# **ORIGINAL ARTICLE**

# Trends in heart failure mortality in Poland between 1980 and 2010

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### **KEY WORDS**

ABSTRACT

heart failure, mortality, prognosis **INTRODUCTION** Data regarding standardized trends in mortality from heart failure (HF) in the general population are limited.

**OBJECTIVES** The aim of the study was to evaluate trends in HF mortality in Poland in the years 1980–2010. **PATIENTS AND METHODS** An analysis of a database of mortality records from 1980–2010 based on National Statistics was performed. Mortality trends for HF by age and sex were analyzed by polynomial or linear regression.

**RESULTS** Total crude numbers of HF deaths in 1980 were 21,519 and 23,008 for women and men, respectively, whereas, in 2010, there were 23,304 and 19,558. There was a significant change in mortality trends for HF, from a decline during the first phase of the study to an increase during the most recent years, 2005–2010 (P < 0.005 for changes of trends for both sexes). The lowest value reached in 2005 constituted 47% and 41% of the baseline for women and men, respectively. These ratios increased to 59% and 52% in 2010. Stratification by age and sex brought similar results, with the exception of the youngest groups, which showed initial increases in the rates for the years 1980–1985.

**CONCLUSIONS** There was a significant decline in the rates of HF mortality in the Polish population for both men and women, showing a maximal reduction of about 50% around 2005. However, between 2005 and 2010, a significant increase in the rates of HF mortality was observed (crude difference equaled 12% for women and 11% for men). It is unknown whether this is a temporary or permanent trend, and the issue requires further investigation.

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**INTRODUCTION** Cardiovascular disease mortality is still an important problem in Europe. Although a substantial improvement has been observed in many countries over the last several decades, in some parts of Europe the problem persists.<sup>1,2</sup> It is estimated that cardiovascular mortality accounts for about 40% of all deaths in the general European population.<sup>1</sup> Recent data regarding cardiovascular mortality for the Polish population have been relatively stable ranging from 50% to 45% of all deaths for the years 1990 and 2011.<sup>3</sup> It has already been shown that despite unfavorable data from a previous publication,<sup>2</sup> there has been a substantial improvement in death rates from coronary artery disease in Poland in the recent years.<sup>4</sup> However, despite the fact that heart failure (HF) is estimated to affect around 1% to 2%

of the general population,<sup>5,6</sup> information regarding trends in HF mortality is limited to a relatively few countries.<sup>1</sup> The first estimation for Poland was reported by Rywik et al.<sup>7</sup> and included data through 1995. Since then, HF treatment has improved and guidelines for therapy have been published.8 In 2002, Korewicki et al.9 in a review of HF management in Poland emphasized that there is a potential for an increase in HF morbidity owing to advances in cardiovascular disease therapy. As the latest available data from the Polish population were collected before significant improvements in HF management were implemented, the objective of this study was to evaluate trends in HF mortality in Poland over a longer period of time, for the years 1980–2010.

Codes for IX revision of IDC	Corresponding codes for X revision of IDC	Explanation
398	109	other rheumatic heart disease
402	l11	hypertensive heart disease
404	113	hypertensive heart and chronic kidney disease
416	127	chronic pulmonary heart disease
425	142	cardiomyopathy
428	150	heart failure
429	151	complications and ill-defined descriptions of heart disease

 TABLE 1
 Codes used for diagnosis of heart failure: IX Revision – 398, 402, 404, 416, 425, 428, 429 and from the X Revision – 109, 111, 113, 127, 142, 150, and 151

PATIENTS AND METHODS All available information regarding the number and underlying causes of deaths was obtained from the Central Statistical Office in Poland (death certificates) for 1980-2010. For the years 1980-1996, the HF diagnosis was based on the IX Revision of the International Classification of Disease and from 1997, it was based on the X Revision. The following codes for HF diagnosis: IX Revision - 398, 402, 404, 416, 425, 428, 429 and from the X Revision - I09, I11, I13, I27, I42, I50, and I51 were used (TABLE 1). To achieve comparable rates with other publications, we applied the European standardization mode.<sup>1</sup> All age-standardized or unstandardized rates were given per 100,000 population. For the purpose of the analyses, we limited subjects' age to 45 years or more, as data for the younger group neither brought any additional information nor changed trends within the studied period. Similar age limits have been applied in other studies, which verified national mortality statistics and trends.<sup>10,11</sup> To analyze the effect of age on HF mortality, all subjects were stratified into 3 age categories: 45-64 years, 65-74 years, and equal or above 75 years of age (unstandardized data).

