








# Increasing home-time after a first diagnosis of heart failure in Sweden, 20 years trends

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## Abstract

**Aims** This study was performed to compare trends in home-time for patients with heart failure (HF) between those of working age and those of retirement age in Sweden from 1992 to 2012.

**Methods and results** The National Inpatient Register (IPR) was used to identify all patients aged 18 to 84 years with a first hospitalization for HF in Sweden from 1992 to 2012. Information on date of death, comorbidities, and sociodemographic factors were collected from the Swedish National Register on Cause of Death, the IPR, and the longitudinal integration database for health insurance and labour market studies, respectively. The patients were divided into two groups according to their age: working age (<65 years) and retirement age (≥65 years). Follow-up was 4 years. In total, following exclusions, 388 775 patients aged 18 to 84 years who were alive 1 day after discharge from a first hospitalization for HF were included in the study. The working age group comprised 62 428 (16%) patients with a median age of 58 (interquartile range, 53–62) years and 31.2% women, and the retirement age group comprised 326 347 (84%) patients with a median age of 77 (interquartile range, 73–81) years and 47.4% women. Patients of working age had more home-time than patients of retirement age (83.8% vs. 68.2%, respectively), mainly because of their lower 4 year mortality rate (14.2% vs. 29.7%, respectively). Home-time increased over the study period for both age groups, but the increase levelled off for older women after 2007, most likely because of less reduction in mortality in older women than in the other groups.

**Conclusions** This nationwide study showed increasing home-time over the study period except for women of retirement age and older for whom the increase stalled after 2007, mainly because of a lower mortality reduction in this group. Efforts to improve patient-related outcome measures specifically targeted to this group may be warranted.

**Keywords** Heart failure; Home-time; Mortality

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## Introduction

Commonly used endpoints in heart failure (HF) research include mortality and hospital readmissions. Composite endpoints are often used for different reasons, mainly to increase power but also when no endpoint alone demonstrates the severe impact HF has on patients.

Mortality can be reported in several different ways, for example, as percentage of patients surviving<sup>1,2</sup> or mortality per patient-years.<sup>3</sup> Reduction in mortality, the most commonly studied outcome in patients with HF, seems to

have stalled in Sweden since 2001, specifically in adult patients of working age.<sup>4</sup> The reason for this is unknown, but mortality remains high.<sup>2,4,5</sup>

Another frequently used outcome in patients with HF is hospital readmissions. However, the manner of calculating readmissions differ considerably between studies, from time to first readmission to number of readmissions during a certain follow-up period (the latter differ considerably between studies). This complicates comparisons between studies. Multiple factors increase the risk of being readmitted after hospitalization for HF, such as male sex, an unmarried

status, and a history of ischaemic heart disease (IHD), anaemia, or kidney failure.<sup>6,7</sup>

A third relevant outcome measure is home-time, which is a parameter that indicates the time spent alive and out of the hospital. The term days alive and out of hospital (DAOH) and per cent DAOH has also been used.<sup>8</sup> Home-time has been shown to correlate well to the functional level after a stroke and can be easily calculated; therefore, it is a cost-efficient way to manage follow-up of a large study population.<sup>9–12</sup> In addition, decreasing home-time is associated with worsening patient-centred outcomes such as self-rated health, low social activity, and depression.<sup>13</sup> Home-time is one of the patient-prioritized outcomes among patients with stroke.<sup>14</sup>

Home-time has been infrequently used in HF populations. It was proposed as an alternative endpoint by Ariti *et al.* in 2011,<sup>15</sup> but became no established concept. In a study from New Zealand, the DAOH after an index hospitalization for HF increased from 1988 to 2008,<sup>16</sup> partly because of decreasing mortality. However, even after the decrease in mortality stagnated in 2000, the increase in home-time continued. This was attributed to a shortened hospital stay, possibly following changes in HF management with respect to primary care and thresholds for hospital admissions.

