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ORIGINAL ARTICLE

Trends in survival of Swedish men and women with heart failure from 1987 to 2014: a population-based case–control study

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Abstract

Aims To compare trends in short-term and long-term survival of patients with heart failure (HF) compared with controls from the general population.

Methods and results We used data from the Swedish National Inpatient Registry to identify all patients aged ≥18 years with a first recorded diagnosis of HF between 1 January 1987 and 31 December 2014 and compared them with controls matched on age and sex from the Total Population Register. We included 702 485 patients with HF and 1 306 183 controls. In patients with HF aged 18–64 years, short-term (29 days to 6 months) and long-term mortality (>11 years) decreased from 166 and 76.6 per 1000 person-years in 1987 to 2000 to 99.6 and 49.4 per 1000 person-years, respectively, in 2001 to 2014. During the same period, mortality improved marginally, in those aged ≥65 years: short-time mortality from 368.8 to 326.2 per 1000 person-years and long-term mortality from 219.6 to 193.9 per 1000 person-years. In 1987–2000, patients aged <65 years had more than three times higher risk of dying at 29 days to 6 months, with an hazard ratio (HR) of 3.66 [95% confidence interval (CI) 3.46–3.87], compared with controls ($P < 0.0001$) but substantially higher in 2001–2014 with an HR of 11.3 (95% CI 9.99–12.7, $P < 0.0001$). HRs for long-term mortality (6–10 and >11 years) increased moderately from 2.49 (95% CI 2.41–2.57) and 3.16 (95% CI 3.07–3.24) in 1987–2000 to 4.35 (95% CI 4.09–4.63) and 4.11 (95% CI 3.49–4.85) in 2001–2014, largely because survival among controls improved more than that among patients with HF ($P < 0.0001$).

Conclusions Absolute survival improved in HF patients aged <65 years, but only marginally so in those aged ≥65 years. Compared with controls, both short-term and long-term relative risk of dying increased, especially in younger patients with HF.

Keywords Heart failure; Survival; Mortality; Trends; Population; Epidemiology

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Introduction

Heart failure is a common clinical syndrome with high morbidity and mortality and is associated with high healthcare costs.[1] In Sweden and other high-income Western countries, the prevalence of heart failure in the adult population is estimated at about 1–2%.[2] Although heart failure prevalence and incidence are highest in elderly people, increased incidence and hospitalization among younger patients have been reported in Sweden and Denmark.[3,4] Similar trends were seen in Canada, but only in younger men, but not in younger women.[5]

In the last few decades, new treatments for heart failure have been developed, and general management has improved.[6] However, the medical and other treatment options (such as devices and pacemakers) have mainly been developed for patients with heart failure and reduced

ejection fraction (HFrEF),[6] which is more common in younger patients.[7,8] In patients with heart failure and preserved ejection fraction (HFpEF), which is more common in women and older patients, management has not advanced to a similar degree, and the prognosis remains poor.[8,9]

With the increasing life expectancy worldwide, the number of patients with heart failure will rise, and improved survival of heart failure patients will potentially contribute to a larger population of people with this condition. Among heart failure patients in Sweden, survival increased until the first few years of the new millennium,[3,10] but not thereafter. Hence, continuing improvement between 2006 and 2010 was seen among heart failure patients in the Stockholm region.[11] A recent study from the United Kingdom found modest improvements in survival from 2002 to 2017.[12]

The extent to which long-term survival of patients with heart failure has changed in relation to that of other people has not been investigated in unselected patients hospitalized with heart failure in Sweden or elsewhere. In the present study, we aimed to determine the short-term and long-term mortality of patients discharged with a diagnosis of heart failure compared with controls from the general population.

Methods

Study design and participants

Sweden has a mainly publicly financed healthcare system, with low out-of-pocket costs for hospitalizations, procedures, and prescription drugs. The Swedish National Inpatient Registry contains complete records for all principal and contributory diagnoses for all hospitalizations since 1987 and has high validity in general and for heart failure in particular (85–95% accuracy compared with patient records).[13,14] Using this inpatient registry, we identified and included all patients aged ≥18 years with a first recorded hospitalization, of heart failure between 1 January 1987 and 31 December 2014. For each heart failure case, up to two controls without any prior hospitalization for heart failure, matched by age, sex, and county, were selected from the Swedish Total Population Registry. Data on times and causes of death were derived from the Cause of Death Registry.

All cases of heart failure (main and contributory diagnoses in any position) and all comorbidities were defined according to International Classification of Diseases (ICD)-9 and ICD-10 codes. Heart failure was defined by 428 for ICD-9, and I50 for ICD-10 (Supporting Information, *Table S1*).

