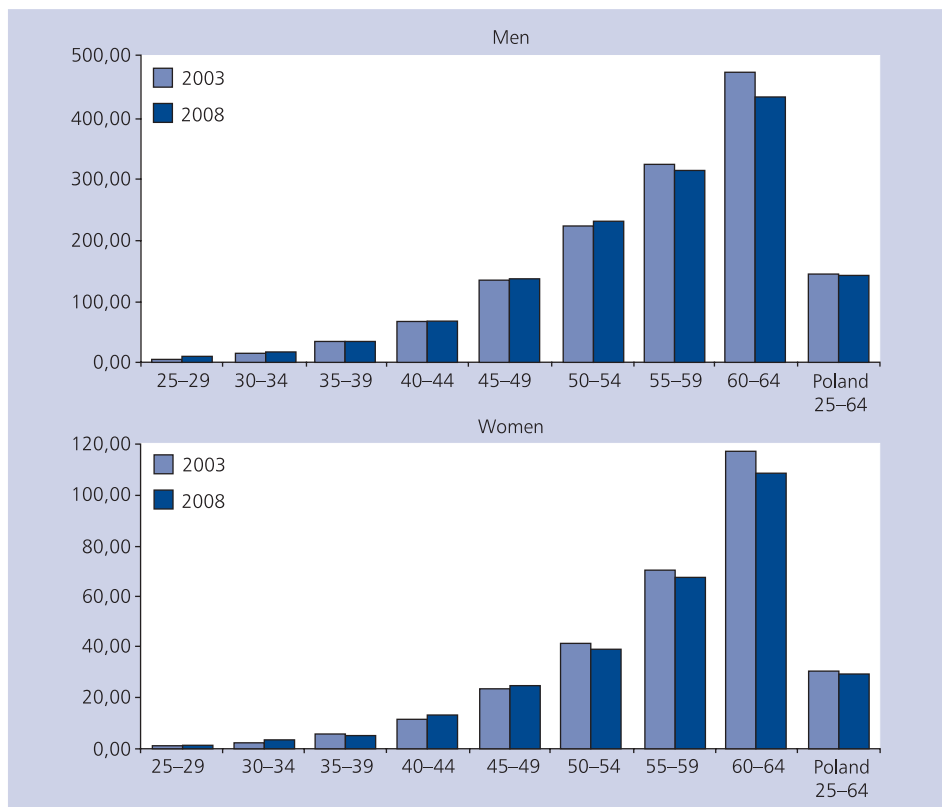


Figure 4. Mean age-specific mortality rates due to ischaemic heart disease and sudden cardiovascular death in 5-year age groups and standardised mortality rates in the Polish population aged 25–64 years in 2003 and 2008