A recent study showed that home-time in a US population of patients with HF aged >65 years correlated well with traditional outcomes such as hospitalization and mortality.<sup>17</sup> In addition, male sex, increasing age, chronic renal failure, dementia, disability, and malnutrition were all factors associated with a reduction in home-time. To the best of our knowledge, this is one of only two<sup>15,17</sup> studies of home-time for patients with HF, and both had some limitations as short follow-up time and an older patient population.

In the present nationwide register-based population study, we investigated trends in home-time after a first hospitalization for HF in Sweden from 1992 to 2012 and possible differences between patients of working age and retirement age. Given the advances in treatment of HF during the last few decades, we postulated that the study would reveal an overall increase in home-time.

## Methods

### Study population

In this nationwide longitudinal population-based study, we identified all patients ( $n = 651\,961$ ) with a first hospitalization for HF in Sweden from 1992 to 2012 using the Swedish National Inpatient Register (IPR).<sup>18</sup> A first-time hospitalization was defined as no preceding diagnosis of HF documented during the 7 years prior to the index admission. For the purpose of this study, we included patients who were alive 1 day after discharge with a diagnosis of HF in any position defined by 427.00, 417.10 [International Statistical Classification of

Diseases and Related Health Problems (ICD) 8], 428.A, 428.B, 428.X (ICD 9), or I50 (ICD 10). We included patients aged 18 to 84 years. After exclusion of patients with a record of hospitalization for HF within 7 years prior to 1992 ( $n = 32\,736$ ), incomplete register data ( $n = 1526$ ), age outside of the defined groups ( $n = 184\,295$ ), and in-hospital death, death within 1 day of hospital discharge, or no discharge during follow-up ( $n = 44\,629$ ), 388 775 patients were included in the study (Figure 1). The patients were divided into two groups according to age: working age (18–64 years) and retirement age (65–84 years). In Sweden, retirement is possible from 61 years of age, but most of the population retires at 65 years, and the age of retirement has been slowly increasing during the past few decades. LISA offers aggregated information on retirement, why we did not have access to information on the exact date of retirement.