All data were anonymized: the study was approved by the Regional Ethical Review Board in Gothenburg, Sweden (Dnr: 026-16). The research conforms with the principles outlined in the Declaration of Helsinki.

Statistical analysis

The study period started on 1 January 1987 and ended on 31 December 2014. All patients were followed from first hospitalization for heart failure in the inpatient registry (baseline) until death or end of follow-up, whichever occurred first. Baseline characteristics are shown as count (percentage) for dichotomous and categorical data and as mean (standard deviation) for numerical variables. A *P* value of <0.05 was considered significant. To determine survival probability after heart failure, the study was split into two periods (1987–2000 and 2001–2014), and the cohort was stratified into two age groups (18–64 years and ≥65 years). Probability of survival was modelled by the Kaplan–Meier method.

For assessment of mortality after heart failure, follow-up data were divided into five periods: 29 days to 6 months, >6 months to 1 year, >1 to 5 years, >5 to 10 years, and >10 years. All-cause mortality rates and corresponding 95% confidence intervals (95% CIs) per 1000 person-years were calculated. Differences in mortality between patients and controls were assessed by Cox proportional-hazards regression to estimate the relative risks of mortality. Multivariable Cox regression was performed to evaluate the impact of sex, age, and baseline comorbidity on the survival times in heart failure cases from period 1987 to 2000 comparing to cases from 2001 to 2014. Survival was modelled by the Kaplan–Meier method.

All statistical analyses and data management were performed with SAS statistical software, version 9.4 (SAS Institute, Cary, NC), and all graphs were created using R Version 3.1.3 3 (http://R-project.org).

Results

In total, we included 702 485 patients with a first hospitalization for heart failure (49.8% men; 50.2% women) and 1 306 183 matched controls (49.4% men; 50.6% women) from the general population without prior heart failure. *Table 1* shows the baseline characteristics, including comorbidities and heart failure risk factors for the two periods (1987–2000 and 2001–2014). Among patients with heart failure, women comprised about 32% of the younger patients aged 18–64 years and about 53% of the older patients aged ≥65 years, with little difference between the two periods. The mean age for patients aged 18–64 years was about 56 years in both periods and in those aged ≥65 years about 80 years in both periods, with the majority (88.7%) of all heart failure patients aged ≥65 years (*Tables 1* and *S2*).

Changes in comorbidities and heart failure risk factors

Overall, patients with heart failure had more comorbidities and heart failure risk factors than controls, including not only ischaemic heart disease, hypertension, atrial fibrillation, diabetes, valvulopathy, and cardiomyopathy but also stroke (*Table 1*). In patients aged <65 years, recorded diagnoses of hypertension, atrial fibrillation, and cardiomyopathy increased from 20.7%, 19.3%, and 7.6% in 1987–2000 to 41.1%, 27.9%, and 12.3% in 2001–2014 (all $P < 0.0001$). All other comorbidities and heart failure risk factors increased significantly ($P < 0.0001$) except cancer where there was no significant change ($P = 0.41$). During same time frame, the most conspicuous change among controls was observed for hypertension, which increased from 4.0% to 8.3% in the second period ($P < 0.0001$).

All recorded comorbidities and heart failure risk factors increased significantly (all $P < 0.0001$) in patients aged ≥65 years, likely at least partly due to changing coding practices. The prevalence of hypertension tripled (17.9% to 52.1%, $P < 0.0001$) and atrial fibrillation almost doubled (26.4% to 44.1%, $P < 0.0001$) from 1987–2000 to 2001–2014. In addition, the prevalence of valvulopathy (7.1% to 13%), cancer (16.1% to 25.6%), ischaemic heart disease (42.6% to 47.4%), diabetes (17% to 21.8%), and chronic obstructive pulmonary disease/asthma (12.4% to 17.3%) increased significantly (all $P < 0.0001$). In controls aged ≥65 years, all comorbidities and heart failure risk factors increased significantly (all P values < 0.0001) except cardiomyopathy that decreased from 0.04% to 0.02% ($P < 0.0001$).

Survival and mortality in patients with heart failure compared with controls from the general population

Figures 1 and *2* show the survival curves after a heart failure diagnosis in patients aged 18–64 years and ≥65 years, respectively. Survival improved in younger patients with heart failure, while survival in older patients showed virtually no improvement between the two periods, despite better survival in controls in the later period.

Overall, the mortality rates were higher during the first 29 days to 6 months after discharge with a heart failure diagnosis. In patients younger (<65 years) with heart failure, the mortality rates for 29 days to 6 months were 166 and 99.6 per 1000 person-years in 1987–2000 and 2001–2014, respectively, compared with 45.4 and 8.8 per 1000 person-years in the controls. Long-term mortality (>11 years) decreased from 76.6 per 1000 person-years in 1987–2000 to 49.4 per 1000 person-years in 2001–2014 in patients, while mortality rates in controls decreased even further (from 24.6 to 12 per person-years) (*Table 2*).