Trends in HF mortality were analyzed by a polynomial or linear regression analysis, when applicable, with the SAS 9.2 software. For statistical significance, P < 0.05 was accepted.

**RESULTS** Crude and standardized rates of heart failure death The total number of HF deaths in 1980 was 21,524 and 23,019 for women and men, respectively, whereas in 2010, the numbers were 23,304 and 19,558. HF deaths for those older than 44 years constituted 97.06% and 98.14% (1980 and 2010) of the total HF mortality. The standardized HF death rates per 100,000 inhabitants in 1980 for women and men, respectively, were 299.8 (crude values - 351 per 100,000) and 519.5 (crude values - 468). In 2010, the standardized age HF death rates per 100,000 population for both sexes decreased to 175.7 (crude rates 266) and 267.8 (crude rates 271) (FIGURE 1). During the entire follow-up period of 1980–2010, the rates of HF deaths for men were higher than for women, but the gap narrowed over time.

A detailed analysis of death trends revealed that from the year 1980 until 2005, standardized

rates of HF deaths declined for both women and men. The lowest values registered were 141.8 for women and 214.2 for men in 2005, which constituted 47% and 41% of the 1980 death rates, respectively. Subsequently, death rates increased between 2005 and 2010 (women – 176.5 and men – 268.7), reaching 59% and 52% of the baseline values (**FIGURE 1**). A polynomial analysis (**FIGURE 2**) showed that the trends changed significantly twice during the follow-up in men and women, from a declining trend through 2005, followed by a recently emerging increase (P < 0.005).

Age groups Stratifying by age groups revealed a positive association between age and crude HF mortality rates for both sexes with the highest values in the oldest subjects throughout the study period (FIGURES 3 and 4).

Trend analysis in the youngest groups (45–64 years) showed that for both sexes death rates for HF increased during the initial phase of the study, reaching their peak around 1985–1990. After that, the rates declined reaching their nadir around 2005. The rates of HF deaths for this younger subgroup declined from 51.7 to 19.9 for women (38% of the initial values) and from 135.0 to 65.1 for men (48%) between 1980 and 2005. However, during the years 2005–2010, an increase was observed. As a result, standardized HF rates reached 27.8 for women and 95.6 for men, constituting 54% and 71% of the baseline 1980 values. Both changes in trends were significant (*P* <0.0001)

Trends for intermediate and oldest groups (both sexes) were similar to those in the youngest group, but differed slightly. For the age groups 65–74 and >74 years, the highest values were recorded in 1980 and were followed by a decline that persisted until around 2005. After 2005, HF mortality began to increase. The lowest points reached for men and women in the intermediate group were similar (32%–33% of the 1980 values), rising up to around 37%–39% of the baseline values by 2010. Trend changes were significant (both sexes, *P* <0.04).

The general tendency in the oldest groups was similar, but the improvement was less impressive and some differences between sexes were found. HF rates declined to 55% and 44% of the baseline for women and men, respectively. As a result of

FIGURE 1 Age-standardized mortality rates for heart failure in men and women per 100,000 population for the years 1980–2010



**FIGURE 2** Polynomial regression analysis of the age-adjusted trends in heart failure mortality for women and men per 100,000 population for the years 1980–2010; P < 0.005

the increase that began in 2005, by 2010 the rates of deaths from HF in this group reached 71% and 55% of the baseline in 1980. Changes in trends were significant for men (P < 0.007). For the oldest women, only a stable decline was confirmed by linear regression (P < 0.0001); however, the recent increase was not significant unlike in all the other subgroups.

Thus, for both men and women, the youngest group experienced the most pronounced deterioration after 2005, despite significant improvement from baseline. Heart failure death as a proportion of cardiovascular and total mortality rates TABLE 2 presents the HF deaths as a proportion of all cardiovascular deaths and all deaths from any cause. Trends of HF death, for specified age groups, expressed as percentage of total cardiovascular mortality per 100,000 inhabitants were relatively similar for men and women. The ratio of HF deaths to cardiovascular deaths declined for all age groups in both sexes until 2005. In 2010, however, this ratio increased in all age groups; moreover, the youngest groups (both men and women) exceeded the baseline FIGURE 3 Heart failure mortality in men by age groups per 100,000 population for the years 1980–2010



FIGURE 4 Heart failure mortality in women by age groups per 100,000 population for the years 1980–2010

values from 1980. They reached 106% for women and 105% for men.

