

Original Article



# Heart Failure Statistics 2024 Update: A Report From the Korean Society of Heart Failure

Chan Joo Lee , MD, PhD<sup>1</sup>, Hokyou Lee , MD, PhD<sup>2</sup>, Minjae Yoon , MD<sup>3</sup>,  
Kyeong-Hyeon Chun , MD<sup>4</sup>, Min Gyu Kong , MD, PhD<sup>5</sup>, Mi-Hyang Jung , MD,  
PhD<sup>6</sup>, In-Cheol Kim , MD, PhD<sup>7</sup>, Jae Yeong Cho , MD, PhD<sup>8</sup>, Jeehoon Kang ,  
MD, PhD<sup>9</sup>, Jin Joo Park , MD, PhD<sup>3</sup>, Hyeon Chang Kim , MD, PhD<sup>2</sup>,  
Dong-Ju Choi , MD, PhD<sup>3</sup>, Jungkuk Lee , MS<sup>10</sup>, and Seok-Min Kang , MD, PhD<sup>1</sup>

<sup>1</sup>Division of Cardiology, Department of Internal Medicine, Severance Hospital, Yonsei University College of Medicine, Seoul, Korea

<sup>2</sup>Department of Preventive Medicine, Yonsei University College of Medicine, Seoul, Korea

<sup>3</sup>Division of Cardiology, Department of Internal Medicine, Seoul National University Bundang Hospital, Seongnam, Korea

<sup>4</sup>Division of Cardiology, National Health Insurance Service Ilsan Hospital, Goyang, Korea

<sup>5</sup>Division of Cardiology, Department of Internal Medicine, Soonchunhyang University Bucheon Hospital, Soonchunhyang University College of Medicine, Bucheon, Korea

<sup>6</sup>Division of Cardiology, Department of Internal Medicine, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea

<sup>7</sup>Division of Cardiology, Department of Internal Medicine, Cardiovascular Center, Keimyung University Dongsan Hospital, Keimyung University College of Medicine, Daegu, Korea

<sup>8</sup>Department of Cardiovascular Medicine, Chonnam National University Medical School and Chonnam National University Hospital, Gwangju, Korea

<sup>9</sup>Department of Internal Medicine, Seoul National University Hospital, Seoul, Korea

<sup>10</sup>Data Science Team, Hanmi Pharm, Co., Ltd., Seoul, Korea

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**Correspondence to**

**Seok-Min Kang, MD, PhD**

Division of Cardiology, Department of Internal Medicine, Severance Hospital, Yonsei University College of Medicine, 50-1 Yonsei-ro, Seodaemun-gu, Seoul 03722, Korea.  
Email: smkang@yuhs.ac

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## ABSTRACT

**Background and Objectives:** The number of people with heart failure (HF) is increasing worldwide, and the social burden is increasing as HF has high mortality and morbidity. We aimed to provide updated trends on the epidemiology of HF in Korea to shape future social measures against HF.

**Methods:** We used the National Health Information Database of the National Health Insurance Service to determine the prevalence, incidence, hospitalization rate, mortality rate, comorbidities, in-hospital mortality, and healthcare cost of patients with HF from 2002 to 2020 in Korea.

**Results:** The prevalence of HF in the total Korean population rose from 0.77% in 2002 to 2.58% (1,326,886 people) in 2020. Although the age-standardized incidence of HF decreased over the past 18 years, the age-standardized prevalence increased. In 2020, the hospitalization rate for any cause in patients with HF was 1,166 per 100,000 persons, with a steady increase from 2002. In 2002, the HF mortality was 3.0 per 100,000 persons, which rose to 15.6 per 100,000 persons in 2020. While hospitalization rates and in-hospital mortality for patients with HF increased, the mortality rate for patients with HF did not (5.8% in 2020), and the one-year survival rate from the first diagnosis of HF improved. The total healthcare costs for patients with HF were approximately \$2.4 billion in 2020, a 16-fold increase over the \$0.15 billion in 2002.

**Conclusions:** The study's results underscore the growing socioeconomic burden of HF in Korea, driven by an aging population and increasing HF prevalence.

**Keywords:** Heart failure; Epidemiology; Statistics; Korea

## INTRODUCTION

In 2021, 56.5 million cases of heart failure (HF) were reported globally, 27.3 million of which were among women and 29.2 million among men.<sup>1)</sup> As HF becomes more prevalent with age, the number of patients with this disease is increasing rapidly in developed countries with an aging population. This phenomenon is particularly pertinent in Korea, which is rapidly becoming a super-aged society. However, HF is a clinical syndrome, and its onset, treatment methods, and outcomes vary greatly depending on the demographics, healthcare systems, and insurance systems in each country. Therefore, the epidemiology of HF in each country or region has been studied and published separately by national societies, expert groups, and official government agencies. In 2020, for the first time, the Korean Society of Heart Failure (KSHF) officially published nationwide statistics on the prevalence, incidence, comorbidities, and outcomes of HF in Korea from the early 2000s to 2018,<sup>2)</sup> which has been very useful to the public, patients, medical professionals, policymakers, and researchers. In this article, we report on the second official epidemiological study of HF in Korea performed by the KSHF, providing the most up-to-date statistical data.

## METHODS

### Study population

Korea has a universal healthcare system; almost all Koreans are covered by the National Health Insurance Service (NHIS). The National Health Information Database (NHID) of the NHIS is a public database on healthcare utilization, health screening, socio-demographic variables, and mortality for the whole population.<sup>3)</sup> In this study, we used a random sample of 35% of the entries in the NHID from 2002 to 2020, which was approved by the NHIS (NHIS-2023-1-072). The NHIS uses the Korean Standard Classification of Diseases (KCD) codes, which is based on the International Classification of Diseases (ICD) codes. We defined patients with HF as those for whom KCD codes for HF (I50, I42, I11.0, I13.0, I13.2, I25.5, and their subcodes) were recorded as the primary or secondary diagnosis codes on their claim data. The final analysis database was merged with death statistics from Statistics Korea to determine the cause of death. This study complied with the Declaration of Helsinki, and its design was approved by Yonsei University Health System's Institutional Review Board (IRB number: 4-2021-1653). The need for informed consent was waived because the data were de-identified and anonymized.

### Statistical analysis

The prevalence, incidence, and HF mortality rates in the total population was presented by year as crude rates and age-standardized

rates based on the 2018 resident population. Age-specific HF prevalence and incidence rates were presented by age group, divided into 10-year increments. For incidence estimation, we defined individuals who had a new record of healthcare utilization with a diagnosis of HF without a record of HF diagnosis in the previous 2 years as individuals who developed HF during the study period. HF mortality was defined as cases in which a diagnosis code of HF was entered as the cause of death. We examined hospitalizations of any cause, hospitalization for HF as a primary or secondary diagnosis, and hospitalization for HF as a primary diagnosis by year to calculate hospitalization rates in the total population and among patients with HF. The prevalence of comorbidities in patients with HF was examined using diagnosis codes entered during the 365 days prior to the last healthcare usage with HF as the primary or secondary diagnosis in that year. KCD codes for comorbidities are presented in **Supplementary Table 1**.