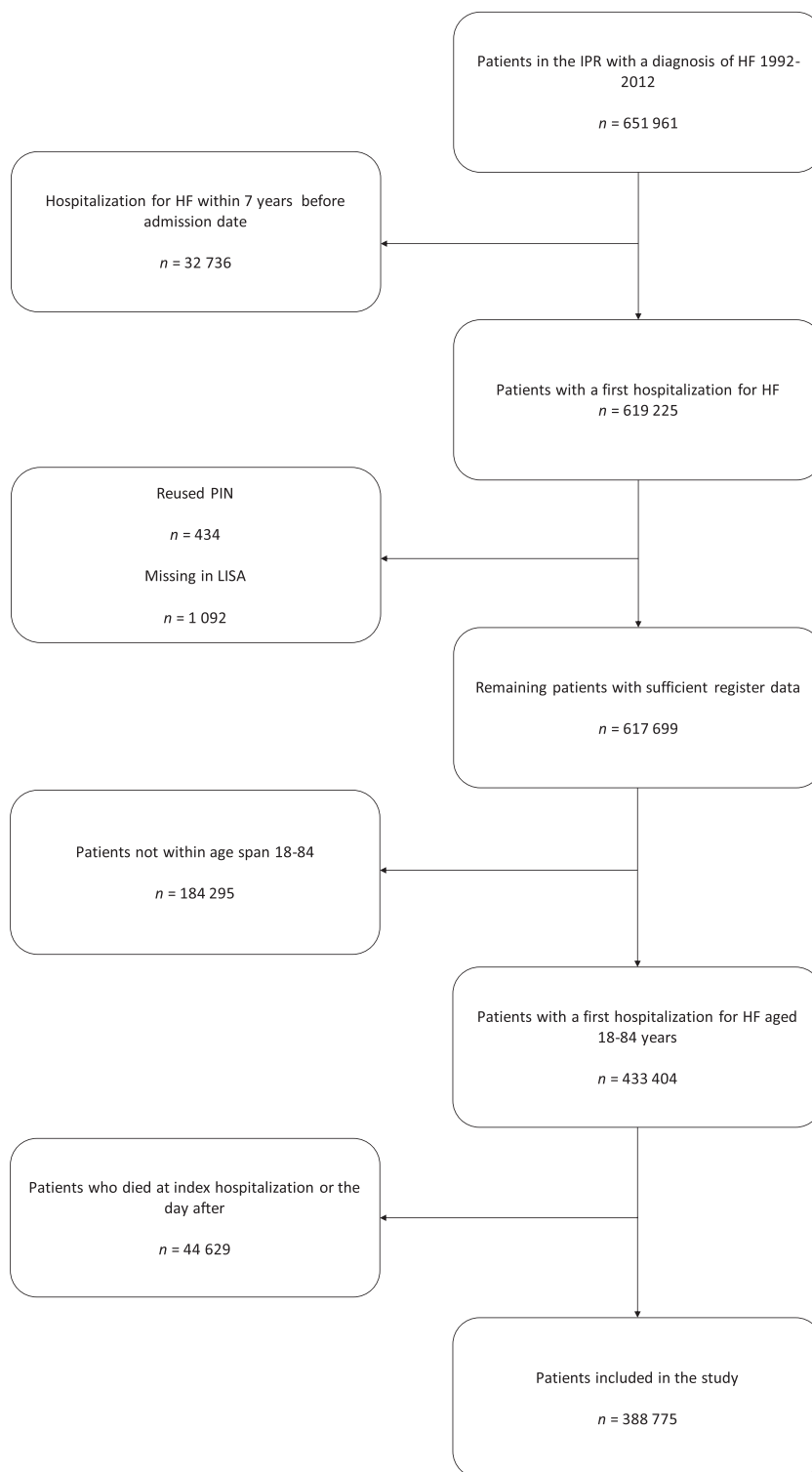
### Socio-economic factors

Information on marital status and education level were obtained from the longitudinal integration database for health insurance and labour market studies (LISA by Swedish acronym). LISA is an integration database of several different national registers provided by Statistics Sweden. The database has held annual registers since 1990 and includes all individuals from 16 years of age who were registered in Sweden as of 31 December each year. Information regarding socio-economic indices such as employment and marital status is available in LISA. Using the patients' unique Swedish personal identity numbers,<sup>19</sup> the IPR was linked with LISA and information for each patient 2 years prior to the first hospitalization was collected. If any data were missing that year, we instead collected data from 1 year prior to the index year and, last, from the index year. Marital status was defined as married, widow/widower, divorced, or never married. From 1995 to 2012, registered partnerships were available for same-sex couples; marriage became available for this group in 2009. We therefore included the different forms of registered partnerships in the marital status groups (registered partner, widowed partner, and divorced partner). Educational level is categorized into seven different subgroups in the register according to the Swedish educational system. In the present study, these seven subgroups were merged into four groups: primary education (<10 years of education), secondary education (10–12 years), tertiary education (>12 years), and missing information on educational level.

### Comorbidities

Data on comorbidities were collected from the index admission and from all hospitalizations during the 7 year period prior to the index date (the first hospitalization for HF). The

Figure 1 Flowchart of patient selection.



following comorbidities were identified from the IPR: IHD, atrial fibrillation/flutter, cardiomyopathy, valvular disease, congenital heart disease, hypertension, diabetes mellitus,

stroke, chronic obstructive pulmonary disease (COPD), chronic renal failure, asthma, and cancer. The ICD codes are listed in *Table A1*.

## Mortality and home-time

The IPR was linked to the Swedish National Register on Cause of Death to obtain information on all-cause mortality. The in-hospital time was defined as all days spent alive and in the hospital for any reason. Home-time was defined as the number of days spent alive outside of the hospital (at home or in a nursing home). The follow-up duration was 4 years; when a patient died, the remaining days until the end of the 4 years were registered.

