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# Heart Failure Statistics in Korea, 2020: A Report from the Korean Society of Heart Failure

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# ABSTRACT

**Background and Objectives**: Heart failure (HF) is a disease with high morbidity and mortality. With ageing society and increasing prevalence of risk factors of HF, the prevalence of HF is expected to increase, as well. In this official report of the Korean Society of Heart Failure the epidemiology of HF in Korea is presented.

**Methods**: The data of Korean National Health Insurance big data, the Korean Heart Failure (KorHF) and the Korean Acute Heart Failure (KorAHF) registries have been used. **Results**: In 2018, the prevalence, incidence, mortality of HF patients, and mortality due to HF were 2,261, 579, 245, and 10.4 per 100.000 persons, respectively. Regarding the temporal trend, there was a continuous increase in HF prevalence (0.77% in 2002, 1.48% in 2013, and 2.24% in 2018) and HF related deaths. The most common etiology for HF was ischemic origin, and the dominant subtype was HF with reduced ejection fraction (EF), defined as EF  $\leq$ 40%. Of these, 77.6%, 58.0%, and 55.1% received renin-angiotensin-system inhibitors (angiotensin-converting-enzyme inhibitors or angiotensin-receptor-blockers), beta-blockers, and aldosterone-antagonists, respectively. In 2018, 1,542 implantable cardiac defibrillators and 272 cardiac resynchronization therapy devices were implanted, and 176 patients received heart transplantation. With improvement of pharmacologic and non-pharmacological therapy, the survival time of HF has been improving in the last 2 decades; nonetheless, it is associated with enormous increase in medical costs.

**Conclusions**: The prevalence of HF has been increasing in Korea. With improvement of therapy, the prognosis of HF has been improving, too. Nonetheless, appropriate interventions are necessary to prevent HF.

Keywords: Heart failure; Epidemiology; Statistics; Korea

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#### **Conflict of Interest**

The authors have no financial conflicts of interest.

#### **Author Contributions**

Conceptualization: Park JJ, Choi DJ; Data curation: Park JJ, Lee CJ, Park SJ, Choi JO, Choi S, Park SM, Choi EY, Kim EJ, Yoo BS, Kang SM, Park MH, Lee J; Formal analysis: Park MH, Lee J; Investigation: Park JJ, Lee CJ; Methodology: Park JJ, Lee J, Choi DJ; Project administration: Park JJ, Choi DJ; Resources: Choi DJ; Software: Park MH; Supervision: Park JJ; Validation: Park JJ, Park MH, Lee J; Visualization: Park JJ, Park SJ, Choi JO, Choi S, Park SM, Choi EY, Kim EJ, Yoo BS, Kang SM; Writing - original draft: Park JJ; Writing review & editing: Park JJ, Lee CJ, Park SJ, Choi JO, Choi S, Park SM, Choi EY, Kim EJ, Yoo BS, Kang SM, Park MH, Lee J, Choi DJ.

# INTRODUCTION

The cardiovascular disease and stroke are the main causes for death and hospitalization in Korea and worldwide.<sup>1)</sup> Until now, there has been no official report on the prevalence, incidence, and outcomes in patients with heart failure (HF) in Korea. This is the first official report on the HF statistics from the Korean Society of Heart Failure, which aims to present the most up-to-date statistics in a single document on the HF. As an official statistical report, it will represent a critical resource for the public, policy makers, media professionals, clinicians, healthcare administrators, researchers, and others seeking the best available data on HF in Korea.

# **METHODS**

## **Study population**

This report has following data sources. From the National Health Information Database (NHID) of National Health Insurance Service (NHIS) we used 25% random-sampling data of entire Koreans from 2002 to 2018. The database includes claims information for all admission and outpatient prescriptions, diagnosis codes, information regarding entitlement, such as date of birth, address, and income level, and vital status. The NHIS uses the Korean Classification of Disease-7 (KCD-7), which is similar to the International Classification of Disease-10 (ICD-10). Patients were defined as having HF when they disease code of HF in the main code or the subcode (I50, I50.x, I11.0, I13.1, I 13.0, I13.2).