Annual mortality rates among patients with HF were calculated by examining deaths of any cause in the year, and age-specific mortality rates for 10-year age groups were also determined. For in-hospital mortality among patients with HF, we examined deaths of any cause, cardiovascular deaths, and deaths related to HF during hospitalization with HF as the primary diagnosis in the year. Cardiovascular deaths were defined as those for which the cause of death was entered as a KCD code of I00–I99. The 15-year survival of patients with HF was examined among those newly diagnosed with HF each year and represented using a Kaplan-Meier curve. Patients hospitalized for HF at least once during the follow-up period were defined as HF inpatients, patients without a history of hospitalization for HF were defined as HF outpatients, and 15-year survival analysis was performed for each group. The one-year survival rate after the first diagnosis for HF was analyzed by dividing the patients into those who were first diagnosed with HF as outpatients and those who were first diagnosed with HF during hospitalization. To calculate the cost of inpatient and outpatient care for patients with HF, the amount billed for diagnosis codes “I50,” “I110,” “I130,” and “I132” in the year for inpatient and outpatient care were calculated. Cost for inpatient and outpatient care excluded costs for medications, as the NHIS did not provide information on the cost of medications. Statistical analyses were performed by professional statisticians using SAS statistical software version 9.3 (SAS Institute Inc., Cary, NC, USA).

## RESULTS

### Prevalence of HF

In the NHID, an estimated 1,326,886 people, or 2.58% of the total population, had HF in 2020. The prevalence in men was 2.55%,

and that in women was 2.62% (Figure 1A). The estimated number of patients with HF increased 3.6-fold in about 18 years, from 369,211 in 2002 (a prevalence of 0.77%). In 2020, the age-specific prevalence of HF was 0.06%, 0.07%, 0.18%, 0.38%, 0.87%,

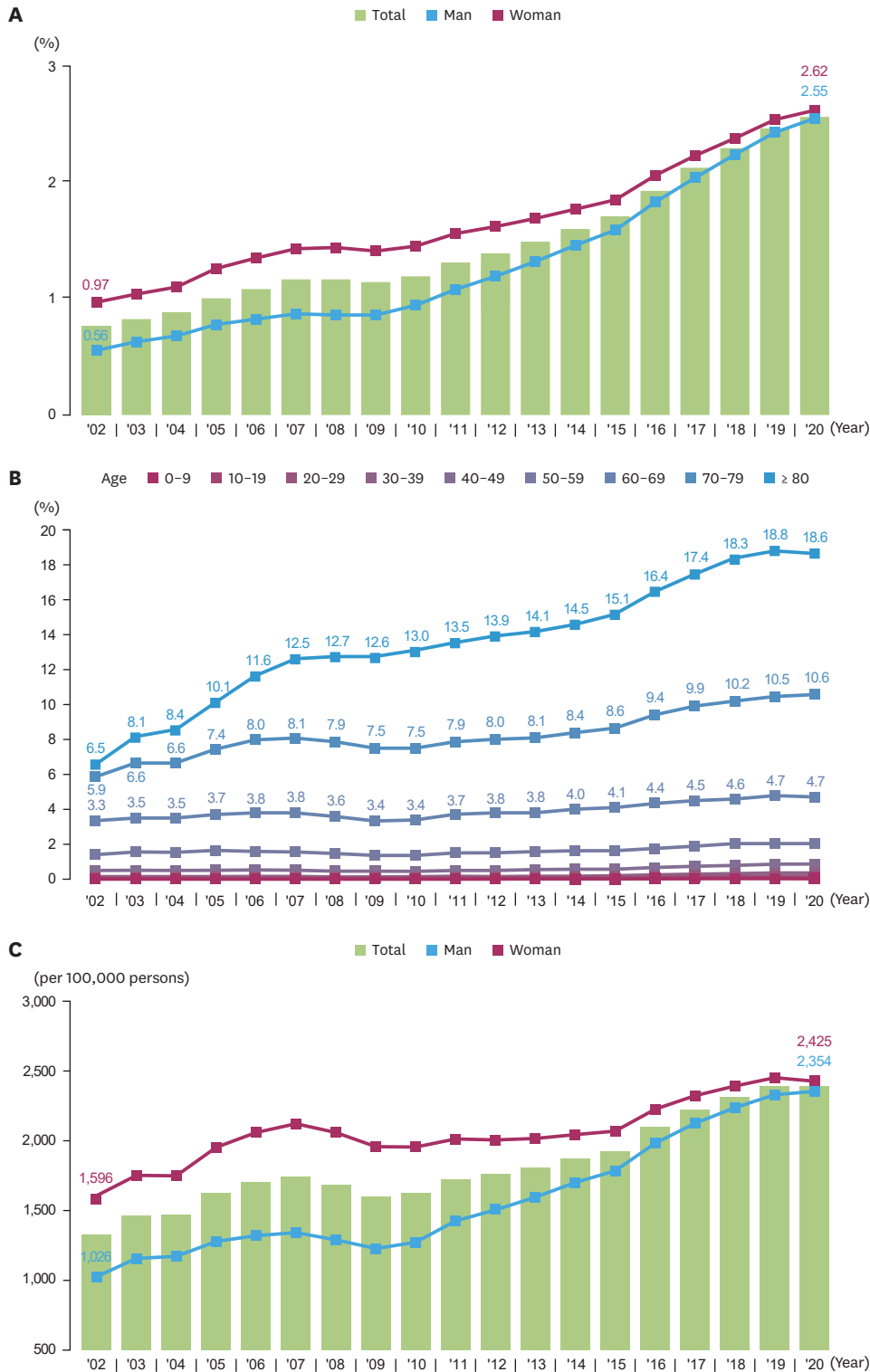


Figure 1. Prevalence of heart failure from 2002 to 2020 in Korea. (A) Temporal trend of crude prevalence. (B) Temporal trend of prevalence according to age. (C) Temporal trend of age-standardized prevalence.

2.02%, 4.71%, 10.57%, and 18.62% for those aged 0–9, 10–19, 20–29, 30–39, 40–49, 50–59, 60–69, 70–79, and ≥80 years, respectively (**Figure 1B**). The age-specific prevalence steadily increased over the past 18 years in all age groups, with a distinct 2–3-fold increase in those aged 70 years and older. The age-standardized prevalence was 1,324 per 100,000 persons in 2002 and increased to 2,390 per 100,000 persons in 2020 (**Figure 1C**). The age-standardized prevalence for men and women in 2020 was 2,354 and 2,425 per 100,000 persons, respectively.