## Statistics

Patients were followed from the date of discharge from their index hospitalization for HF and the following 4 years. Because of data availability, we defined the follow-up period as 4 years after the initial hospitalization for HF. Cumulative mortality was estimated by the Kaplan–Meier estimator. Cox proportional hazards models were used to analyse the change in mortality over time. Four separate models were estimated, one for each combination of sex and age of <65 or ≥65 years. All models were adjusted for age, duration of index hospitalization, educational level, marital status, and comorbidities (IHD, cancer, atrial fibrillation/flutter, diabetes

mellitus, COPD, stroke, hypertension, cardiomyopathy, valvular disease, asthma, and congenital heart disease). Cubic restricted splines with knots placed at the 5th, 35th, 65th, and 95th percentiles were used to adjust for age and duration of the index hospitalization.

The per cent home-time was calculated as the number of days alive and out of the hospital divided by the total number of days from the index discharge to the end of the follow-up period (i.e. up to 4 years). The per cent in-hospital time and per cent time deceased were calculated in an analogous manner.

All statistical analyses were performed using SAS Version 9.4TS1M6 (SAS Institute, Cary, NC, USA).

The ethics committee of the University of Gothenburg approved the study (Gbg 026-16), which was conducted in accordance with the Declaration of Helsinki.

## Results

### Study population

The median age of all patients was 76.0 [interquartile range (IQR), 69.0–80.0] years, and 44.8% were women (*Table 1*).

**Table 1** Patient characteristics according to age group

	Working age 62 428 (16.0)	Retirement age 326 347 (84.0)	Total 388 775 (100)
<b>Patient characteristics</b>			
Women	19 452 (31.2)	154 631 (47.4)	174 083 (44.8)
Age, median (IQR)	58.0 (53.0–62.0)	77.0 (73.0–81.0)	76.0 (69.0–80.0)
<b>Comorbidities</b>			
IHD	25 103 (43.8)	142 925 (43.2)	168 028 (43.2)
Atrial fibrillation/flutter	14 860 (23.8)	113 878 (34.9)	128 738 (33.1)
Cardiomyopathy	6232 (10.0)	5120 (1.6)	11 352 (2.9)
Valvular disease	4473 (7.2)	22 852 (7.0)	27 325 (7.0)
Congenital heart disease	781 (1.3)	928 (0.3)	1709 (0.4)
Hypertension	18 165 (29.1)	103 730 (31.8)	121 895 (31.4)
Diabetes mellitus	14 186 (22.7)	67 588 (20.7)	81 774 (21.0)
Chronic renal failure	1979 (3.2)	9354 (2.9)	11 333 (2.9)
Stroke	4781 (7.7)	52 019 (15.9)	56 800 (14.6)
COPD	6597 (10.6)	43 946 (13.5)	50 543 (13.0)
Asthma	3221 (5.2)	17 717 (5.4)	20 938 (5.4)
Cancer	4096 (6.6)	38 938 (11.9)	43 034 (11.1)
<b>Marital status</b>			
Married	30 779 (49.3)	163 700 (50.2)	194 479 (50.0)
Widow/widower	2251 (3.6)	92 104 (28.2)	94 355 (24.3)
Divorced	13 896 (22.3)	40 240 (12.3)	54 136 (13.9)
Never married	15 502 (24.8)	30 303 (9.3)	45 805 (11.8)
<b>Educational level</b>			
Primary education	25 909 (41.5)	195 928 (60.0)	221 837 (57.1)
Secondary education	25 788 (41.3)	82 974 (25.4)	108 762 (28.0)
Tertiary or higher	9344 (15.0)	26 874 (8.2)	36 218 (9.3)
Unknown	1387 (2.2)	20 571 (6.3)	21 958 (5.6)
<b>Time</b>			
Time at hospital, days (%)	28.0 (1.9)	30.3 (2.1)	29.9 (2.1)
Home-time, days (%)	1217.9 (83.8)	990.3 (68.2)	1026.8 (70.7)
Deceased, days (%)	206.0 (14.2)	430.4 (29.7)	394.3 (27.2)

COPD, chronic obstructive pulmonary disease; IHD, ischaemic heart disease; IQR, interquartile range; *n*, total number of subjects. All numbers are *n* (%) if not otherwise stated.