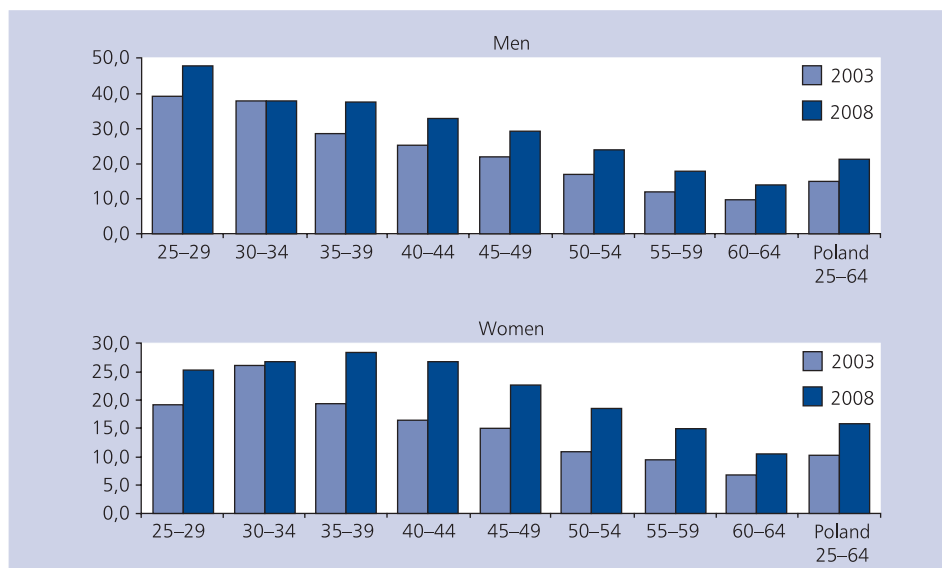
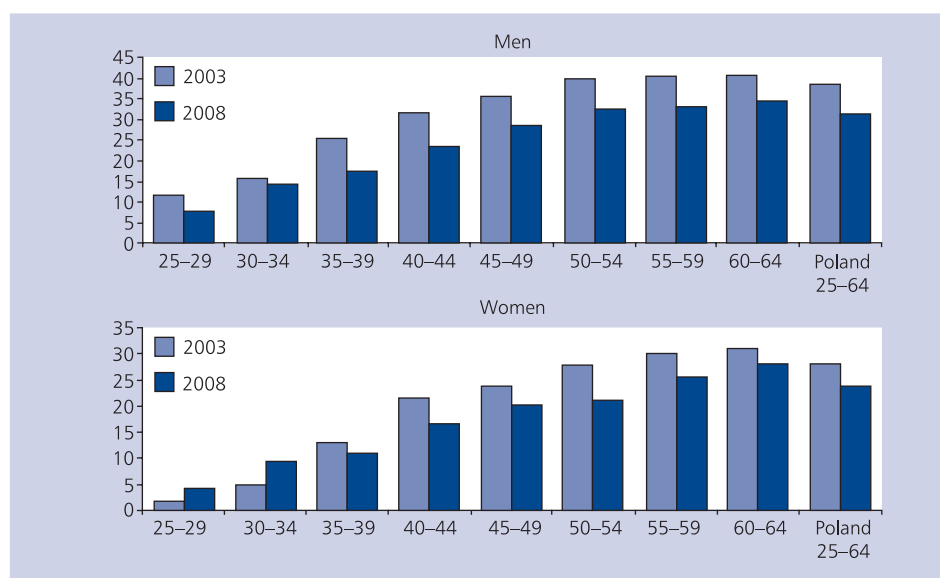


Figure 5. Proportion (%) of sudden cardiovascular deaths in total cardiovascular disease mortality in 5-year age groups and the Polish population aged 25–64 years in 2003 and 2008



**Figure 6.** Proportion (%) of deaths due to ischaemic heart disease in total cardiovascular disease mortality in 5-year age groups and the Polish population aged 25–64 years in 2003 and 2008

in women, reaching the highest values in the youngest age groups at both analysed time points. However, proportion of mortality due to SCD in all age groups, both in men and in women, increased during the analysed 5 years. The proportion of mortality due to IHD in total CVD mortality (Fig. 6) clearly increased with age but decreased between 2003 and 2008 in all age groups, which is clearly a advantageous trend. However, contribution of IHD+SCD in total CVD mortality among men and women changed only little in all age groups during the analysed 5 years.

#### ***Sudden deaths and the country region***

Both mortality rates due to IHD and SCD, and proportions of these deaths in total mortality show large variation depending on the country region (Figs. 7, 8).

In 2003, largest mortality rates due to IHD in men were noted in the Silesian, Greater Poland, and West Pomeranian voivodeships (Fig. 7), and in woman additionally in the Kuyavian-Pomeranian voivodeship. Lowest mortality rates were noted in the Lublin, Warmian-Masurian, and Masovian voivodeships in men, and in the Lublin and Podlaskie voivodeships in women. In nearly all voivodeships, mortality rates decreased in the analysed period. Among men, largest percentage mortality decreases during the analysed 5 years were noted in the Opole (by 35%), Pomeranian (31%), and Greater Poland (27%) voivodeships. Increases in mortality rate were noted only in the Lubusz and Lesser Poland voivodeships (by 10% and 20%, respectively).