Table 1 Baseline characteristics of patients with heart failure and controls from the general population for 1987–2000 and 2001–2014 by age group

	HF patients aged 18–64 years			HF patients aged ≥65 years		
	1987–2000 *n* = 37 765	2001–2014 *n* = 41 572	*P* value	1987–2000 *n* = 331 567	2001–2014 *n* = 291 581	*P* value
Mean age, years (SD)	56.6 (7.5)	55.8 (8.2)		79.6 (7.2)	81.1 (7.6)	
Women, *n* (%)	12 076 (32.0)	12 689 (30.5)	<0.0001	175 050 (52.8)	152 976 (52.5)	
Diabetes, *n* (%)	8223 (21.8)	10 203 (24.5)	<0.0001	56 479 (17.0)	63 707 (21.8)	<0.0001
Hypertension, *n* (%)	7815 (20.7)	17 070 (41.1)	<0.0001	59 260 (17.9)	152 017 (52.1)	<0.0001
IHD, *n* (%)	16 590 (43.9)	16 784 (40.4)	<0.0001	141 106 (42.6)	138 296 (47.4)	<0.0001
Atrial fibrillation, *n* (%)	7277 (19.3)	11 591 (27.9)	<0.0001	87 507 (26.4)	128 484 (44.1)	<0.0001
Valvulopathy, *n* (%)	3421 (9.1)	4607 (11.1)	<0.0001	23 626 (7.1)	37 937 (13.0)	<0.0001
Cardiomyopathy, *n* (%)	2888 (7.6)	5129 (12.3)	<0.0001	2730 (0.8)	5712 (2.0)	<0.0001
Stroke, *n* (%)	2770 (7.3)	3237 (7.8)	0.0163	45 676 (13.8)	52 165 (17.9)	<0.0001
Pulmonary embolism, *n* (%)	766 (2.0)	1179 (2.8)	<0.0001	7221 (2.2)	11 859 (4.1)	<0.0001
COPD/asthma, *n* (%)	5008 (13.3)	6306 (15.2)	<0.0001	41 230 (12.4)	50 377 (17.3)	<0.0001
Cancer, *n* (%)	4956 (13.1)	5538 (13.3)	0.4105	53 367 (16.1)	74 754 (25.6)	<0.0001

COPD, chronic obstructive pulmonary disease; HF, heart failure; IHD, ischaemic heart disease, SD, standard deviation.

Table 1 (continued)

	Controls aged 18–64 years 1987–2000 *n* = 73 944	2001–2014 *n* = 82 353	*P* value	Controls aged ≥65 years 1987–2000 *n* = 619 355	2001–2014 *n* = 530 531	*P* value
Mean age, years (SD)	56.6 (7.5)	55.8 (8.2)		79.4 (7.1)	80.3 (7.2)	
Women, *n* (%)	23 738 (32.1)	25 207 (30.6)		327 988 (53.0)	283 774 (53.5)	
Diabetes, *n* (%)	2854 (3.86)	3591 (4.36)	<0.0001	38 480 (6.21)	50 622 (9.54)	<0.0001
Hypertension, *n* (%)	2962 (4.01)	6852 (8.32)	<0.0001	46 166 (7.45)	137 310 (25.9)	<0.0001
IHD, *n* (%)	4892 (6.62)	3948 (4.79)	<0.0001	84 537 (13.6)	95 555 (18.0)	<0.0001
Atrial fibrillation, *n* (%)	926 (1.25)	1567 (1.9)	<0.0001	28 341 (4.58)	57 396 (10.8)	<0.0001
Valvulopathy, *n* (%)	396 (0.54)	477 (0.58)	0.2474	6795 (1.1)	14 952 (2.82)	<0.0001
Cardiomyopathy, *n* (%)	69 (0.09)	22 (0.03)	<0.0001	229 (0.04)	95 (0.02)	<0.0001
Stroke, *n* (%)	1544 (2.09)	1592 (1.93)	0.0292	51 073 (8.25)	58 735 (11.1)	<0.0001
Pulmonary embolism, *n* (%)	199 (0.27)	396 (0.48)	<0.0001	4504 (0.73)	8941 (1.69)	<0.0001
COPD/asthma, *n* (%)	1666 (2.25)	2288 (2.78)	<0.0001	24 065 (3.89)	30 887 (5.82)	<0.0001
Cancer, *n* (%)	6097 (8.25)	5822 (7.07)	<0.0001	77 210 (12.5)	112 463 (21.2)	<0.0001

COPD, chronic obstructive pulmonary disease; HF, heart failure; IHD, ischaemic heart disease; SD, standard deviation.