### Incidence rate of HF

In 2003, the incidence rate of HF was 482 per 100,000 persons, with incidence rates of 377 and 587 per 100,000 men and women, respectively (**Figure 2A**). Compared with that in 2002, the incidence rate in 2020 was higher at 609 per 100,000 persons, with incidence rates of 619 and 599 per 100,000 men and women, respectively. However, the age-standardized incidence rate decreased from 824 per 100,000 persons in 2002 to 572 per 100,000 persons in 2020 (**Figure 2B**). In particular, the age-standardized incidence rate for women decreased from 961 per 100,000 persons in 2003 to 564 per 100,000 persons in 2020, while the age-standardized incidence rate for men decreased from 678 per 100,000 persons in 2003 to 580 per 100,000 in 2020.

The crude incidence by age was 28, 43, 114, 197, 340, 615, 1,148, 2,084, and 3,094 per 100,000 persons among those aged 0–9, 10–19, 20–29, 30–39, 40–49, 50–59, 60–69, 70–79, and ≥80 years, respectively (**Figure 2C**). The incidence rate tended to increase from 2002 to 2020 in the under-40 age group but decrease in the over-50 age group.

### Hospitalization rate for HF in the general population

In 2020, the hospitalization rate for any cause for patients with HF was 1,166 per 100,000 persons (**Figure 3A**). The rate of hospitalizations for HF as the primary diagnosis was 74 per 100,000 persons, and the rate of hospitalizations for HF as the primary or secondary diagnosis was 648 per 100,000 persons. The overall hospitalization rate for patients with HF and the hospitalization rate specifically for HF increased steadily from 2002 to 2017, after which it plateaued.

In 2020, the age-standardized hospitalization rate for any cause of patients with HF was 1,073 per 100,000 persons. The age-standardized hospitalization rate for HF as primary diagnosis was 67 per 100,000 persons, and that as primary or secondary diagnosis was 594 per 100,000 persons (**Figure 3B**).

### Mortality rate for HF in the general population

In 2002, an estimated 1,431 deaths occurred owing to HF, with a rate of 3.0 per 100,000 persons. In 2020, an estimated 8,020

deaths occurred owing to HF, a rate of 15.6 per 100,000 persons. An increasing trend was observed from 2002 to 2020 (**Figure 4A**). The age-standardized HF mortality rate was 7.0 per 100,000 persons in 2002 and 13.8 per 100,000 persons in 2020 (**Figure 4B**). The HF mortality rate was higher among women than that among men in 2002 and 2020 (2002: 3.9 per 100,000 vs. 2.0 per 100,000; 2020: 21.5 per 100,000 vs. 9.7 per 100,000).

### Comorbidity prevalence among patients with HF

In 2020, the prevalence of hypertension among patients with HF was 78.7%, followed by diabetes at 58.8% (**Figure 5A**). The prevalence of ischemic heart disease was 50.6%, while the prevalence of atrial fibrillation, chronic kidney disease (CKD), and cerebral infarction was 20.3%, 15.8%, and 14.5%, respectively (**Figure 5B**). The prevalence of the 6 comorbidities exhibited an increasing trend from 2002 to 2020.

### Hospitalization rate among patients with HF

In 2020, 45.1% of patients with HF were hospitalized for any cause. Among patients with HF, the hospitalization rate for HF as the primary diagnosis was 2.9%, and that for HF as a primary or secondary diagnosis was 25.1% (**Figure 6A**). While the hospitalization rate for HF as the primary diagnosis did not change substantially over the 18-year period from 2.7% in 2002, that for HF as a primary or secondary diagnosis and that for any cause tended to be increasing.

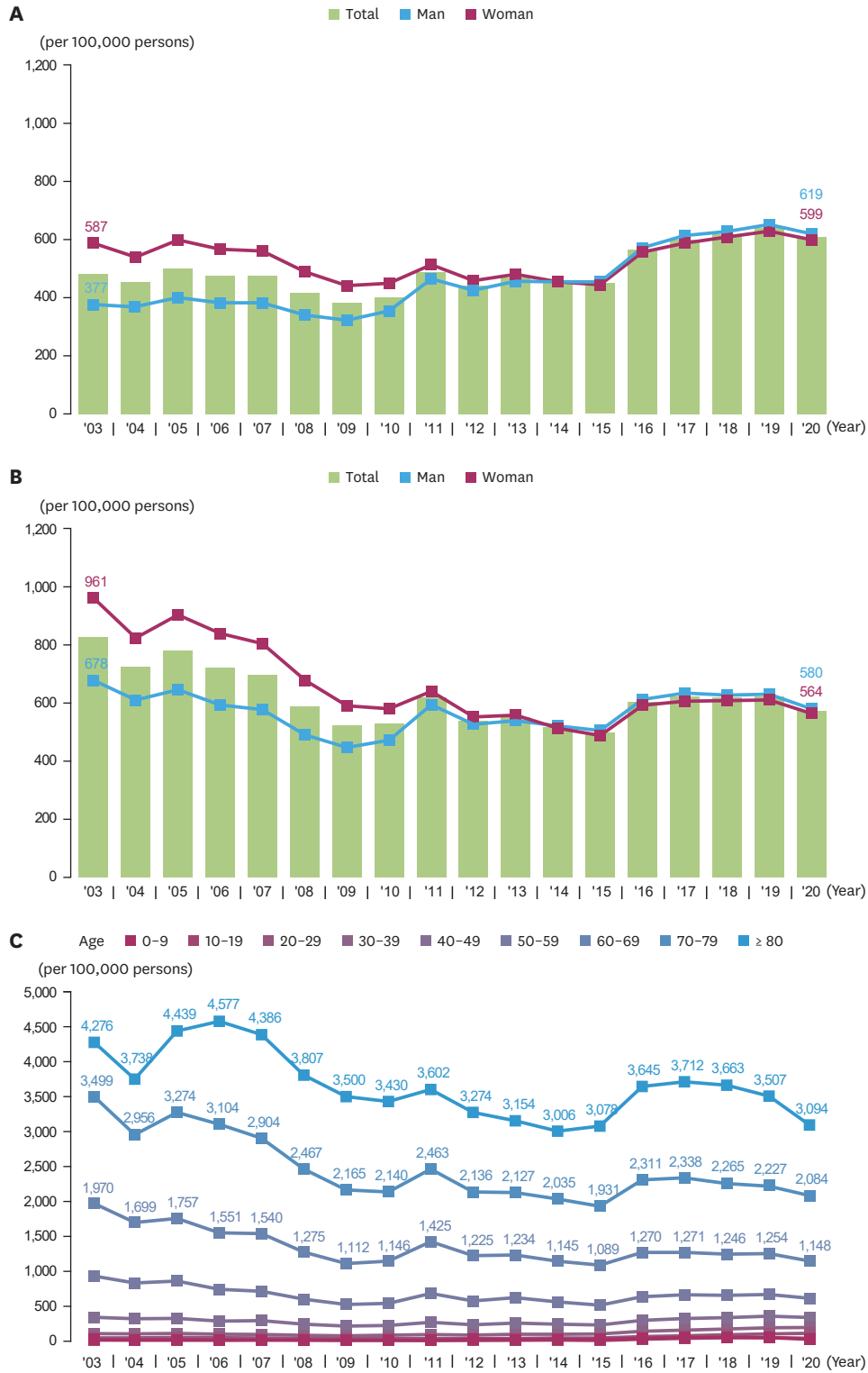
### Mortality rate among patients with HF