Because NIHD does not provide information on the left ventricular (LV) ejection fraction (EF), we used the data of Korean Heart Failure (KorHF)<sup>2</sup>) registry from 1998 to 2003 and the Korean Acute Heart Failure Registry (KorAHF)<sup>3</sup>) from 2004 to 2009 for description of therapy and outcomes according to the HF types. Both registries included patients admitted for acute HF. HF types are defined as HF with reduced EF (HFrEF, LVEF  $\leq$ 40%), HF with midrange EF (HFmrEF, 40%< LVEF  $\leq$ 50%), and HF with preserved EF (HFpEF, LVEF  $\geq$ 50%).<sup>4)5</sup>

The study was approved by the Institutional Review Board of the Seoul National University Bundang Hospital (IRB No: X-1611-372-901).

#### **Statistical analyses**

Descriptive statistics were used to evaluate the patient data. We first identified all patients with HF diagnosis, then we classified according to the clinical setting of HF diagnosis. Therefore, the data are presented as i) patients with HF (all patients diagnosed with HF), ii) inpatients with HF (patients diagnosed with HF during hospital admission), and iii) outpatients with HF (patients diagnosed with HF in the outpatient clinic).

For the estimation of the incidence, we identified patients who were diagnosed HF for the first time without having been diagnosed HF in the previous 2 years (wash out period). We calculated the crude and the age-adjusted incidence, prevalence, and mortality per 100,000 inhabitants using the Korean standard population in 2018. Because patients can die with or due to HF, we defined "mortality of HF patients" as all-cause deaths of patients with HF diagnosis and "mortality due to HF" as deaths of patients whose cause of death is attributed to HF.

The chronological trend of the survival was expressed as Kaplan-Meier estimates. The log-rank test was performed for the comparison of the differences according to the time of the HF diagnosis.

Statistical analyses were performed by professional statisticians using SAS statistical software version 9.3 (SAS Institute Inc., Cary, NC, USA).

# RESULTS

# Prevalence

In the NHID data, 1,159,776 persons (2.24%) were estimated to have HF in 2018. Regarding the sex, there was a preponderance for female sex (600,244 [2.31%] women; 559,532 [2.16%] men). Furthermore, there has been a continuous increase in the HF prevalence from 0.77% in 2002 to 2.24% in 2018 (**Figure 1A**). The crude and age-adjusted prevalence of HF increased from 768 and 1,270 patients per 100,000 persons in 2002 to 2,261 and 2,164 patients per 100,000 persons in 2018, respectively (**Figure 1B**). In men, the crude and age-adjusted prevalence increased by 284% (569  $\rightarrow$  2,186 patients per 100,000 persons) and 115.8% (1,106  $\rightarrow$  2,386 patients per 100,000 persons), respectively. In women, the crude and age-adjusted prevalence increased by 194% (768  $\rightarrow$  2,261 patients per 100,000 persons) and 70.48% (1,270  $\rightarrow$  2,164 patients per 100,000 persons), respectively.

When stratifying according to the age, the crude prevalence of HF per 100,000 persons in 2018 was 92, 94, 141, 313, 775, 1,922, 4,491, 9,997, and 7,483 for age 0–9, 10–19, 20–19, 30–39, 40–49, 50–59, 60–69, 70–79,  $\geq$ 80 years, respectively. When stratifying according to age and sex, there was an increase in the prevalence of HF from 2002 to 2018 in both sexes (**Figure 1C**).

# Incidence

In the NHID data, the crude incidence of patients with HF per 100,000 persons was 453 in 2004 and increased to 579 in 2018, which corresponds to an increase by 21.7%. However, the age-adjusted incidence per 100,000 persons was 693 in 2004 and 554 in 2018, displaying a decrease by 20% (**Figure 2**). In men, the crude incidence increased by 59% ( $367 \rightarrow 587$  patients per 100,000 persons); whereas the age-adjusted incidence decreased by 19% ( $650 \rightarrow 524$  patients per 100,000 persons). In women, the crude incidence increased by 5.8%% ( $540 \rightarrow 572$  patients per 100,000 persons); whereas the age-adjusted incidence decreased by 31.8% ( $729 \rightarrow 497$  patients per 100,000 persons).