Among women, largest mortality decreases were noted on the Opole (by nearly 53%), Greater Poland (37%), and Warmian-Masurian (33%) voivodeships. Similarly to men, in-

creases in mortality rate among women were noted only in the Lubusz and Lesser Poland voivodeships, slightly in the former and by more than 54% in the latter.

If these data are compared with mortality rates due to SCD, close inverse relationships can be noted (Fig. 8). In men, mortality rates due to SCD increased in nearly all voivodeships, and decreases in mortality were noted only in the Lubusz and Lesser Poland voivodeships. Mortality rate due to SCD per 100,000 decreased by more than 25%. Among women, a decrease in mortality rate was noted only in the Lubusz voivodeship.

Large increases in mortality rates due to SCD per 100,000 in men were noted in the Pomeranian (by 171%), Świętokrzyskie (66%) and Opole (60%) voivodeships, and in women in the Pomeranian (by 248%), Silesian (88%), and Opole (85%) voivodeships.

In most voivodeships, no changes in mortality rates due to IHD+SCD were noted in men (Fig. 9). An increase in standardised mortality rate by more than 10% was noted only in the Pomeranian and Lesser Poland voivodeships, and a decrease by more than 10% was noted only in the Greater Poland voivodeship. Among women, standardised mortality rates increased by more than 10% in the Lesser Poland and Pomeranian voivodeships, and decreased by more than 10% in the Kuyavian-Pomeranian, Subcarpathian, Silesian, Świętokrzyskie, Greater Poland, and West Pomeranian voivodeships.

Both in men and in women, no differences in mortality rate due to IHD+SCD between voivodeships were noted in relation to the mortality rate in the whole country at both analysed time points.

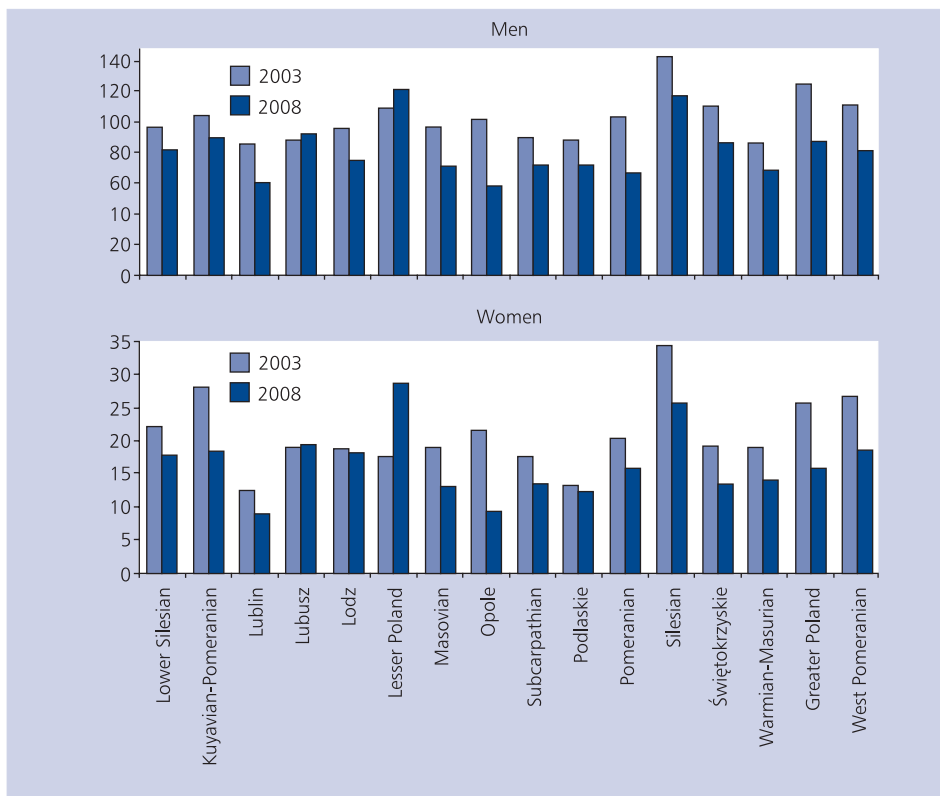


Figure 7. Standardised mortality rates due to ischaemic heart disease per 100,000 inhabitants in voivodeships in Poland in 2003 and 2008