In 2002, the annual mortality rate for patients with HF was 4.9%, with rates of 6.5% and 4.0% for men and women, respectively. In 2020, the annual mortality rate was 5.8%, with rates of 5.8% and 5.7% for men and women, respectively (**Figure 6B**). The age-specific mortality rates for patients with HF were 1.5%, 1.4%, 1.1%, 1.2%, 1.5%, 1.9%, 2.5%, 4.7%, and 13.2% for 0–9, 10–19, 20–29, 30–39, 40–49, 50–59, 60–69, 70–79, and ≥80 years, respectively, with no substantial changes in overall mortality rates for patients with HF from 2002 to 2020 (**Figure 6C**).

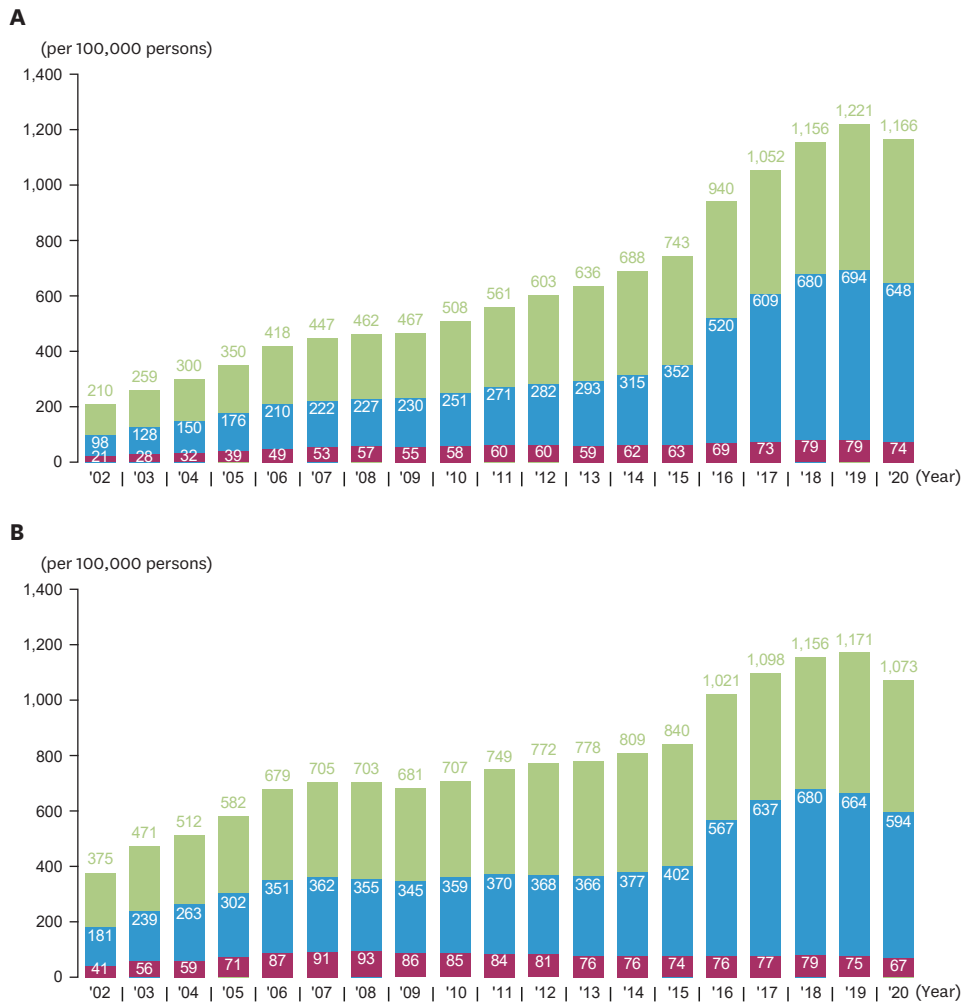
Among patients who were hospitalized for HF as the primary diagnosis, mortality of any cause, cardiovascular mortality, and HF mortality in 2020 were 16.0%, 9.3%, and 5.3%, respectively (**Figure 6D**). Overall, the mortality rates among patients hospitalized for HF increased over the study period, and the increase in HF mortality was pronounced.

The 1-, 5-, 10-, and 15-year survival rates for patients with HF were 91%, 79%, 66%, and 54%, respectively (**Figure 7A**). HF inpatients, who had a history of at least one hospitalization for HF, had 1-, 5-, 10-, and 15-year survival rates of 84%, 66%, 48%, and 34%,

respectively (Figure 7B), compared to 96%, 88%, 79%, and 71% for HF outpatients, who had no history of HF hospitalizations (Figure 7C). The one-year survival rate was unchanged for patients first diagnosed with HF in outpatient settings, at 96.0% in 2003 and



**Figure 2.** Incidence of heart failure from 2002 to 2020 in Korea. (A) Temporal trend of crude incidence. (B) Temporal trend of age-standardized incidence. (C) Temporal trend of incidence according to age.



**Figure 3.** Hospitalization rates for heart failure in the general population from 2002 to 2020 in Korea. (A) Temporal trend of hospitalization rates for any cause, for heart failure as primary or secondary diagnosis, and for heart failure as primary diagnosis. (B) Temporal trend of age-standardized hospitalization rates for any cause, for heart failure as primary or secondary diagnosis, and for heart failure as primary diagnosis.

96.8% in 2020 (**Figure 7D**). Conversely, for patients who were first diagnosed with HF during hospitalization, the one-year survival rate improved to 80.0% in 2020 from 70.8% in 2003 (**Figure 7E**).