The crude and age-adjusted incidence of inpatients with HF increased by 139% (88  $\rightarrow$  210 persons per 100,000 persons) and 40.2% (143  $\rightarrow$  201 persons per 100,000 persons), respectively.

# Mortality

In the NHID data, the mortality of HF patients per 100,000 persons was 39 in 2002 and 245 in 2018. The corresponding age-adjusted mortality of HF patients was 75 in 2002 and 219 in 2018. In men, the crude mortality of HF patients increased by 320% ( $39 \rightarrow 231$  patients per 100,000 persons) and the age-adjusted mortality of HF patients increased by 131% ( $97 \rightarrow 292$  patients per 100,000 persons). In women, the crude mortality of HF patients increased by 354% ( $39 \rightarrow 259$  patients per 100,000 persons) and the age-adjusted mortality of HF patients increased by 354% ( $39 \rightarrow 259$  patients per 100,000 persons) and the age-adjusted mortality of HF patients increased by 40% ( $61 \rightarrow 194$  patients per 100,000 persons). When stratifying according to the setting of HF diagnosis, the crude and age-adjusted mortality of inpatients with HF increased by 294% ( $18 \rightarrow 97$  patients per 100,000 persons) and 120% ( $35 \rightarrow 93$  patients per 100,000 persons), respectively. In men, the crude and age-adjusted mortality of inpatients with HF increased by 283% ( $20 \rightarrow 97$  patients per 100,000 persons) and 112% ( $47 \rightarrow 120$  patients per 100,000 persons), respectively. In women, the crude and age-adjusted mortality of inpatients with HF increased by 283% ( $20 \rightarrow 97$  patients per 100,000 persons) and 112% ( $47 \rightarrow 120$  patients per 100,000 persons), respectively. In women, the crude and age-adjusted mortality of inpatients with HF increased by 283% ( $20 \rightarrow 97$  patients per 100,000 persons) and 112% ( $47 \rightarrow 120$  patients per 100,000 persons), respectively. In women, the crude and age-adjusted mortality of and  $47 \rightarrow 120$  patients per 100,000 persons) and 112% ( $47 \rightarrow 120$  patients per 100,000 persons), respectively. In women, the crude and age-adjusted mortality of patients per 100,000 persons) and 112% ( $47 \rightarrow 120$  patients per 100,000 persons), respectively. In women, the crude and age-adjusted mortality patients per 100,000 persons), respectively. In women, the crude and age-adjusted mortality patients per 100,000 persons), respectively. In women, the crud

Patients with HF (men)

A Estimated prevalence of HF between 2002–2018



**B** Prevalence of patients with HF between 2002–2018 (per 100,000 persons)



C Prevalence of patients with HF according to age and sex between 2002–2018 (per 100,000 persons)



Figure 1. Prevalence of HF. (A) Estimated prevalence of patients with HF between 2002 and 2018. (B) Temporal trend of crude and age-adjusted prevalence of patients with HF. (C) Temporal trend of prevalence of patients with HF according to age and sex between 2002 and 2018. HF = heart failure.

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Incidence of patients with HF between 2004–2018 (per 100,000 persons)



Figure 2. Incidence of HF. Temporal trend of crude and age-adjusted incidence of patients with HF (upper panel) and that of inpatients with HF (lower panel) between 2004 and 2018. HF = heart failure.

of inpatients with HF increased by 314% (17  $\rightarrow$  97 patients per 100,000 persons) and 122% (27  $\rightarrow$  73 patients per 100,000 persons), respectively (**Figure 3A**).

In the NHID data, the 1-, 5-, 10-, 15-year survival of patients with HF was 91%, 79%, 66%, and 54%, respectively. For hospitalized patients, the 1-, 5-, 10-, 15-year survival of inpatients with HF was 75%, 55%, 40%, and 30%, respectively. Regarding the temporal trend of the survival, patients diagnosed with HF in 2016–2018 had better survival than those diagnosed with HF in 2004–2006, suggesting a survival improvement of HF patients in the last 2 decades (**Figure 3B**).