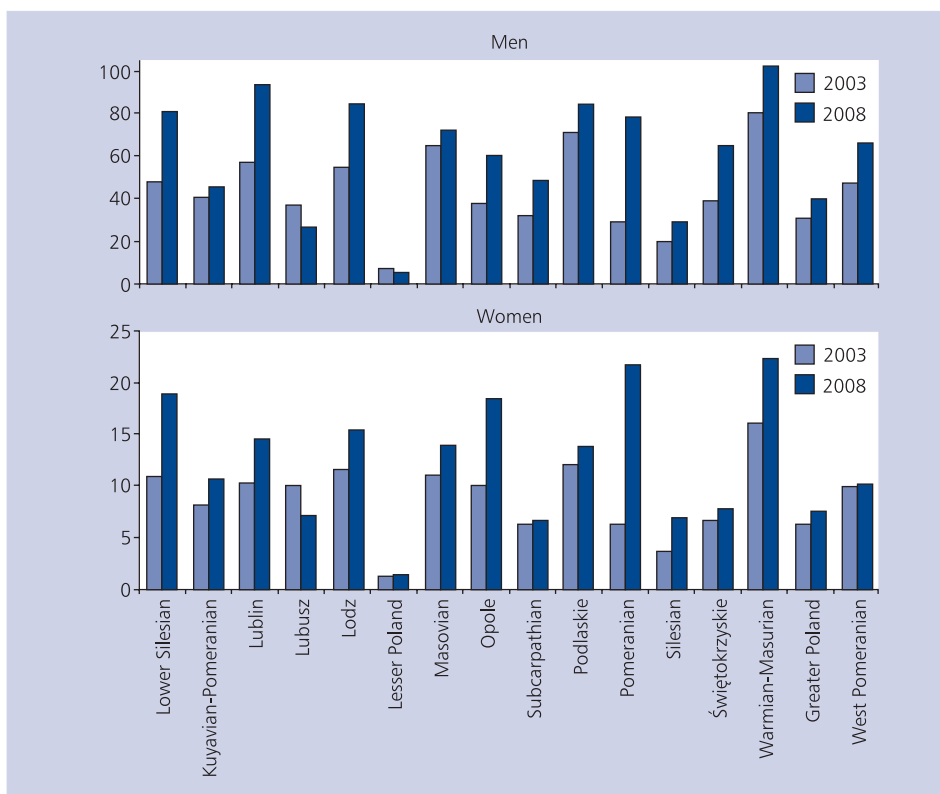
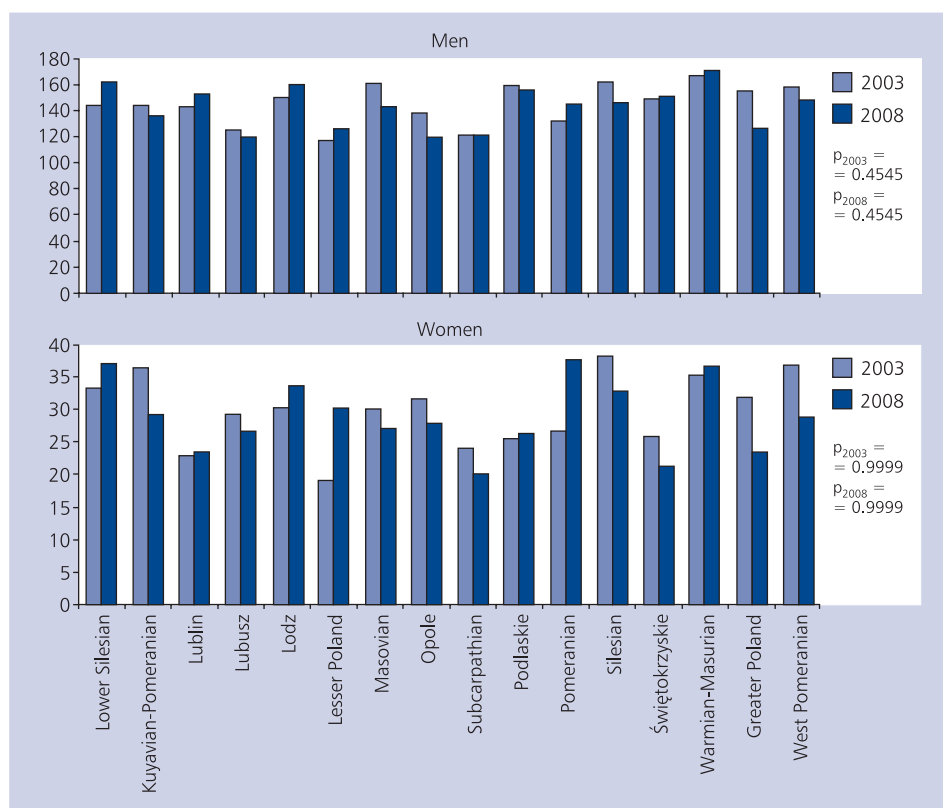