For the remaining age groups, at the end of follow-up, the values were between 72% and 100% of those recorded in 1980. Moreover, although at the beginning of the follow-up, the ratio of HF deaths to overall cardiovascular deaths was lower in women than in men, and this reversed by the end of the follow-up period.

Likewise, the ratio of HF deaths to total deaths was similar in both sexes, and declined until 2005, then increased between 2005 and 2010. Despite the increase, the 2010 values did not exceed the 1980 baseline. With the exception of the youngest group, HF deaths were responsible for a higher proportion of total deaths in women than in men in 2010, as opposed to 1980. Thus, there was an overall modest decrease in the contribution of HF deaths to total cardiovascular mortality or overall mortality. However, in the youngest groups the ratio of HF deaths to total cardiovascular deaths increased.

**DISCUSSION** Death certificates are increasingly used to evaluate cardiovascular mortality rates, including HF mortality.<sup>1,12</sup> Despite concerns about regional or country differences in coding of death certificates,<sup>13,14</sup> this method of monitoring mortality has an advantage over others. It is less susceptible to inconsistency of the inclusion criteria, differences in follow-up periods or the effect of population aging and findings can be more easily generalized than analyses of in-hospital mortality.<sup>1,15,16</sup> Based on the information

TABLE 2 Proportion of heart failure deaths to cardiovascular or all-cause (total) mortality in both sexes for every 5 years between 1980–2010, by age groups, per 100,000 population (expressed in %)

Years	Age group, 45–64 y				Age group, 65–74 y			Age group, ≥75 γ				
	women		men		women		men		women		men	
	HF/CVD		HF/CVD	HF/total	HF/CVD		HF/CVD		HF/CVD		HF/CVD	
	death	death	death	death	death	death	death	death	death	death	death	death
1980	21.68	7.88	21.81	8.98	25.89	14.44	29.83	15.42	25.87	16.42	29.81	17.62
1985	19.07	7.44	18.44	7.78	22.34	12.77	24.06	12.63	21.33	14.22	24.73	15.18
1990	17.52	6.97	17.01	7.34	19.27	10.66	20.72	10.95	18.02	12.40	20.78	13.25
1995	18.78	6.77	19.13	7.58	19.72	10.83	21.49	10.94	17.64	11.57	19.92	12.40
2000	15.24	4.61	14.54	5.23	17.15	8.42	17.27	7.96	20.26	12.88	20.65	11.66
2005	15.76	4.03	15.70	5.05	16.31	7.32	16.05	6.72	19.10	11.93	18.97	10.18
2010	22.96	5.52	22.80	7.42	22.14	9.03	21.34	8.66	25.82	16.11	25.49	13.61

Abbreviations: CVD - cardiovascular disease, HF - heart failure

available from the Central Statistical Office for 1992–2010, there was about 10% reduction of cardiovascular causes of death in Poland. Despite this decrease, cardiovascular deaths accounted for around 46% of all deaths, remaining the leading cause of death in Poland.<sup>3</sup>

**Mortality rates** During 30 years of follow-up (1980–2010), we demonstrated nearly a 50% reduction in adjusted HF mortality rates in both sexes. HF mortality declined during most of the follow-up period. The reduction in mortality due to HF within similar observation periods was documented consistently in the previous publications.<sup>1,14,17,18</sup>

There are at least 2 reasons for the tendencies observed. First, the study period is characterized by an overall increase in life expectancy in Poland by about 6 years for men and women.<sup>19</sup> Advances in the treatment of HF that have begun in the late 1980s are another likely reason. The high quality of HF pharmacotherapy in Poland was confirmed previously.<sup>20</sup> Changes in the treatment of underlying diseases are also likely a modifying factor. Efforts to reduce the risk of coronary artery disease, that is a major cause of HF in the Polish population, have resulted in a lower myocardial infarction incidence. Further, the severity of coronary events and size of damaged myocardium likely declined due to a more aggressive use of reperfusion therapy. Effective treatment of hypertension, another cause of HF, is also likely to have contributed to a reduction in risk of HF. Nevertheless, neither of the latter successful approaches eliminates the risk of HF but postpones the development of the disease. HF mortality rates did not change during 1950–1979 with significant improvement thereafter.<sup>14</sup> This is consistent with the notion that the biggest advance in cardiovascular therapy occurred after 1980.