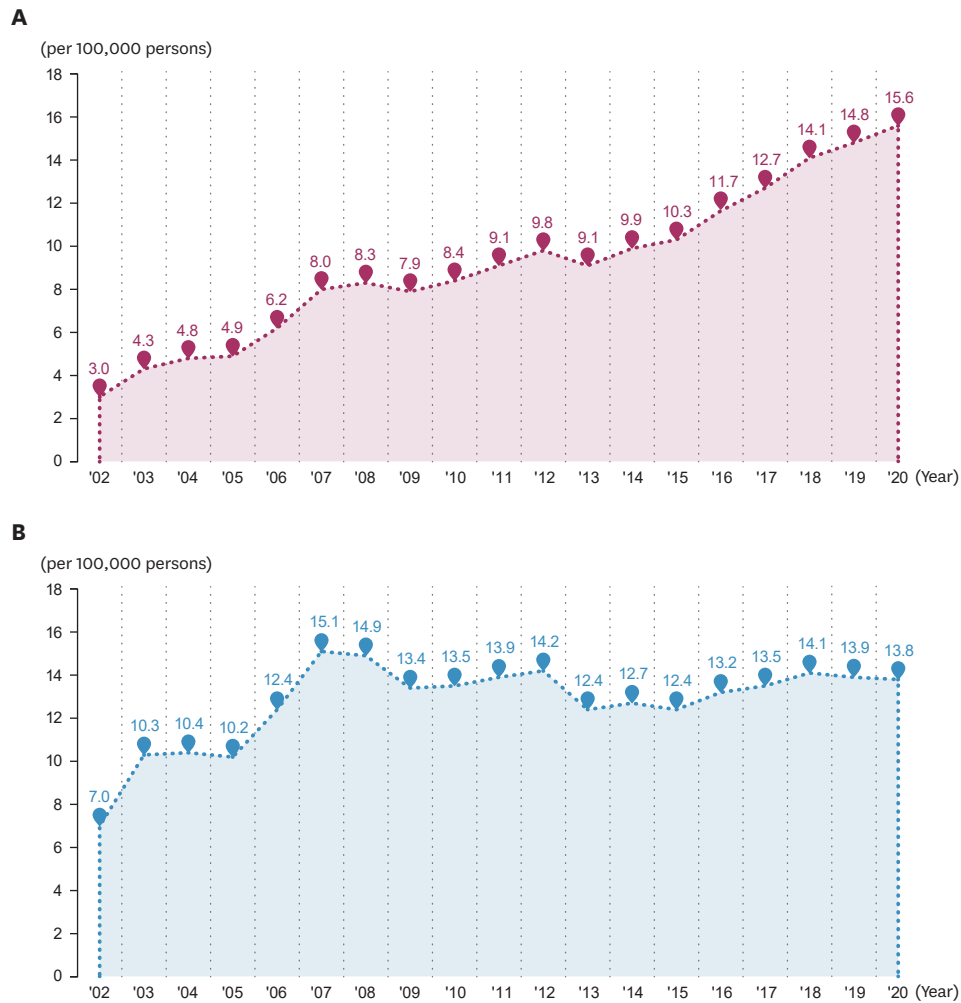
### Healthcare costs for patients with HF

In 2020, the total costs for inpatient and outpatient care of patients with HF were \$2.4 billion (approximately ₩3.2 trillion; exchange rate: \$1/₩1,300). This is about 16 times that in 2002 (\$0.15 billion). In 2020, inpatient care accounted for \$2.1 billion and outpatient care for \$0.3 billion, with inpatient care accounting for approximately 90% of the total billings. In 2002, the cost of inpatient care was \$0.11 billion, and the cost of outpatient care was \$0.03 billion (**Figure 8**). Compared to medical expenses in 2020, the cost of inpatient care increased 19 times, and the cost of outpatient care increased 8.3 times. Healthcare costs per person with HF increased 2.7 times from \$2,423 in 2002 to \$6,561 in

2020 for inpatient care and 2.5 times from \$106 in 2002 to \$265 in 2020 for outpatient care (**Figure 8**).

## DISCUSSION

This analysis of data from Korea's NHID from 2002 to 2020 provides reliable national statistics on HF. The study revealed a steady increase in the prevalence of HF in Korea over the 18-year period, which is consistent with previous studies on the epidemiology of HF in other countries. The increase in the prevalence of HF was especially noticeable among older adults, but interestingly, the incidence of HF did not increase significantly from 2002 to 2020, and the age-standardized and age-specific incidences actually decreased. However, hospitalizations and mortality among patients with HF rose nationally from 2002 to 2020, and the



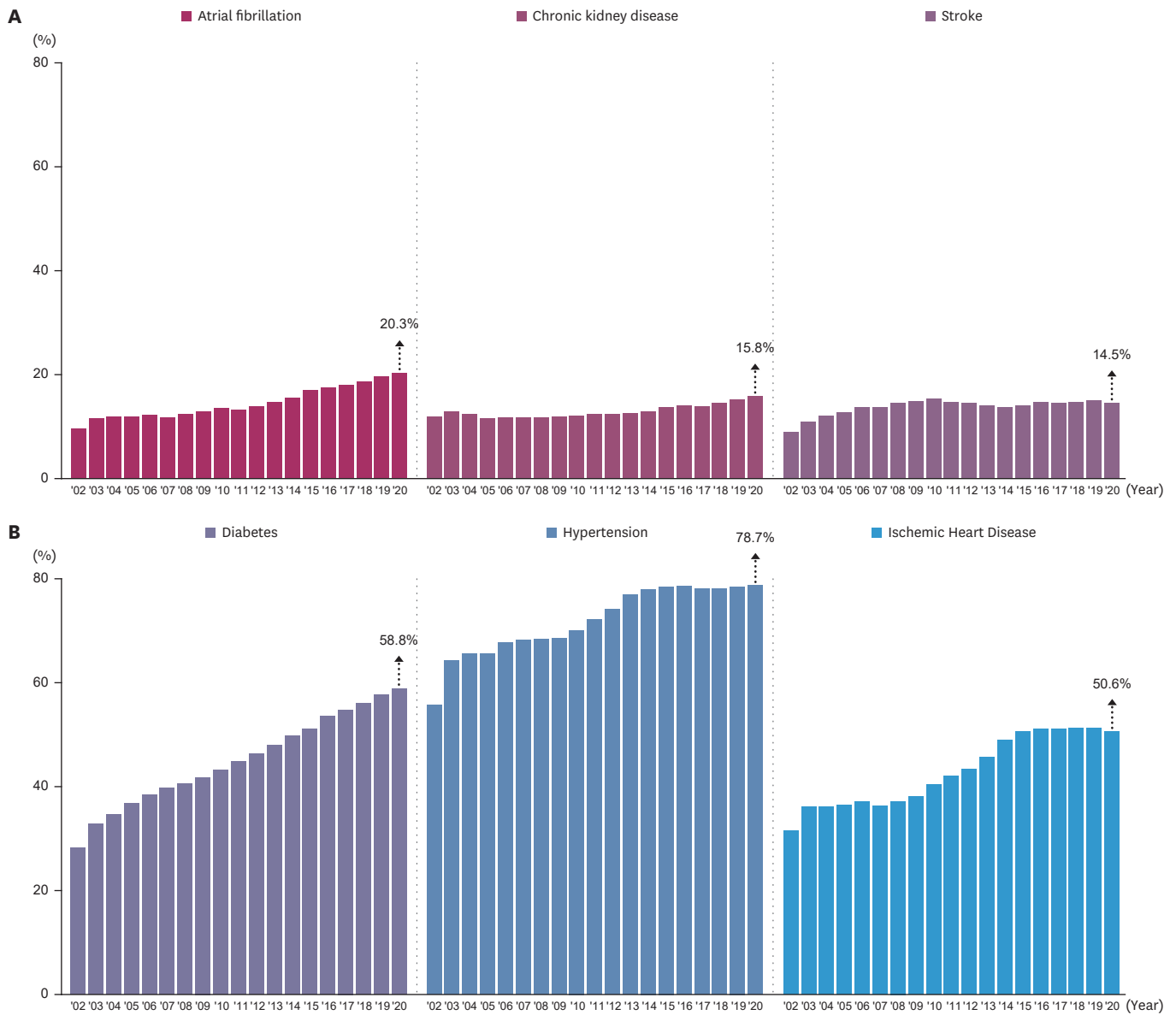
**Figure 4.** Heart failure mortality rate in the general population from 2002 to 2020 in Korea. (A) Temporal trend of heart failure mortality rate. (B) Temporal trend of age-standardized heart failure mortality rate.