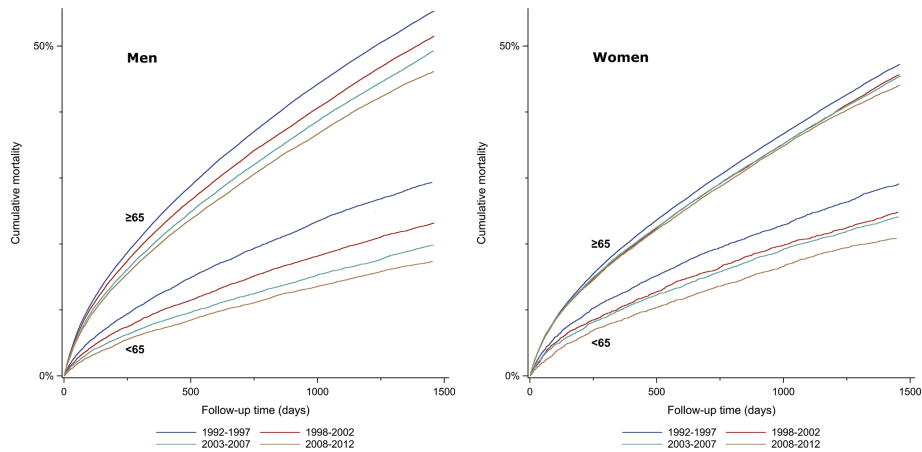
The working age group constituted 16.0% of the total study population; these patients had a median age of 58.0 (IQR, 53.0–62.0) years, 31.3% were women, and 41.5% had a primary education only. In the retirement age group, the patients' median age was 77.0 (IQR, 73.0–81.0) years, nearly half (47.5%) were women, 60.0% had a primary education, and almost one-third (28.2%) were widowed. Both groups had high rates of cardiovascular and other comorbidities, with no major differences in IHD (43.8% and 43.2% for working age and retirement age, respectively), valvular disease, hypertension, diabetes, chronic renal failure, COPD, or asthma. The prevalence of cardiomyopathy was higher in the working age group than the retirement age group (10.0% vs. 1.6%, respectively). The working age group also had a higher prevalence of congenital heart disease, whereas

the older group had higher prevalences of atrial fibrillation and cancer.