In younger patients with heart failure, the risk of dying was almost four times higher than that in controls [hazard ratio (HR) 3.66, 95% CI 3.46–3.87, $P < 0.0001$] at 29 days to 6 months in 1987–2000 (*Table 2*). Because the decreasing death rates in controls, the relative risk of death at 29 days to 6 months in patients with heart failure increased (HR 11.3, 95% CI 9.99–12.7, $P < 0.0001$) in 2001–2014. Notably, although the absolute mortality rates during follow-up improved in heart failure patients, the relative risk compared with controls increased, for long-term mortality (>11 years) increased from 3.16 (95% CI 3.07–3.24) in 1987–2000 to 4.11 (95% CI 3.49–4.85, $P < 0.0001$) in 2001–2014. To compare the risk in the first period (1987–2000) and the second period (2001–2014), we included time period in the multivariable cox regression model. The relative risk of death was significantly higher in the first period with a HR of 1.54 (95% CI 1.51–1.57, $P < 0.0001$) in patients with heart failure <65 years and a HR of 1.24 (95% CI 0.23–1.24, $P < 0.0001$) in those aged ≥65 years.

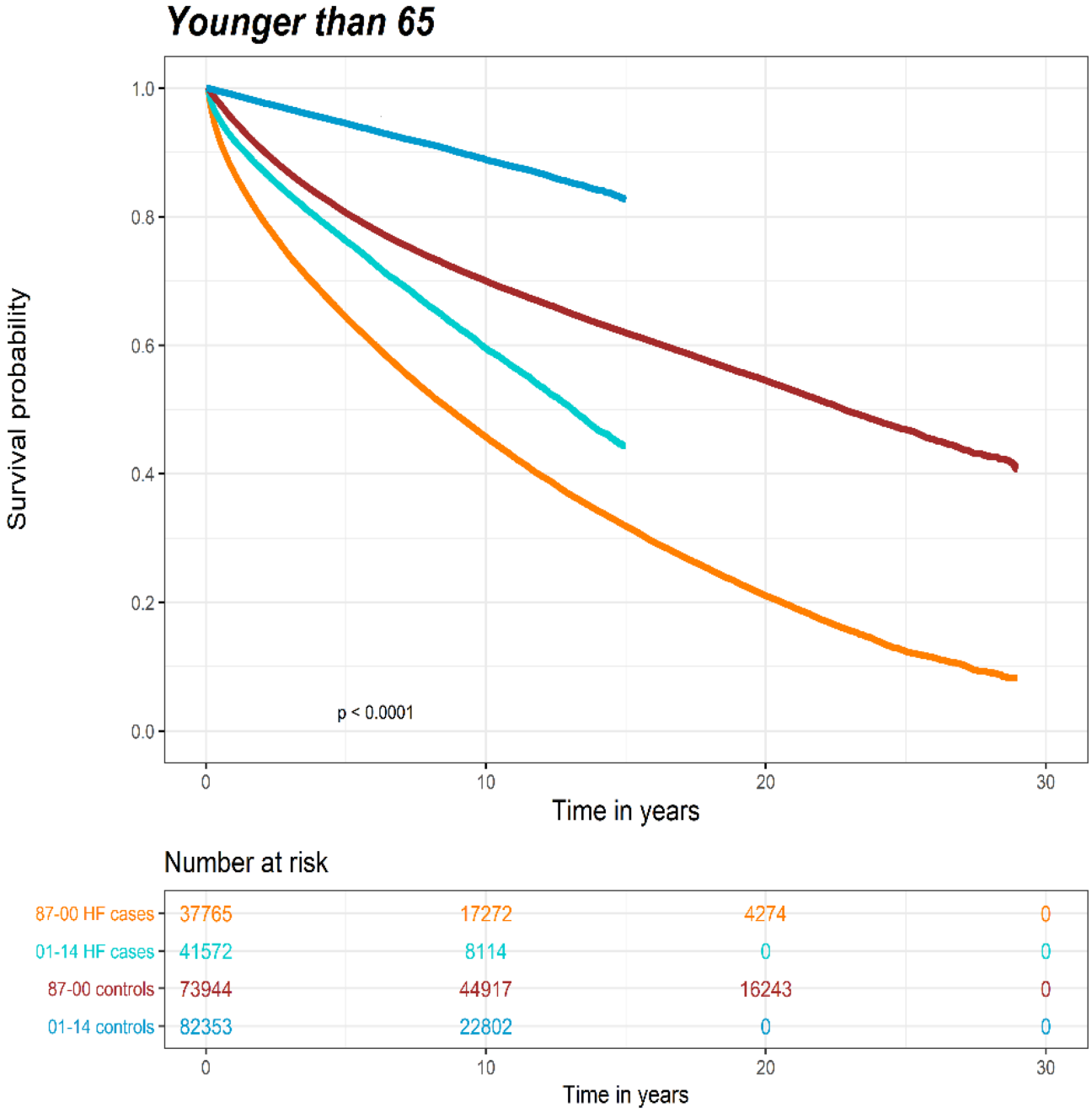
The mortality rates in patients aged ≥65 years improved marginally from 368.8 to 326.2 per 1000 person-years at 29 days to 6 months from 1987–2000 to 2001–2014, while long-term-mortality (>11 years) decreased slightly more from 219.6 to 193.9 per 1000 person-years during the same time frame. During the first 10 years of follow-up, the HRs for heart failure patients compared with controls were consistently higher in 2001–2014 compared with 1987–2000 (*Table 2*).