Most published data that inform about cardiovascular mortality trends do not report on results after 2005. Alarming tendencies can be observed while analysing HF mortality trends for 2002/2003 and later. In a UK study, a slight increase of age-standardized HF mortality in both men and women emerges after 2000.18 In another study analyzing mortality data from different European countries, after declining, mortality appears to level off after 2005. Furthermore, stratification by countries shows slowing of mortality improvements with a plateau or even minimal upward tendency in some countries.<sup>1</sup> Similar stabilization of mortality trends can be identified in studies from Scotland and Sweden after 2000.<sup>17,21</sup> In a recent paper from the Czech Republic, trends in HF mortality within comparable period were at best stable.<sup>22</sup> Thus, the mortality trends we presented here are consistent with those reported for other European countries, although our study shows a more pronounced change of slope than other studies. Our study benefits from examining the longest follow-up period reported so far.

An interesting finding from our study is the crossing-over of the crude HF death rates for women and men at the end of study, showing higher values in women as seen in Spanish and American populations.<sup>23,24</sup> This pattern is abolished after standardization, but the trends have shown that women experienced less improvement in HF mortality than men between 1980 and 2010. This fact may be explained by prevalent ischemic etiology in men and hypertension in women<sup>17</sup> and more prevalent diastolic dysfunction in elderly women, a condition with no proven disease-modifying strategies<sup>21</sup> and increased mortality.<sup>25</sup> It cannot be excluded either that some role can be played by the lack of social support as most of HF elderly women are lonesome (unpublished data), which can be a determining factor in the late phase of life.

Based on the epidemiologic data, the incidence of HF was increasing until the late 1990s,<sup>26</sup> and then plateaued or even decreased slightly as reported in recent publications.<sup>27</sup> For the last several decades, the prevalence of HF is still rising.<sup>26,27</sup> It has also been suggested that with the incidence of HF stable over the last several decades, prognosis of HF patients may be worsened by the increasing prevalence of obesity and diabetes.<sup>21</sup>

Initially, it was estimated that 1-year survival after HF diagnosis is approximately 60%.<sup>28</sup> We must assume a few years' lag in implementing HF evidence-based therapies and the resulting improvement in prognosis.<sup>1</sup> Thus, deaths were delayed by the introduction of effective therapies and the trends observed reflect this delay in death rates. This hypothesis is possible although there are no data to confirm it.

Another aspect is the changing mode of death. Both pharmacological treatment and implementation of sudden death prevention (by increasing the number of defibrillators implanted) in recent decades decreased the risk of sudden death.<sup>29,30</sup> As it has been shown recently, the 3-year risk of sudden death decreased by 65% for the years 2005–2010 compared with 1993–1998, whereas the risk of death owing to progressive HF remained stable within the same period.<sup>30</sup> Thus the number of subjects surviving potentially lethal arrhythmias and living longer, susceptible to dying from pump failure, must have increased significantly within the analyzed period.<sup>20,30</sup>

**Age stratification** A positive association between HF mortality and age is well established.<sup>10,11,15-17,23,24,31</sup> In general, our results show a similar trend of an initial decline followed by an increase in HF mortality across both sexes and all age groups. In all age groups, the rates of HF deaths were higher for men compared with women, which was consistent with some other studies.<sup>15,16,21,31</sup> Yet, in some papers, in the older groups, the reverse was true.<sup>24</sup>

With longer life expectancy, the proportion of elderly subjects characterized by more unfavorable prognosis is increasing. On the other hand, healthy life style popularization, improvement in cardiovascular risk profile, and adequate therapy of underlying cardiovascular condition should modify prognosis in younger individuals. Thus, one might expect that mortality rates would decline more for younger subjects.<sup>15,24,31</sup> Unfortunately, our data show the contrary. As far as the older groups are concerned, the predicted trends are true for the groups of elderly women, but not for men. These trends may also be explained by later onset of cardiovascular diseases that are the principal cause of HF in women,<sup>24,32</sup> whereas ischemic heart disease that is more prevalent in men has earlier onset.<sup>33</sup> Recent increases in death rates in most elderly women observed after 2005 may be caused by higher prevalence of HF without systolic dysfunction<sup>15</sup> and/or less intensive care in the elderly.

The most striking observation was made in our youngest patients. Although the overall decline over the study period is comparable with other reports ending by 2000,<sup>15,31</sup> the improvement reported here is even more convincing. However,

in the final years of the follow-up, HF mortality measures for both sexes deteriorated substantially, particularly in men. These trends stand in contrast to reports from the United States<sup>15</sup> and Scotland.<sup>31</sup> The cause of these trends is unknown and there is little literature on the topic that covers trends in HF mortality in recent years around the world.