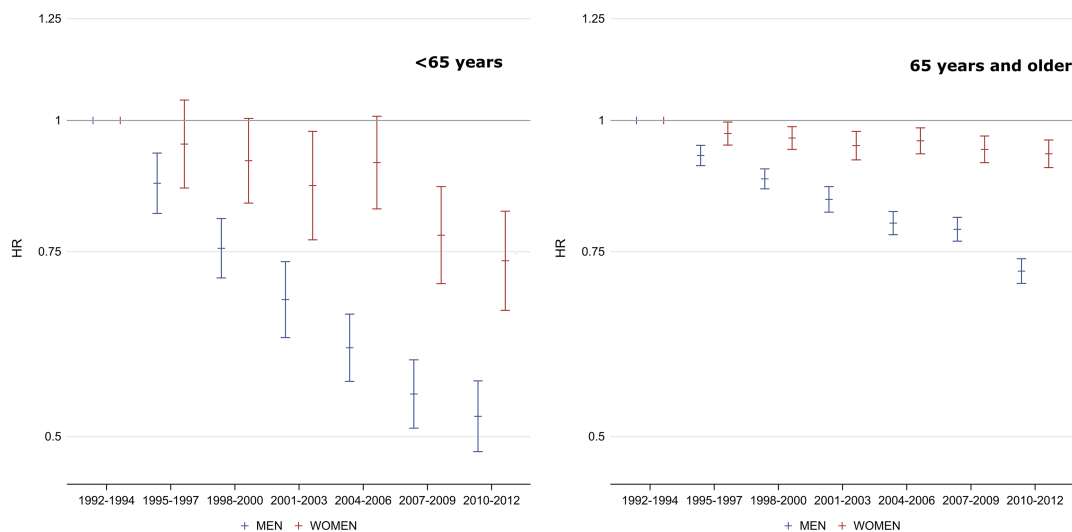
### Mortality

To be able to determine home-time, mortality was calculated. The overall 4 year all-cause mortality rate was 44.5% (23.3% and 48.5% for patients of working and retirement age, respectively) and was higher in men than in women (*Figure 2*). Mortality decreased over the study period for all patients, but the decrease was less pronounced for women of retirement age than among other groups. A model adjusted for age, sex, comorbidities, and socio-economic factors showed similar results (*Figure 3*) with decreasing mortality over the study

**Figure 2** Unadjusted mortality curves for men and women by age group and year of first hospitalization.



**Figure 3** Forest plot of adjusted association between mortality risk and year of first hospitalization by men and women in both age groups.



period for both men and women of working age as well as for men of retirement age. For women of retirement age, the hazard ratio for mortality continuously decreased compared with the reference period until the period 2001 to 2003, after which time the decrease stalled, further indicating a less pronounced decrease in mortality for this group.

## Home-time

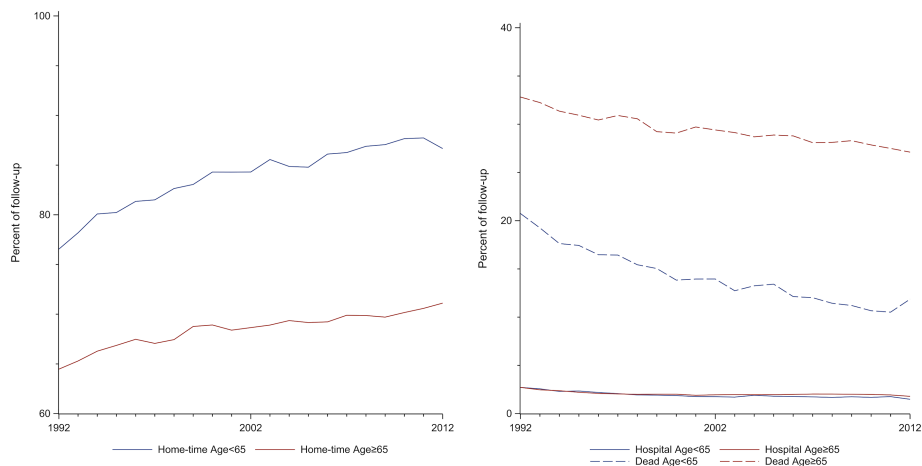
Home-time was calculated as time spent alive and out of hospital. Overall, during the 4 year follow-up period, patients spent 2.1% and 70.7% of their time in-hospital and alive outside the hospital, respectively, while 27.2% of the time was accounted for by death (*Table 1*). Patients of working age had more home-time than those of retirement age (83.8%

vs. 68.2%, respectively), mainly because of their lower mortality rate (14.2% vs. 29.7%, respectively). Home-time increased over the study period for both groups (*Figure 4*). Men and women had increasing home-time during the study period; however, this increase stalled in women after 2007 (*Figure 5*).