Table 3 shows all-cause mortality and causes of death in the patients with heart failure and controls in 1987–2000 and 2001–2014 until the end of the study. Only one in five of patients aged 18 to 64 identified in 1987 to 2000 was still alive at the end of the second study period, and virtually none of the older patients. Notably, in only a small proportion of all patients was heart failure stated as the underlying cause of death. In patients aged ≥65 years, heart failure was the cause of death in about 2.5% of the cases with no significant increase ($P = 0.70$ from 1987–2000 to 2001–2014), whereas in those ≥65 years, there was a minor increase (7.4% to 8.7%, $P < 0.0001$). These results further emphasize the heterogeneities in the causes and multiple comorbidities in this disorder. The proportion of deaths from ischaemic heart disease decreased between the periods in both patients with heart failure and controls.

Discussion

This large nationwide register study, including more than 700 000 patients with heart failure and about 1.3 million matched controls from the general Swedish population, showed that even though mortality rates from heart failure decreased from 1987 to 2014, short-term and long-term mortality remained high. While survival improved in younger

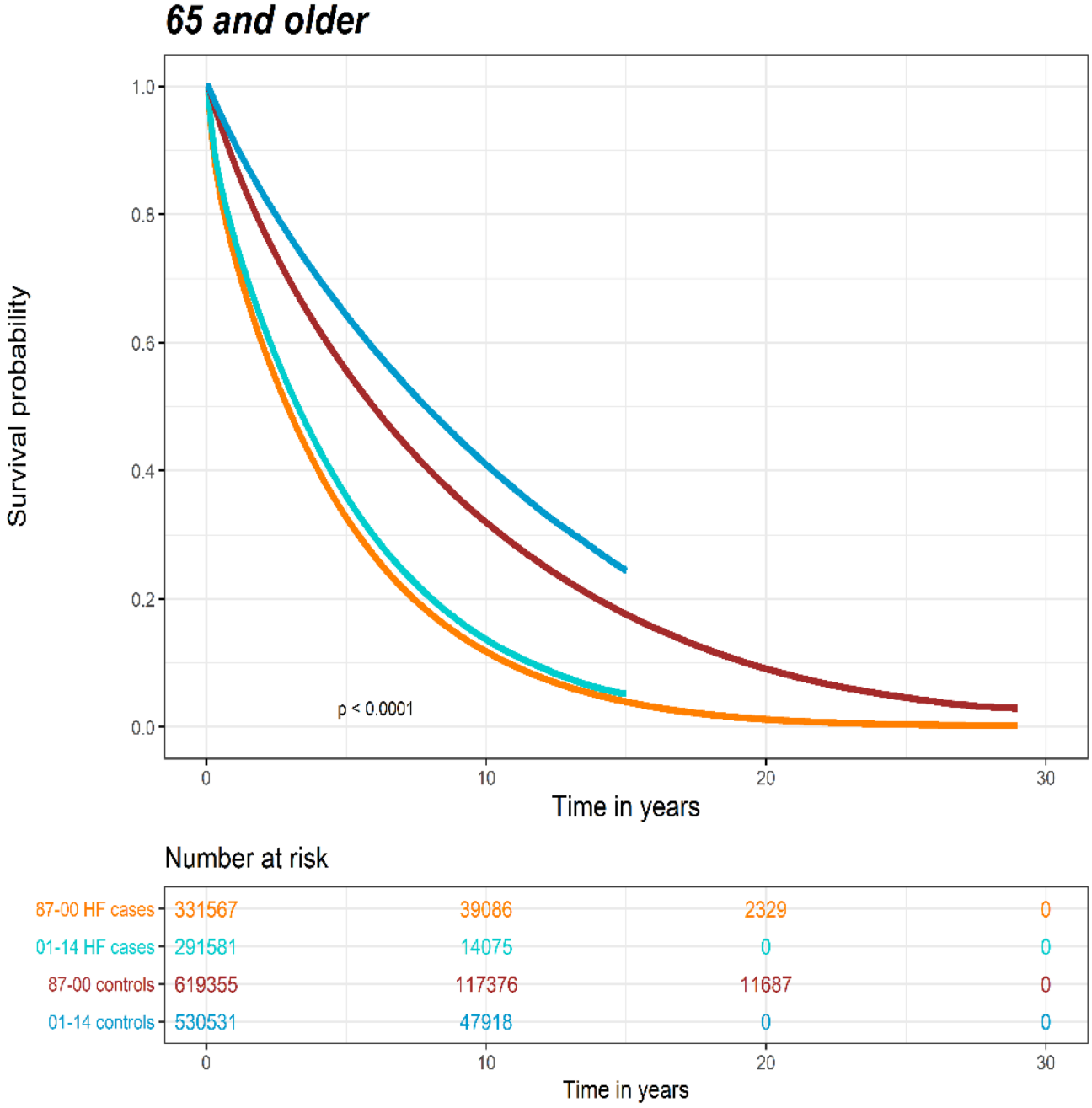
Figure 1 Survival probability after heart failure in patients aged 18–64 years.