In the NHID data, the crude mortality due to HF per 100,000 persons was 0.7 in 2002 and 10.4 in 2018. The corresponding age-adjusted HF deaths was 1.5 in 2002 and 10 in 2018



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A Mortality of patients with HF between 2002-2018 (per 100,000 persons)



Figure 3. Morality of HF. (A) Temporal trend of crude and age-adjusted mortality of patients with HF (upper panel) and that of inpatients with HF (lower panel) between 2002 and 2018. (B) Temporal trend of survival from HF diagnosis in patients with HF (left) and that in inpatients with HF (right). (C) Temporal trend of crude and age-adjusted mortality due to HF in patients with HF (upper panel) and that in inpatients with HF (lower panel) between 2002 and 2018. HF = heart failure. (continued to the next page)

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C Mortality due to HF between 2002–2018 (per 100,000 persons)



**Figure 3.** (Continued) Morality of HF. (A) Temporal trend of crude and age-adjusted mortality of patients with HF (upper panel) and that of inpatients with HF (lower panel) between 2002 and 2018. (B) Temporal trend of survival from HF diagnosis in patients with HF (left) and that in inpatients with HF (right). (C) Temporal trend of crude and age-adjusted mortality due to HF in patients with HF (upper panel) and that in inpatients with HF (lower panel) between 2002 and 2018. HF = heart failure.

(Figure 3C). In men, the crude mortality due to HF increased by 1,174% ( $0.5 \rightarrow 6.3$  patients per 100,000 persons) and the age-adjusted mortality due to HF increased by 423% ( $1.6 \rightarrow 8.4$  patients per 100,000 persons). In women, the crude mortality due to HF increased by 1,504% ( $0.9 \rightarrow 14.5$  patients per 100,000 persons) and the age-adjusted mortality due to HF increased by 587% ( $1.5 \rightarrow 9.9$  patients per 100,000 persons). Regarding the mortality of inpatients with HF, the crude and age-adjusted mortality due to HF increased by 1,905% ( $0.2 \rightarrow 4.8$  patients per 100,000 persons) and 776% ( $0.5 \rightarrow 4.6$  patients per 100,000 persons), respectively. In men, the crude and age-adjusted mortality due to HF increased by 1,555% ( $0.2 \rightarrow 3.0$  patients per 100,000 persons) and 590% ( $0.6 \rightarrow 4.0$  patients per 100,000 persons), respectively. In women, the crude and age-adjusted mortality due to HF increased by 2,113% ( $0.3 \rightarrow 6.6$  patients per 100,000 persons) and 853% ( $0.5 \rightarrow 4.8$  patients per 100,000 persons) and 853% ( $0.5 \rightarrow 4.8$  patients per 100,000 persons) and 853% ( $0.5 \rightarrow 4.8$  patients per 100,000 persons) and 853% ( $0.5 \rightarrow 4.8$  patients per 100,000 persons) and 853% ( $0.5 \rightarrow 4.8$  patients per 100,000 persons) and 853% ( $0.5 \rightarrow 4.8$  patients per 100,000 persons) and 853% ( $0.5 \rightarrow 4.8$  patients per 100,000 persons) and 853% ( $0.5 \rightarrow 4.8$  patients per 100,000 persons) and 853% ( $0.5 \rightarrow 4.8$  patients per 100,000 persons) and 853% ( $0.5 \rightarrow 4.8$  patients per 100,000 persons) and 853% ( $0.5 \rightarrow 4.8$  patients per 100,000 persons) and 853% ( $0.5 \rightarrow 4.8$  patients per 100,000 persons) and 853% ( $0.5 \rightarrow 4.8$  patients per 100,000 persons) and 853% ( $0.5 \rightarrow 4.8$  patients per 100,000 persons) and 853% ( $0.5 \rightarrow 4.8$  patients per 100,000 persons) and 853% ( $0.5 \rightarrow 4.8$  patients per 100,000 persons) and 853% ( $0.5 \rightarrow 4.8$  patients per 100,000 persons) and 853% ( $0.5 \rightarrow 4.8$  patients per 100,000 persons) and 853% ( $0.5 \rightarrow 4.8$  patients per 100,000 persons) and 853% patients per 100,000 persons) and 853% patients per 100,000 persons) and 853% patients per 100,

In the KorHF-registry the in-hospital mortality and 1-year mortality was 7.6% and 8.4%, respectively. It is of note that the 1-year mortality data were not validated in all patients.