Figure 8. Standardised mortality rates due to sudden cardiovascular death per 100,000 inhabitants in voivodeships in Poland in 2003 and 2008



**Figure 9.** Standardised mortality rates due to ischaemic heart disease and sudden cardiovascular death per 100,000 inhabitants in voivodeships in Poland in 2003 and 2008

Notable findings were obtained regarding the proportion of sudden deaths in total CVD mortality (Table 1). Lowest values in 2003 and 2008, both in men and in women, were noted in the Lesser Poland voivodeship. Here, the proportion of sudden deaths was below 4%, and decreased to less than 3% during the analysed 5-year period. The proportion of sudden deaths in total CVD mortality also decreased by 3 percentage points among men and by 2 percentage points among women in the Lubusz voivodeship, but increased in the remaining 14 voivodeships. A large, 3-fold increase in the proportion of SCD in total CVD mortality was noted both in men and in women in the Pomeranian voivodeship.

## DISCUSSION

Sudden cardiac death is a major problem in Poland due to adverse factors contributing to an increased rate of these events [14]. In this study, we used official governmental statistics, i.e. data collected and made available by the Central Statistical Office.

Official governmental statistics regarding mortality rates are based on individual data including cause of death coded by a physician or a team of coding physicians. This diagnosis, expressed as a code from the international classification of diseases, is final and not verified. In this study, we defined a category of SCD by combining two codes, I46.1 and R96, as they are both related to sudden deaths, although the cause of sudden death is unknown in case of the R96 code. Ba-

sed on the autopsy studies it is known, however, that many of these deaths are due to IHD. Thus, mortality rates due to SCD are slightly overestimated, and this overestimation decreases with age.

At the same time, mortality rates due to IHD in the Polish population aged 25–64 years are underestimated. Of note, voivodeships with low mortality rates due to SCD were also characterised by higher mortality rates due to IHD. Such a relationship was noted both in 2003 and in 2008. This confirms a significant contribution of sudden deaths to the mortality rate due to IHD [4]. Estimating this contribution in the analysed Polish population would require a large-scale performance of autopsy studied allowing precise determination of actual causes of death.

In some voivodeships in Poland, SCD rate per 100,000 inhabitants is low, and in some it is disturbingly high. This is clearly related to healthcare system performance and diagnostic opportunities that would allow establishing the cause of death. Of note, an increasing trend was noted for the sudden death rate in 14 out of 16 voivodeships. At the same time, mortality rate due to IHD decreased in nearly all voivodeships.