patients with heart failure aged <65 years, survival only improved marginally in older patients aged ≥65 years, who constituted the absolute majority of all patients. The general improvement in life expectancy among the Swedish general population was not evident to the same extent in patients with heart failure. This is in line with official statistics from the Swedish Board of Health and Social Welfare which shows that age-adjusted mortality in adults aged <65 years decreased by over a third between 1997 and 2019.[15] Notably, the relative risk in heart failure patients compared with controls increased markedly between the two periods, with an increasing difference in survival between people with and without heart failure.

During the study period, the mortality rates in heart failure patients initially decreased in the first period in 1987–2000, but showed no further reduction during the second period 2001–2014. These results are consistent with a recently published paper from the United Kingdom, which showed a

Figure 2 Survival probability after heart failure in patients aged ≥65 years.



modest improvement in survival among patients diagnosed with heart failure after 2001.[12] A study from the United States showed an increase in deaths from heart failure in the general population, but it was unclear whether this arose from an increase in incident heart failure or poorer survival.[16] A recently published systematic review showed that short-term mortality from any cause in patients hospitalized for acute heart failure decreased over the past four decades but did not describe prognosis beyond the first year.[17] In the present study, we also found that all-cause deaths declined from the first period (1987–2000) to the second period (2001–2014), most markedly in younger patients.

Compared with controls from the population, both short-term and long-term mortality were higher in patients with heart failure, and because survival improved more markedly in controls than in patients, the relative risk of dying increased in patients between the two periods. For example, in younger patients, the risk of dying at 29 days to

Table 2 Mortality rates and relative risks of death in patients with heart failure compared with controls from the general population by age group and period

	Total				Age 18–64 years				Age ≥65 years			
	Mortality rate[a]		HR (95% CI) HF patients vs. controls		Mortality rate[a]		HR (95% CI) HF patients vs. controls		Mortality rate[a]		HR (95% CI) HF patients vs. controls	
Time period	HF patients	Controls		*P* value	HF patients	Controls		*P* value	HF patients	Controls		*P* value
1987–2000												
29 days–6 months	346.7	111.5	3.12 (3.08–3.16)	<0.0001	166.0	45.4	3.66 (3.46–3.87)	<0.0001	368.8	119.7	3.09 (3.05–3.13)	<0.0001
7–12 months	222.2	121.4	1.83 (1.80–1.86)	<0.0001	105.2	50.0	2.10 (1.98–2.24)	<0.0001	237.7	130.9	1.82 (1.79–1.84)	<0.0001
1–5 years	223.1	123.8	1.78 (1.77–1.79)	<0.0001	88.1	45.1	1.93 (1.88–1.98)	<0.0001	246.4	137.3	1.77 (1.76–1.78)	<0.0001
6–10 years	170.0	90.5	1.87 (1.86–1.89)	<0.0001	65.5	26.3	2.49 (2.41–2.57)	<0.0001	202.4	108.9	1.86 (1.84–1.88)	<0.0001
>11 years	157.0	81.6	1.91 (1.89–1.93)	<0.0001	76.6	24.6	3.16 (3.07–3.24)	<0.0001	219.6	120.1	1.84 (1.82–1.87)	<0.0001
2001–2014												
29 days–6 months	296.3	73.6	4.03 (3.97–4.11)	<0.0001	99.6	8.8	11.3 (9.99–12.7)	<0.0001	326.2	84.1	3.89 (3.82–3.96)	<0.0001
7–12 months	193.6	80.5	2.40 (2.36–2.45)	<0.0001	66.1	10.1	6.54 (5.80–7.36)	<0.0001	215.0	92.5	2.32 (2.28–2.37)	<0.0001
1–5 years	203.0	87.3	2.27 (2.25–2.29)	<0.0001	56.8	11.7	4.76 (4.55–4.99)	<0.0001	235.5	103.7	2.21 (2.19–2.23)	<0.0001
6–10 years	151.5	66.9	2.26 (2.23–2.30)	<0.0001	48.2	11.1	4.35 (4.09–4.63)	<0.0001	193.2	86.5	2.24 (2.20–2.27)	<0.0001
>11 years	136.2	68.4	1.99 (1.89–2.10)	<0.0001	49.4	12.0	4.11 (3.49–4.85)	<0.0001	193.9	98.3	1.97 (1.87–2.08)	<0.0001