associated healthcare costs were evident, indicating a growing socioeconomic burden. The annual mortality rate for patients with HF was 5.8% in 2020, only 0.9% more than that in 2002, and survival after the first diagnosis improved. However, in-hospital HF mortality slightly increased over the study period.

This paper is an extension of the previously published “Heart Failure Statistics in Korea, 2020” with some differences. This is because the operational definition used, the available database provided by the NHIS, and the detailed analysis methods are slightly different. In the previous paper, the operational definition of HF included I50, I11.0, I13.1, I13.0, I13.2, and their subcodes, whereas in this paper, I50, I42, I11.0, I13.0, I13.2, I25.5, and their subcodes were used. Therefore, the prevalence and incidence of HF reported in the 2 reports show discrepancies. The 2 papers also differ in how they examine the prevalence of comorbidities. The previous paper examined the presence of comorbidities each year

based on claims from the date of the last visit for HF to January 1 of that year, whereas this paper examined comorbidities within 365 days of the last visit for HF. In the statistics of medical costs, the previous report reported the cost of medication, inpatients, and outpatient care respectively. However, in this report, we could not use the database to calculate the cost of medication, so we could only report the cost for inpatients and outpatient care.

The epidemiology of HF has been published every few years in various countries around the world. The prevalence is reported in different ways in different studies, such as crude, age-standardized, or age- and sex-standardized prevalence, complicating direct comparisons. In general, the estimated prevalence of HF in the general population in industrialized countries is between 1% and 3%. In 2019, the Atlas project of the Heart Failure Association (HFA) reported an estimated prevalence of HF of 17 per 1,000 persons in 13 European countries.<sup>4)</sup> In the United States, the



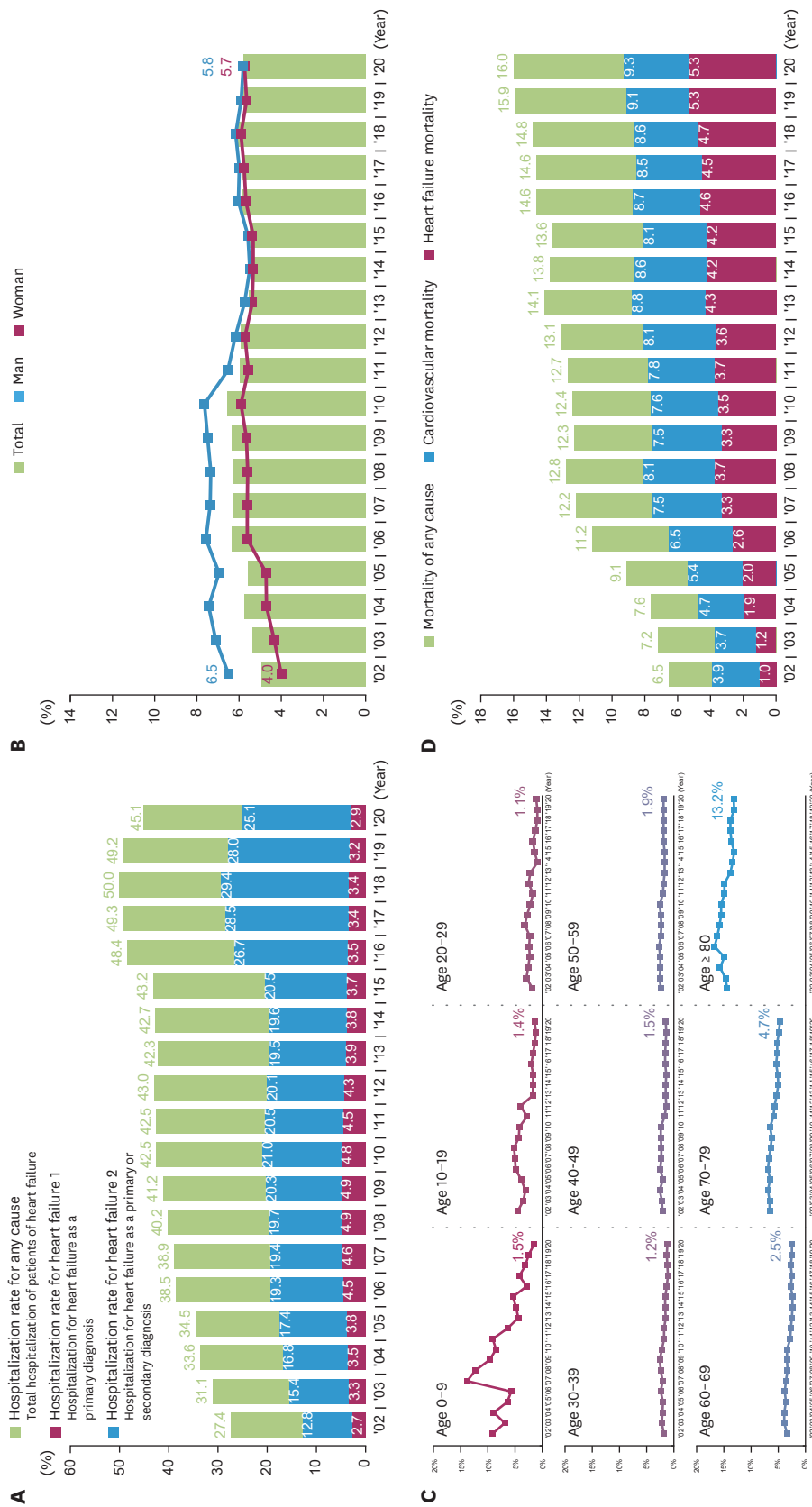
**Figure 5.** Prevalence of comorbidities among patients with heart failure from 2002 to 2020 in Korea. (A) Temporal trend of prevalence of diabetes, hypertension, and ischemic heart disease. (B) Temporal trend of prevalence of atrial fibrillation, chronic kidney disease, and stroke.