These distorted mortality rates due to IHD and SCD may lead to self-complacency of healthcare providers, as nobody can be blamed for sudden deaths due to an unknown cause, and an apparent reduction in mortality rate due to IHD is taken as an indicator of an improved healthcare quality.



**Table 1.** Proportion (%) of mortality due to ischaemic heart disease (IHD) and sudden cardiovascular death (SCD) in total cardiovascular mortality in voivodeships of Poland in 2003 and 2008

Voivodeship	Men						Women					
	IHD		SCD		IHD+SCD		IHD		SCD		IHD+SCD	
	2003	2008	2003	2008	2003	2008	2003	2008	2003	2008	2003	2008
Lower Silesian (dolnośląskie)	32.7	23.9	16.2	23.5	40.2	47.4	23.9	18.5	11.8	19.7	35.7	38.2
Kuyavian-Pomeranian (kujawsko-pomorskie)	39.0	33.6	15.1	17.0	49.5	50.6	32.6	23.3	9.4	13.5	42.0	36.8
Lublin (lubelskie)	28.5	19.7	19.0	30.9	32.6	50.6	18.1	13.0	14.8	21.1	32.8	34.1
Lubusz (lubuskie)	31.5	34.6	13.2	10.0	38.3	44.7	22.3	25.7	11.7	9.5	34.0	35.2
Lodz (łódzkie)	30.9	23.0	17.7	25.7	36.9	48.7	22.5	21.2	13.8	17.9	36.3	39.0
Lesser Poland (małopolskie)	49.8	59.3	3.3	2.6	57.8	61.9	29.0	48.6	2.1	2.4	31.1	51.0
Masovian (mazowieckie)	35.9	25.3	24.2	25.8	43.0	51.1	26.4	18.8	15.4	20.1	41.7	39.0
Opole (opolskie)	38.4	21.9	14.2	22.5	46.5	44.4	26.8	11.8	12.4	23.5	39.2	35.3
Subcarpathian (podkarpackie)	35.4	30.2	12.6	20.3	42.4	50.5	26.4	26.4	9.4	13.0	35.8	39.4
Podlaskie	31.1	30.7	25.2	36.2	35.8	66.9	20.4	22.9	18.4	25.8	38.9	48.8
Pomeranian (pomorskie)	41.5	29.6	11.7	34.6	49.8	64.2	27.3	22.6	8.3	30.8	35.6	53.4
Silesian (śląskie)	48.1	43.0	6.8	10.6	59.7	53.6	36.2	31.0	3.9	8.3	40.1	39.3
Świętokrzyskie	38.7	30.0	13.7	22.6	45.4	52.6	27.9	20.3	9.6	11.6	37.6	31.8
Warmian-Masurian (warmińsko-mazurskie)	29.4	24.2	27.2	35.9	35.8	60.1	24.9	17.3	21.1	27.3	46.0	44.5
Greater Poland (wielkopolskie)	44.7	35.9	11.2	16.2	53.9	52.1	31.9	23.5	7.7	11.1	39.6	34.6
West Pomeranian (zachodniopomorskie)	38.3	29.9	16.3	24.4	47.5	54.2	30.3	25.5	11.3	13.9	41.6	39.4

Based on our findings, we were unable to reject a hypothesis that mortality rates due to IHD+SCD per 100,000 in voivodeships of Poland remain at the same level ( $p > 0.05$ ). Thus, significant regional differences in the approach to coding causes of deaths in death certificates are likely.

## CONCLUSIONS

It seems that these results indicate deficiencies in our medical care system. At the diagnostic level, an improved knowledge on the part of primary care physicians and emergency medical services would be required, and patients with unstable IHD should be hospitalised and treated according to the national guidelines to prevent sudden deaths. It is also necessary to increase community awareness of symptoms of life-threatening conditions that require immediate medical attention.

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**Conflict of interest:** none declared

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# Częstość nagłego zgonu sercowo-naczyniowego i zgonu z powodu choroby niedokrwiennej serca: jak się zmieniła w ciągu 5 lat (2003–2008)?