CI, confidence interval; HF, heart failure; HR, hazard ratio.
[a]Per 1000 person-years.

6 months was nearly four times the risk in that of the controls during the first period (1987–2000), increasing to 11 times during the second period (2003–2014). The long-term mortality (>11 years) also increased, but not to the same extent, with the HRs for mortality being consistently higher in 2001–2014 compared with 1987–2000. These results are in line with the results in the study from the United Kingdom.[12] In patients with heart failure aged ≥65 years, all comorbidities and heart failure risk factors increased from 1987–2000 to 2001–2014, with greater increases than those observed in controls aged ≥65 years. Taken together, this would contribute to explain why survival in controls improved more than in patients with heart failure. According to the official statistics from the Board of Health and Social Welfare, rates for all major causes of death, for example, cancer (by about 40%), cardiovascular disease (50%), and external causes (15%),[15] have increased, indicating major progression over a broad range of preventative and treatment measures in this age group.

There was little improvement in survival in older patients with heart failure. Considering that these patients constituted nearly 90% of all heart failure patients in the study, the lack of improvement is of particular concern. A recent systematic review on modes of death among patients with HFpEF stated that cause-specific mortality warrants further investigation but further indicated that non-cardiovascular death was an important competing risk.[18] This is further underlined by the multiple causes of death in the heart failure group and indicates the need for a comprehensive approach with respect to the many comorbidities in this population. Another explanation may be the lack of effective treatments in heart failure patients with HFpEF.

Clinical trials have mainly focused on patients with HFrEF, with major developments during the 1980s and 1990s when beta-blockers, angiotensin-converting enzyme inhibitor inhibitors,[6] and mineralocorticoid/aldosterone receptor antagonists (e.g. spironolactone)[19] were shown to reduce the risk of heart failure hospitalization and death in patients with reduced left ventricular ejection fraction. Few of these therapies have been proven to reduce mortality in patients with HFpEF.[6] However, a large intervention review did show that mineralocorticoid/aldosterone receptor antagonists reduced the risk of heart failure hospitalization in patients with HFpEF.[20]

Currently, treatments with renin-angiotensin-aldosterone blockers are standard in patients with heart failure and reduced left ventricular function.[6] Novel treatments have also been developed to reduce the risk of premature death and sudden death in these patients, including left ventricular assist devices and cardioverter-defibrillators in patients with end-stage HFrEF with optimal medication and cardiac resynchronization therapy in patients with HFrEF and left bundle branch block.[6] However, relatively few patients are offered these treatments even though they meet the treatment

Table 3 Causes of death in patients with heart failure and controls from the general population in 1987–2000[a] and 2001–2014[a] by age