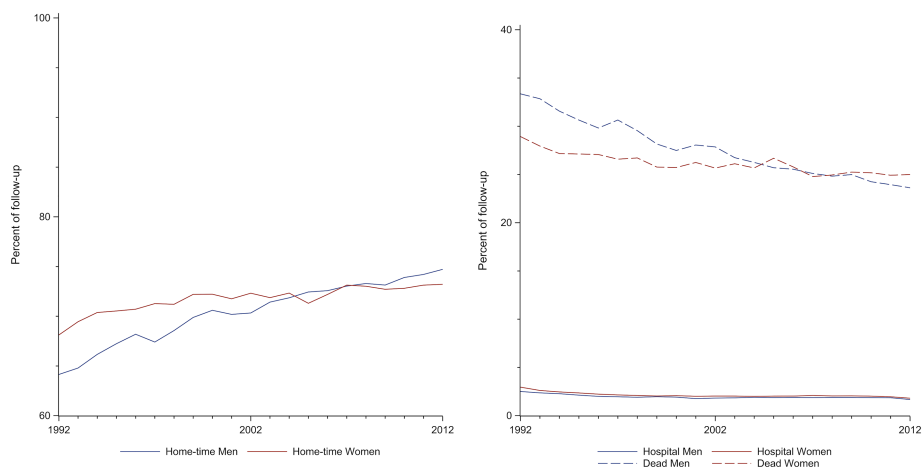
## Discussion

The major finding of this nationwide study is that patients with HF spent merely 70.7% of the 4 years following their first hospitalization for HF alive and out of the hospital. Home-time, a patient-centred measure found to correlate well with traditional time-to-event mortality and hospitalization outcomes,<sup>17</sup> increased over the study period; notably, however, the increase levelled out in women after 2007, mainly

**Figure 4** Home-time, in-hospital time, and time deceased during 4 year follow-up by year of first hospitalization and age group.



**Figure 5** Home-time, in-hospital time, and time deceased during 4 year follow-up by year of first hospitalization and sex.



because of the lower reduction in mortality rates in older women than in other groups.

Only two studies prior to this have investigated home-time for patients with HF and they had limitations. In the study by Greene *et al.*,<sup>17</sup> the follow-up was limited to 2 years, and only 70.6% patients had complete data for the entire period. In addition, only patients with HF hospitalized from 2011 to 2014 were included, preventing an analysis of changes over time. Finally, the study only included patients aged >65 years. In the second study, Ariti *et al.*<sup>15</sup> investigated home-time in patients in the CHARM trial where candesartan was compared with placebo in patients with HF, with a median follow-up of 38 months. They found that patients on candesartan compared with placebo had a mean increase in home-time of 24.1 days, mainly driven by lower mortality.

Furthermore, Greene *et al.* found that the per cent of home-time was only 57.4% during the first 2 years after hospitalization for HF in the United States in an age group corresponding to our retirement age population. In that study, however, living in a long-term care or rehabilitation facility was not defined as home-time. When including the time spent in different institutions as home-time, the percentage increased to 63.5%, which is comparable with our finding of 68.2% home-time for patients of retirement age.

In the second study, Ariti *et al.*<sup>15</sup> investigated home-time in patients in the CHARM trial where candesartan was compared with placebo in patients with HF, with a median follow-up of 38 months. They found that patients on candesartan compared with placebo had a mean increase in home-time of 24.1 days, mainly driven by lower mortality. Ariti *et al.*<sup>15</sup> argued that home-time puts more emphasis on deaths occurring early in follow-up and illustrates the length of all hospitalizations, not only the number of readmissions. In a population from New Zealand, the number of days spent alive and out of the hospital 2 years following the index hospitalization for HF increased by 2 months from 1988 to 2008,<sup>16</sup> and the proportion of days lost to death or hospitalization decreased from 38.5% to 30.0%. According to our calculations, this corresponds to an increase in home-time from 61.5% to 70.0%, comparable with our results.