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## Streszczenie

**Wstęp:** Od połowy lat 90. XX w. obserwuje się w Polsce spadek współczynników umieralności spowodowanej chorobami układu sercowo-naczyniowego (CVD), w tym chorobą niedokrwinną serca (IHD), a jednocześnie szybki wzrost współczynników umieralności z powodu zgonów nagłych.

**Cel:** Celem pracy była ocena zmian umieralności ludności Polski w wieku 25–64 lata spowodowanej nagłym zgonem sercowo-naczyniowym (SCD), IHD oraz połączeniem obydwu rozpoznań (SCD lub IHD) między rokiem 2003 i 2008.

**Metody:** Podstawowe indywidualne dane pochodzące z aktów zgonu i dane demograficzne uzyskano z Głównego Urzędu Statystycznego, a wszelkie analizy wykonał zespół Zakładu Epidemiologii, Prewencji ChUK i Promocji Zdrowia IK. Nagły zgon sercowo-naczyniowy rozpoznano jako I46.1 lub R96 (wg ICD-10), a IHD jako I20-I25. Wyliczone współczynniki umieralności na 100 000 mieszkańców dla 5-letnich grup wieku były standaryzowane przy uwzględnieniu struktury populacji europejskiej. Analizie poddano współczynniki umieralności w latach 2003 i 2008.

**Wyniki:** W okresie 1997–2008 przedwczesna umieralność dorosłych mężczyzn i kobiet w wieku 25–64 lata spowodowana SCD wykazywała niewielkie wahania do 2003 r., po czym nastąpiła znaczna tendencja wzrostowa. W latach 2005–2008 zaobserwowano wzrost współczynników umieralności o 40% wśród mężczyzn i 45% wśród kobiet. Jednak umieralność z powodu IHD+SCD utrzymywała się na wyrównanym poziomie. Nie stwierdzono wyraźnego zróżnicowania udziału IHD+SCD w umieralności spowodowanej CVD u mężczyzn i kobiet. Częstość występowania SCD zależała od wieku. Charakterystyczne jest wyrównanie specyficznych współczynników umieralności IHD+SCD na 100 000 ludności w prawie wszystkich grupach wiekowych, oprócz grupy najstarszych mężczyzn i kobiet. Dla całej populacji polskiej w wieku 25–64 lat brakuje wyraźnego zróżnicowania standaryzowanych współczynników między 2003 a 2008 rokiem. Częstość występowania SCD oraz ich udział w umieralności spowodowanej CVD wykazuje znaczne zróżnicowanie terytorialne. Spadek liczby zgonów nagłych na 100 000 osób wśród mężczyzn w woj. lubuskim i małopolskim wyniósł ponad 25%. Wśród kobiet spadek ten zaobserwowano jedynie w woj. lubuskim. W pozostałych województwach stwierdzono wzrost umieralności. Znaczny wzrost liczby zgonów nagłych wystąpił wśród mężczyzn w woj. pomorskim — wzrost o 171%, świętokrzyskim — 66%, opolskim — 60%, wśród kobiet zaś w woj. pomorskim — wzrost o 248%, śląskim — 88%, opolskim — 85%. Nie stwierdzono różnic w umieralności dla IHD+SCD zależnie od regionu kraju.

**Wnioski:** Współczynniki umieralności z powodu IHD w populacji polskiej w wieku 25–64 lata są w większości województw niedoszacowane. Jednocześnie w tych samych województwach współczynniki dla zgonów nagłych są przeszacowane. Prezentowane wyniki pokazują niedoskonałość polskiego systemu opieki zdrowotnej w zakresie diagnostycznym, prewencji i zapobiegania nagłym zgonom oraz świadomości społeczeństwa o objawach stanu zagrożenia życia.

**Słowa kluczowe:** nagły zgon sercowo-naczyniowy, choroba niedokrwiennej serca, klasyfikacja przyczyn zgonów, umieralność  
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