	HF patients aged 18–64 years			HF patients aged ≥65 years		
	1987–2000 *n* = 37 765	2001–2014 *n* = 41 572	*P* value	1987–2000 *n* = 331 567	2001–2014 *n* = 291 581	*P* value
Any cause of death, *n* (%)	30 125 (79.8)	13 660 (32.9)	<0.0001	327 312 (98.7)	213 250 (73.1)	<0.0001
Cause of death[b], *n* (%)	30 125 (100)	13 660 (100)		327 312 (100)	213 250 (100)	
Heart failure, *n* (%)	686 (2.28)	362 (2.65)	0.0180	24 235 (7.4)	18 549 (8.7)	<0.0001
IHD, *n* (%)	11 033 (36.6)	3518 (25.8)	<0.0001	110 546 (33.8)	53 368 (25.0)	<0.0001
Stroke, *n* (%)	1375 (4.56)	487 (3.57)	<0.0001	28 629 (8.75)	14 486 (6.79)	<0.0001
Other CVD	4547 (15.1)	1853 (13.6)	<0.0001	49 722 (15.2)	34 199 (16.0)	<0.0001
Cancer, *n* (%)	4082 (13.6)	2506 (18.4)	<0.0001	33 181 (10.1)	28 242 (13.2)	<0.0001
Injuries, *n* (%)	1905 (6.32)	1583 (11.6)	<0.0001	9613 (2.94)	12 765 (5.99)	<0.0001
Other causes, *n* (%)	6497 (21.6)	3351 (24.5)	<0.0001	71 386 (21.8)	51 641 (24.2)	<0.0001
	Controls aged 18–64 years			Controls aged ≥65 years		
	1987–2000 *n* = 73 944	2001–2014 *n* = 82 353	*P* value	1987–2000 *n* = 619 355	2001–2014 *n* = 530 531	*P* value
Any cause of death, *n* (%)	30 783 (41.63)	7001 (8.50)	<0.0001	409 633 (66.1)	214 009 (40.3)	<0.0001
Cause of death[b], *n* (%)	30,783 (100)	7001 (100)		409 633 (100)	214 009 (100)	
Heart failure, *n* (%)	156 (0.51)	38 (0.54)	0.7036	12 733 (3.11)	7279 (3.4)	<0.0001
IHD, *n* (%)	5629 (18.3)	975 (14.0)	<0.0001	81 761 (20.0)	30 413 (14.2)	<0.0001
Stroke, *n* (%)	2132 (6.93)	322 (4.6)	<0.0001	56 165 (13.7)	25 011 (11.7)	<0.0001
Other CVD	1846 (6.0)	399 (5.7)	<0.3417	40 770 (9.95)	20 851 (9.74)	0.0840
Cancer, *n* (%)	12 815 (41.6)	3182 (45.5)	<0.0001	82 710 (20.2)	47 421 (22.2)	<0.0001
Injuries, *n* (%)	1608 (5.22)	683 (9.76)	<0.0001	13 139 (3.21)	12 091 (5.65)	<0.0001
Other causes, *n* (%)	6597 (21.4)	1402 (20.0)	<0.0093	122 355 (29.9)	70 943 (33.2)	<0.0001

CVD, cardiovascular disease; HF, heart failure; IHD, ischaemic heart disease.
[a]Deaths up to 2014.
[b]Mutually exclusive causes of death.

criteria[21] and large subgroups of patients with HFrEF still lack specific therapies to improve survival.[22,23] Taken together, this could contribute to an explanation for why there was no reduction in mortality from 2001 to 2014 in older patients. Moreover, clinical studies have mainly focused on patients with HFrEF, who tend to be younger and more often men,[24] while there has been less improvement in treatment in older patients who are more likely to have HFpEF.

In contrast to the limited improvement in prognosis among older patients, net survival in younger patients increased. Compared with older patients, younger patients more often have reduced left ventricular ejection fraction, which is the category of patients for whom treatment has demonstrated to improve survival. Even so, heart failure is rare in young people, with the large majority of heart failure patients being at an age where little improvement was observed. Treatment in younger patients has the potential to be more ambitious, and fulfilment of treatment goals may be more frequently achieved. With an estimated heart failure prevalence of 10–20% among people aged ≥70 years,[2–4] improved prevention and management of heart failure in these patients should be a public health priority.

Strengths and limitations

The present study has several strengths and some limitations. First, this nationwide register study included more than 700 000 patients hospitalized for heart failure over a long time period and matched these patients with controls from the general population with nearly complete coverage of the population in Sweden (>99%).[26] The validity of a heart failure diagnosis in the inpatient registry was shown to be high.[13,14] In addition, data on times and causes of death were obtained from the Cause of Death Registry with virtually complete coverage.[25] The registered diagnoses of more severe conditions as heart disease, stroke, and cancer are likely correct, but the incidence of hypertension and diabetes is probably underestimated, particularly during the first period. Furthermore, in younger people, heart failure may have remained undiagnosed, especially among those with obesity, because the symptoms associated with obesity and heart failure can be difficult to distinguish.[26] Because obesity is less predominant in older patients with heart failure, therefore, this factor is unlikely to have influenced the results to any great extent.

Conclusions

Absolute survival of heart failure patients improved between 1987 and 2014 among those aged 18–64 years, but improved only marginally among those aged ≥65 years. During the study period, mortality rates in the general population decreased markedly and therefore

relative short-term and long-term survival in patients with heart failure relative to controls deteriorated, particularly among younger patients.

Conflict of interest

Lena Björck, Carmen Basic, Christina E. Lundberg, Tatiana Zverkova Sandström, Maria Schaufelberger, and Annika Rosengren declare that they have no conflict of interest.

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Supporting information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table S1. International Classification of Diseases ICD-9 and ICD-10 codes used to identify comorbidities in the National Patient Register.

Table S2. Baseline characteristics of patients with heart failure and controls from the general population by age and sex.

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