During the two decades that we studied, we found an increasing home-time for both patients of working age and patients of retirement age. The younger age group had more home-time; this was mainly due to lower mortality because the time spent in-hospital was almost equal to that of the older age group. Interestingly, home-time shifted between men and women in 2005, with women having less home-time than men (*Figure 5*) for the first time and during the rest of the study period. In the New Zealand study,<sup>16</sup> women had a slightly higher median length of hospital stay from 1988 to 1998 in contrast to our study, in which the time spent in-hospital decreased slightly for both men and women over the study period. Instead, the stalling of the reduction in home-time for women in our study seems to be an effect of a

similar levelling off in mortality, explaining the shift between sexes. For men, the adjusted hazard ratio for mortality continuously decreased in both age groups over the whole study period. For women of retirement age however, this continuous reduction in mortality stalled after 2001 to 2003. The reason for this disparity in our study is not evident, but it is known that women have HF with a preserved ejection fraction more often than do men<sup>20</sup> and that guideline-recommended therapy does not impact mortality in patients with HF with a preserved ejection fraction in the same manner as in patients who have HF with a reduced ejection fraction.<sup>21,22</sup> In addition, IHD in patients with HF is associated with increased mortality.<sup>23</sup> IHD is more common in men than in women,<sup>24</sup> and the declining mortality in IHD during the last few decades<sup>25,26</sup> might therefore have a greater impact on mortality in men than in women. Another Swedish study comparing patients with HF of ischaemic and non-ischaemic aetiologies from 1987 to 2003 revealed the most marked decrease in 3 year mortality in men aged 35 to 64 years with ischaemic HF and a less marked reduction in 3 year mortality for women.<sup>27</sup> The reduction was also most pronounced in the first time period, and there was no further reduction during the last period (2002–2003). Overall, these findings might explain the lack of improvement in mortality for older women in the later years.

## Limitations

This was an observational study based on register data and the possibility of unknown confounders is present, but information on many patient characteristics that could affect the results such as comorbidities and socio-economic factors are available in the registers.

Another limitation of our nationwide registers is that they do not contain detailed clinical information on imaging findings or, in particular, the ejection fraction, laboratory parameters, or other clinical data. Similarly, the available data from LISA do not contain detailed socio-economic information such as living alone or the self-reported experience of social deprivation. However, both registers are nationwide, and reporting of hospital discharge diagnoses to the IPR is mandatory. Therefore, these registers provide unique possibilities to study large patient groups from an entire country.<sup>28</sup> A diagnosis of HF in the IPR has been externally validated and found to have high validity of 82.0–94.4%.<sup>29,30</sup>

Furthermore, the inclusion period ends in 2012 since we prioritized a long follow-up.

In addition, the registers used in this study contain no information on which location to which patients are discharged. Because of this, we could not differentiate between time spent at home or at a long-term care facility. In Sweden, however, these facilities effectively became the

home of the patient after the 1992 reform of elderly care and should therefore be included in home-time.

To conclude, in this large nation-based study population, we found increasing home-time over the study period except for women of retirement age, for whom the increase stalled in 2007; this was probably because of a decreased reduction in mortality among these patients. Home-time has been found to correlate well with a variety of patient-centred measures, and home-time might therefore be more readily understandable for not only patients but also for politicians and clinicians, making it a useful measurement parameter. We found diverging trends in the improvement of home-time for patients with HF, where it levelled off in the women >65 years mainly due to a relative decrease in mortality compared with other groups. While the overall mortality for elderly women was lower than for elderly men, further studies to investigate potential improvements in this group may be warranted.

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## Conflict of interest

None declared.

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## Appendix A

**Table A1** Comorbidities according to the International Statistical Classification of Diseases and Related Health Problems (ICD)

	ICD 8	ICD 9	ICD 10
Ischaemic heart disease	410–414	410–414	I20–25
Atrial fibrillation/flutter	427.92	427D	I48
Cardiomyopathy	425	425	I42
Valvular disease	393–398	393–398	I05–09, I34–35
Congenital heart disease	746–747	746–747	Q20–28, Q87, Q89
Hypertension	401–405	401–405	I10–15
Diabetes mellitus	250	250	E10–11, E14
Chronic renal failure	585	585	N18, N26
Stroke	430–438	430–438	I60–69
COPD	490–496	490–496	J44
Asthma	493	493	J45
Cancer	140–208, 230–234	140–208, 230–234	C00–97, D00–09

COPD, chronic obstructive pulmonary disease.