reported prevalence among all participants in the National Health and Nutrition Examination Survey (NHANES) was 19 per 1,000 persons in 1999 and 26 per 1,000 persons in 2017.<sup>5)</sup> In our study, the prevalence of HF in the general Korean population was 2,390 per 100,000 people in 2020, similar to that in Western countries. The prevalence of HF increased with age in previous studies. In the 2017–2020 NHANES, the prevalence estimates for HF were 4.93% in the 60–69-year age group, 6.96% in the 70–79-year age group, and 10.14% in the ≥80-year age group.<sup>6)</sup> ICD code-based diagnosis of HF was used in several previous studies, as in our study. The reported prevalence in 2013 in America was 172 per 1,000 persons aged ≥65 years, and in a retrospective analysis of

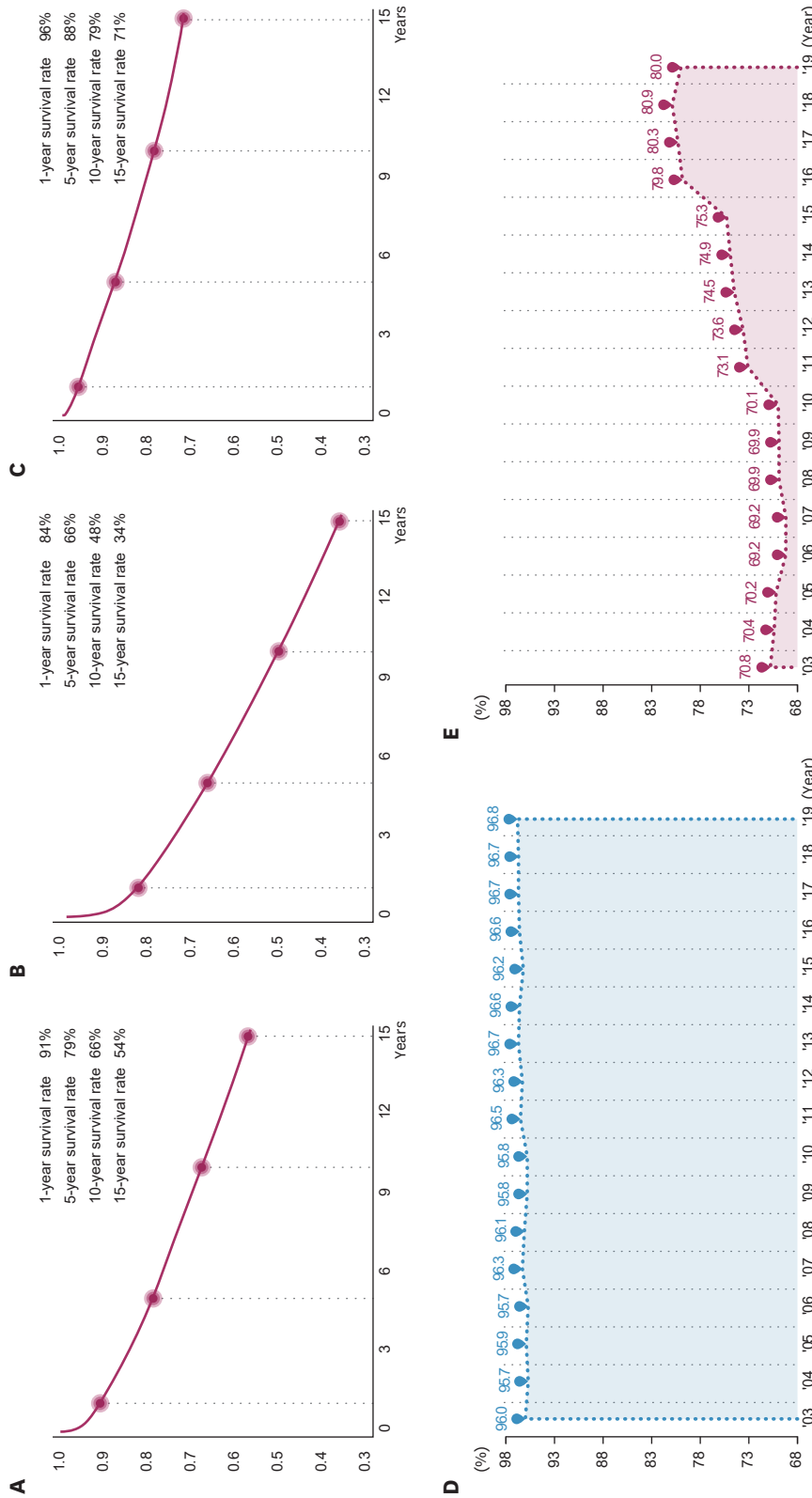
German healthcare claims data, the reported prevalence was 2,460 per 100,000 persons in the 65–69-year age group and 4,616 per 100,000 persons in the 80–84-year age group.<sup>7,8)</sup> Our results confirm the increasing prevalence of patients with HF as the population ages.

The Atlas project of the HFA revealed a median annual incidence of HF of 3.2 per 1,000 person-years, which varied considerably between countries, even within Europe.<sup>4)</sup> This variation is probably due to differences in the diagnostic criteria for HF between studies; in Spain, in a study based on the Framingham criteria for HF, the reported incidence was 3.9 per 1,000 person-years in 2007.<sup>9)</sup>

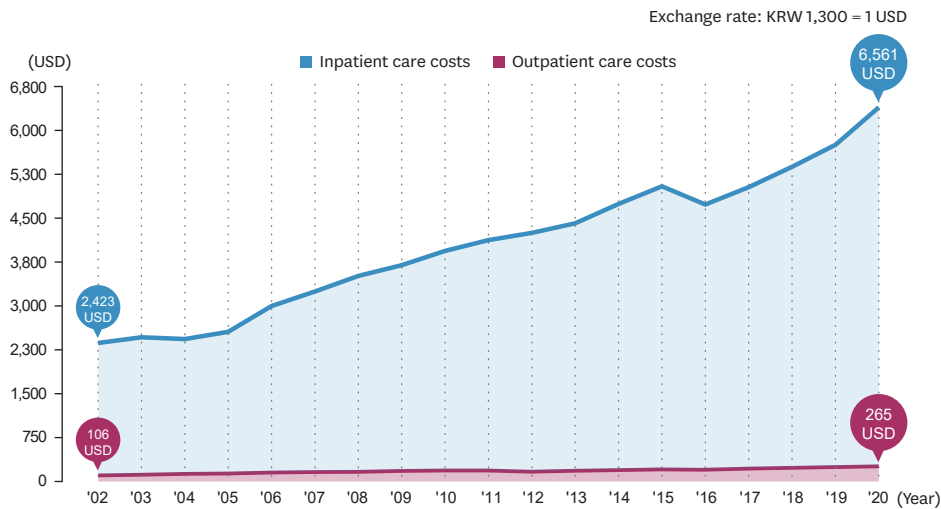




**Figure 6.** Hospitalization and mortality rates among patients with heart failure from 2002 to 2020 in Korea. (A) Temporal trend of hospitalization rates for any cause, for heart failure as primary or secondary diagnosis, and for heart failure as primary cause. (B) Temporal trend of mortality rates for any cause, for heart failure as primary or secondary diagnosis, and for heart failure as primary cause. (C) Temporal trend of mortality rates for any cause, for heart failure as primary or secondary diagnosis, and for heart failure as primary cause. (D) Temporal trend of in-hospital mortality rates for any cause, cardiovascular disease, and heart failure.