Heart failure death as the proportion of cardiovascular or total mortality The ratio of HF mortality to total cardiovascular deaths or to overall mortality is regarded as a true marker of HF death coding.<sup>34</sup> With a decline of cardiovascular deaths<sup>3</sup> accompanied by a similar or even more pronounced reduction in HF mortality, the ratio should be relatively stable or should decline, which is consistent with the overall findings in our population.

Rising values in the youngest analysed groups confirm the magnitude of the problem. Moreover, the proportion of HF deaths to total cardiovascular deaths in 2010 was even higher for both sexes compared with baseline parameters. In the oldest groups, the 2010 values almost equalled the initial rates. In addition, the reported proportions appear to be at odds with other publications,<sup>16,35</sup> which showed smaller numbers for the ratio of HF to cardiovascular mortality.

Similarly, unfavorable trends for the relationship between HF mortality and overall mortality in the youngest group were observed. Our observation showed a more pronounced deterioration and, therefore, was in disagreement with the previous reports.<sup>16,31,35</sup>

In summary, our results suggest a growing role of HF as a deadly condition, as despite the overall decline in HF mortality, the rates of HF deaths expressed as a proportion of cardiovascular or overall mortality did not decline in general.

Limitations During 1996–1998, due to health service strikes, information regarding National Statistics was not fully available so it was not included in the analysis (death certificates were incomplete). Another issue was incomplete uniformity of coding of the cause of death across the country despite the applied standardization procedures. As in the other publications, we did not verify the death certificates by autopsy examinations. Nevertheless, these represent the best data available, and similar challenges have been identified in studies of populations from various countries. Despite this, we believe that our results are representative and adequately illustrate the current epidemiological situation.

**Conclusions** During 30 years of follow-up, we documented a marked decline in overall standardized HF mortality rates in both sexes. After an extended period of improvement, an increase in death rates was seen by the end of the follow-up. It is unknown if it is a permanent trend or temporal fluctuation. The most striking finding of this report is that the initial gains in HF mortality rates in younger subjects, particularly men, were lost by the end of follow-up. Moreover, the rising proportion of HF mortality to either total cardiovascular or overall death rates suggests that HF remains a growing problem, which is an important contributor to the overall mortality of the Polish population.

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# **ARTYKUŁ ORYGINALNY**

# Trendy umieralności z powodu niewydolności serca w populacji polskiej w latach 1980–2010

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## SŁOWA KLUCZOWE STRESZCZENIE

niewydolność serca, rokowanie, umieralność **WPROWADZENIE** Obecnie dysponujemy jedynie niepełnymi danymi dotyczącymi umieralności z powodu niewydolności serca (NS) w populacji ogólnej.

CELE Celem pracy była analiza trendów umieralności z powodu NS w Polsce w latach 1980–2010.

**PACJENCI I METODY** Przeprowadzono analizę danych z kart zgonów z Głównego Urzędu Statystycznego. Trendy umieralności z powodu niewydolności serca oceniano na podstawie analizy regresji wielomianowej lub liniowej w zależności od płci i wieku.

WYNIKI Ogólne współczynniki umieralności z powodu NS w 1980 r. wynosiły dla kobiet i mężczyzn odpowiednio 21519 i 23008, natomiast w 2010 r. – odpowiednio 23304 oraz 19558. W trakcie analizowanego okresu doszło do istotnej zmiany trendu umieralności z powodu NS. W początkowej fazie obserwacji widoczny był trend spadkowy, a następnie wzrostowy dla lat 2005–2010 (p <0,005 dla zmiany trendu dla obu płci). Najniższe wartości stwierdzone około 2005 r. stanowiły 47% i 41% wartości wyjściowych, odpowiednio dla kobiet i mężczyzn. W dalszej obserwacji najwyższe wartości odnotowano w 2010 r. (59% wartości wyjściowych dla kobiet i 52% dla mężczyzn). Podział na grupy względem wieku i płci nie zmienił istotnie trendów, poza grupą najmłodszą, dla której zarejestrowano początkowo wzrost współczynników umieralności (lata 1980–1985).

WNIOSKI Uzyskane dane wskazują na zmniejszenie umieralności z powodu NS w populacji polskiej zarówno wśród kobiet, jak i mężczyzn. Największą redukcję umieralności (ok. 50%) odnotowano około 2005 r. Niemniej jednak w latach 2005–2010 stwierdzono wyraźną tendencję wzrostową (w wartościach bezwzględnych dla kobiet i mężczyzn o 12% i 11%). Nie można obecnie jednoznacznie ocenić, czy jest to zmiana krótkotrwała, czy też trwała zmiana trendu.

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