In the KorAHF registry, the in-hospital mortality was 4.8% and urgent heart transplantation was performed in 1.2%. All deaths were adjudicated. Among 79.6% of the patients who died of cardiovascular deaths, 62.2%, 34.1%, and 3.7% had pump failure, acute coronary syndrome or myocardial infarction, and sudden cardiac death, respectively. The remaining 20.4% died of non-cardiovascular deaths. The most common cause was sepsis (37.0%) followed by pneumonia (28.3%). The post-discharge 30-day and 1-year mortality was 3.3% and 18.2%, respectively.

### Comorbidities

In the NHID data, 86.9% had hypertension, 67.6% had diabetes mellitus, and 17.9% had atrial fibrillation in 2018 (**Figure 4A**). There was a continuous increase in the comorbidities from 2002 to 2018, especially for diabetes mellitus, hypertension, and ischemic heart disease.



**Figure 4.** Heart transplantation in Korea. (A) Temporal trend of comorbidities (left panel) between 2004 and 2018 and medications in 2018 (right panel). (B) ICD and CRT implantation between 2016 and 2019. (C) Heart transplantation between 2000 and 2019. ACEi = angiotensin-converting-enzyme inhibitor; AF = atrial fibrillation; ARB = angiotensin-receptor-blocker; BB = beta-blockers; CKD = chronic kidney disease; CVA

ACEI = anglotensin-converting-enzyme inhibitor; AF = atrial fibrillation; ARB = anglotensin-receptor-blocker; BB = beta-blockers; CKD = chronic kidney disease; CVA = cerebrovascular accident; CRT = cardiac resynchronization therapy; DCM = dilated cardiomyopathy; DM = diabetes mellitus; HCM = hypertrophic cardiomyopathy; HTN = hypertension; ICD = implantable cardioverter defibrillator; IHD = ischemic heart disease; RAS = renin-angiotensin-system; VHD = valvular heart disease. In the KorHF registry, 46.5% had hypertension, 30.5% had diabetes mellitus, 18.9% had stroke, 9.2% had chronic renal disease, and 3.5% had chronic pulmonary disease.

In the KorAHF registry, 62.2% had hypertension, 40% had diabetes mellitus, 42.9% had ischemic heart disease, 28.5% had atrial fibrillation, and 14.3% had chronic renal failure.

## **HF etiologies**

In the KorHF registry, the most common etiology for HF was ischemia (52%) followed by hypertension (37%), cardiomyopathy (27%), idiopathic dilated cardiomyopathy (23%), and valvular heart disease (13%).

In the KorAHF registry, the most common etiologies for HF included ischemia (37.6%), cardiomyopathies (20.6%), valvular heart disease (14.3%), tachycardia-induced HF (10%), and hypertension (4.0%). It is of note that the hypertension as HF etiology was lower than in other registries.

### HF types according to the LVEF

In the KorHF registry, the data of LVEF were available in 2,843 (88.8%) patients: the mean LVEF was 38.5±15.7%. Among patients with available LVEF, 1,638 (57.6%), 491 (17.3%), and 714 (25.1%) patients had HFrEF, HFmrEF, and HFpEF, respectively.

In the KorAHF registry, 5,103 of 5,625 patients (91%) underwent echocardiographic assessment and LVEF were available in these patients: 3,088 (60.5%), 730 (14.3%), and 1,285 (25.2%) patients had HFrEF, HFmrEF, and HFpEF, respectively.

# HF types according to the longitudinal LVEF changes

Many patients with HF experience a significant change in LVEF during follow-up.<sup>6)</sup> Of 5,625 in the KorAHF registry, 5,103 patients had baseline echocardiography and 2,302 patients had follow-up echocardiography at 12 months.

- Heart failure with improved ejection fraction (HFimpEF): when defining HFimpEF as having LVEF ≤40% at baseline and improved to >40% at follow-up, 31.3% patients were diagnosed as having HFimpEF, and these patients had favorable prognosis than other HF types.<sup>6)7)</sup>
- Heart failure with declined ejection fraction (HFdEF): when identifying HFdEF as having LVEF ≥50% at admission and <50% at follow-up, 9.6% patients were classified as having HFdEF who had poor prognosis.<sup>8)</sup>

# Medication at the hospital discharge

In the NHID data, 62.1% of inpatients with HF received renin-angiotensin-system (RAS) inhibitors, 61.2% beta-blockers, and 51.3% diuretics at the hospital discharge (**Figure 4A**).

In the KorHF registry, 58.6% of the patients received beta-blockers, 53.7% received RAS-inhibitors, and 53.1% received aldosterone-antagonists at the discharge.

In the KorAHF registry, 68.8%, 52.2%, and 46.6% of patients received RAS-inhibitors, betablockers, and spironolactone at discharge, respectively. Because the effect of these drugs is limited to patients with reduced EF, further analyses were performed to evaluate appropriate prescription rate according to the indications of the different drug.<sup>5)</sup> Among patients with LVEF  $\leq$ 40%, 77.6% and 58.0% of the patients received RAS-inhibitors and beta-blockers, respectively. Among patients with LVEF <35%, 55.1% received aldosterone-antagonists at the discharge.

# Implantable cardioverter defibrillator (ICD) and cardiac resynchronization therapy (CRT)

The current guidelines recommend ICD for primary prevention in symptomatic HF patients with LVEF ≤35%, despite >3 months of optimal medical therapy. According to Asian Pacific Heart Rhythm Society, a total of 1,113, 1,157, 1,542, and 1,248 ICDs were implanted in 2016, 2017, 2018, and 2019, respectively (**Figure 4B**).

CRT is indicated in symptomatic patients with LVEF  $\leq$  35%, despite optimal medical therapy, who have left bundle branch block and QRS duration  $\geq$ 130 ms.<sup>4)5)</sup> According to Asian Pacific Heart Rhythm Society, a total of 281, 350, 272, and 352 CRTs were implanted in 2016, 2017, 2018, and 2019. respectively.

## **Heart transplantation**

In Korea, the first heart transplantation was performed in 1992 and there has been a steady increase in heart transplantation since. Based on the data of Korean Network for Organ Sharing (KONOS) 194 patients underwent heart transplantation in 2019 (**Figure 4B**).

## Costs

HF is a disease with health care burden for the high cost.

- In the NIHD data, in 2002 total medical costs for medication, hospitalization, and outpatient clinic visits were 727,984,499,404 KRW (≈728 million USD), 56,185,074,590 KRW (≈50 million USD), and 11,824,705,330 KRW (≈10.5 million USD), respectively. There was a steady increase in the medical costs and in 2018, the total cost for medication, hospitalization, and outpatient clinic visits were 11,190,000,000,000 KRW (≈10 billion USD), 630,757,729,150 KRW (≈564.6 million USD), and 78,172,589,880 KRW (≈70 million USD), respectively. The cost for each hospitalization increased from 4,599,679 KRW (≈4,100 USD) in 2002 to 8,306,657 KRW (≈7,400 USD) in 2018. The cost per outpatient clinic visit increased from 35,110 KRW (≈31 USD) in 2002 to 57,435 KRW (≈51 USD) in 2018 (**Figure 5**).
- In the KorHF registry, the mean medical cost per patient was 6,315,210.00 KRW (≈6,500 USD) during hospitalization for acute HF. The mean hospital stay was 9 days.
- In the KorAHF registry, the mean total cost for hospital care was approximately 9,600 USD. The mean hospital stay was 9 days.



Figure 5. Medical cost of HF. Temporal trend of total medical cost (left panel) and the cost for each hospitalization and each outpatient clinic visit (right panel) between 2002 and 2018. HF = heart failure; KRW = Korean won.

# DISCUSSION

In 2018, the prevalence, incidence, mortality of HF patients, and mortality due to HF were 2,261, 579, 245, and 10.4 per 100.000 persons, respectively. Regarding the temporal trend, the prevalence has been increasing, whereas the incidence was steady or slightly decreasing. Although mortality of HF patients and mortality due to HF have been increasing, the survival time of HF has been improving in the last 2 decades. The most common etiology for HF was ischemic origin. Regarding HF type, the dominant type was HFrEF. Of these, 77.6%, 58.0%, and 55.1% received RAS-inhibitors, beta-blockers, and aldosterone-antagonists at the discharge, respectively. The implantation of ICD and CRT were relatively low. Regarding the advanced HF, the number of patients receiving heart transplantation has been increasing steadily.

HF affects more than 26 million people world-wide and its prevalence has been increasing.<sup>9)</sup> In this report using the 25% sampling data of medical insurance subscribers, the estimated prevalence of HF in Korea was 0.77% in 2002, 1.48% in 2013, and 2.24% in 2018. In a previous report, Lee JH et al reported the prevalence of HF in Korea was 0.75% in 2002 and 1.53% in 2013, using the Data from the National Sample Cohort (NSC) based on the National Health Information Database which consists of approximately 1 million medical insurance subscribers, accounting for approximately 2% of the entire nation.

Hypertension, diabetes mellitus, ischemic heart disease, atrial fibrillation, valvular heart disease, and obesity are established risk factors for HF development. The fact that the prevalence of and the exposure to these risk factors increase with age may explain the high prevalence of HF, especially, in elderly. With decrease in birth rate and increase in life expectancy, Korea became aged society 2017, defined as in which more than 14% of the population is 65 years or older. Accordingly, the ageing of the society explains the steady increase in HF prevalence in the last two decades in Korea. In addition, the prevalence of HF is expected to rise due to the change in population structure.<sup>10</sup>

By contrast, the incidence of HF has been steady or slightly decreasing in the last 2 decades. In UK, the incidence of HF decreased from 2002 to 2014 by 7%, whereas the estimated absolute number of individuals with newly diagnosed HF increased by 12%, largely due to an increase in population size and age.<sup>11)</sup> The decreasing incidence may be attributed to the improved treatment of myocardial infarction and/or ischemic heart disease which are the leading causes for HF.

These data need to be interpreted carefully because the development and introduction of new diagnostic methodology and easy accessibility to medical service may have increased the diagnosis of HF, inferring that HF may have been underdiagnosed in earlier period.

Patients with HF can die due to or with HF. As for the later one, because older HF patients have many competing causes of deaths such as malignancy, cerebrovascular disease, myocardial infarction, infection, among others, the identification of mortality due to HF is not always easy. Between 2002 and 2018, mortality of and due to HF has been increasing. Interestingly, there was a survival improvement of HF patients in the last two decades; patients with recently diagnosed with HF live longer than their counterparts diagnosed earlier. This may explain the improvement of HF-specific and general medical care.

HF is a disease with a significant health care burden. The total cost for HF has been increasing exponentially. The medical expense per hospitalization increased from 4,599,679 KRW in 2002 to 8,306,657 KRW in 2018. The medical expense per outpatient clinic visit increased from 35,110 KRW in 2002 to 57,435 KRW in 2018. Because the HF prevalence is expected to increase along with the aging of the Korean society, the medical cost will continue to grow. It will predispose a significant medical and economic burden for the health care system, so that its prevention remains crucial.

We provided the age-adjusted incidence, prevalence, and mortality using the Korean standard population in 2018. Age-adjustment is at statistical process that allows comparison of outcomes between groups with different age structures. Because Korea is a rapidly ageing society and HF occurs at different rates in different age groups, age-adjustment allows to compare the incidence and prevalence of HF throughout the observation periods.

There are also several limitations. First, the NHID data have been collected for medical service claims and reimbursement purposes and, consequently, it lacks information on the test results and personal health history. Therefore, NHID do provide data on the heart failure type according to the LVEF, which crucial to assess the adherence to guideline-directed medical therapy. To overcome this limitation, we used the data of two large representative KorHF registries. Second, the diagnosis of HF can be challenging, even for HF specialists, and HF diagnosis is not adjudicated in NHID; therefore, the real prevalence of HF may be over- or under-estimated.

In conclusion, HF is a disease with high morbidity and mortality. With ageing society and increasing prevalence of risk factors of HF, the prevalence of HF has been increasing in the last two decades in Korea. However, with improvement of pharmacologic and non-pharmacological therapy, the prognosis of HF has been improving; nonetheless, it is associated with enormous economic and healthcare burden. Changes in social perception and countermeasures are urgently needed, along with appropriate interventions to prevent HF and to improve its prognosis.

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