**Figure 7** Survival curves and 1-year survival rates among patients with heart failure. (A) Survival curve in all patients with heart failure. (B) Survival curve in heart failure inpatients. (C) Survival curve in heart failure outpatients. (D) One-year survival rate after diagnosis of heart failure in outpatients. (E) One-year survival rate after diagnosis of heart failure during hospitalization.



**Figure 8.** Temporal trend of the costs for inpatient and outpatient care among patients with heart failure.

In the abovementioned German study, the incidence was 665 per 100,000 person-years in 2010.<sup>8</sup> The incidence varied across studies in the United States, likely owing to differences in sources, diagnostic criteria for HF, and study periods. The Olmsted study in the United States was based on ICD codes, and the age- and sex-adjusted incidence of HF was 3 per 1,000 person-years in 2002 and 2 per 1,000 person-years in 2010,<sup>10</sup> whereas in a study of participants in the Framingham Heart Study and the Cardiovascular Health Study, the incidence of HF from 2000 to 2008 was 18.9 per 1,000 person-years.<sup>11</sup> Owing to this wide variation among studies, the estimated global incidence of HF is 1–20 per 1,000 person-years. However, a common observation across studies is that the incidence has remained constant or declined steadily over time, especially in developed countries.<sup>6,12</sup> In our study, the crude incidence of HF in Korea appeared to increase slightly from 2002 to 2020, but the age-standardized prevalence decreased substantially from 2002 to 2020, similar to the trend of HF incidence in other countries.

In one study in the United States, the hospitalization rate for HF was approximately 500 per 100,000 persons, and the hospitalization rate for HF as a secondary cause was approximately 1,500 per 100,000 persons.<sup>13</sup> In another American study, in which ICD codes were used to determine patients with a primary discharge diagnosis of HF from 2004 to 2018, the crude hospitalization rate for HF in 2018 was 4.9 per 1,000 persons, and the rate was nearly twice as high in blacks, at 9 per 1,000 persons.<sup>14</sup> In contrast, in a Danish population-based cohort study in which hospitalizations for HF as the primary or secondary cause were examined, the hospitalization rate for HF was 210 per 100,000 person-years in 1983 and 164 per 100,000 person-years in 2012.<sup>15</sup> In our study, the hospitalization rate for HF as a primary or secondary diagnosis in

2012 was 282 per 100,000 person-years. The large difference in the hospitalization rate for HF as a proportion of the total population between our study and previous studies is probably due to differences in healthcare systems across countries and different criteria for HF diagnoses and hospitalizations across studies. However, whereas studies in the United States and Europe revealed a gradual decrease in hospitalization rates over 15 to 20 years, the gradual increase in hospitalization rates for HF in the total population in Korea is likely due to the rapid increase in the prevalence of patients with HF.

Hypertension, diabetes mellitus, and coronary artery disease are the most important risk factors for the development of HF, accounting for two-thirds of the population-attributable risk.<sup>16</sup> In an American study, the prevalence of hypertension in patients hospitalized for HF was 68–73%.<sup>17</sup> In the Get With the Guidelines–Heart Failure (GWTG-HF) registry, 83.6% of patients with HF had previously been diagnosed with hypertension.<sup>18</sup> The reported prevalence of diabetes varies from 10% to 47%, and because of the increased risk of HF in patients with diabetes, the prevalence of diabetes in patients with HF is likely to be higher than that in the general population.<sup>19</sup> The prevalence of hypertension and diabetes in our study was similar to that in previous studies. Atrial fibrillation had a reported prevalence of 20–40% in patients with HF in other studies, which was similar to the results of this study.<sup>20,21</sup> Approximately half of patients with HF with preserved ejection fraction had coronary artery disease in one study,<sup>22</sup> and 57–65% of patients hospitalized for acute decompensated HF had coronary artery disease in another study.<sup>17</sup> Our results were relatively similar to those of previous studies. Although epidemiological evidence on the prevalence of stroke in patients with HF is limited, about 16% of participants in the GWTG-HF registry had a history

of stroke, which was similar to the results of our study.<sup>18,23</sup> CKD is observed in 23–30% of patients with HF.<sup>17,18</sup> Our study revealed a lower prevalence of CKD than that in previous studies, which may be owing to the fact that the prevalence of CKD was based on ICD-related codes in this study.

In the United States, HF mortality increased from 2010 to 2020, and the age-adjusted HF mortality rate in 2020 varied by race, with a rate of 12.9 per 100,000 persons among non-Hispanic Asian or Pacific Islanders and 41.4 per 100,000 persons among African Americans.<sup>6</sup> In our study, the age-standardized HF mortality rate was 13.8 per 100,000 persons, similar to that of Asians in the United States. The estimated number of patients with HF in the United States in 2020 was 6.7 million, with an overall annual mortality rate of 9%.<sup>6</sup> In our study, the annual mortality rate for patients with HF was somewhat lower, at 5.8%. Among patients discharged from the hospital with acute HF, 20% died within one year of discharge in one study.<sup>24</sup> Similarly, in our study, the 1-year survival rate was 84% for patients with a prior hospitalization for HF as the primary diagnosis, and 80% for those with a first diagnosis of HF upon admission. In the European Society of Cardiology Heart Failure Long-Term Registry, the 1-year mortality rates for acute and chronic HF were 23.6% and 6.4%, respectively, and the 1-year mortality rates for ambulatory patients with HF ranged from 6.3% to 8.8%, suggesting that patients with stable HF have a relatively high survival rate, as confirmed by our results.<sup>20,25</sup> However, in the Danish nationwide cohort study, the 1-year mortality rate was 33% and the 5-year mortality rate was 43% in patients with a first hospitalization for HF.<sup>15</sup> In the United States GWTG-HF registry, the 5-year mortality rate was 75.4%, which was much higher than that in our study.<sup>26</sup> Nevertheless, one encouraging finding is that there has been a clear improvement in one-year survival for patients who have been hospitalized for HF. This is presumably due to the development of new medications, advances in device therapy, and improved management of advanced HF. This improvement in survival may also explain why the prevalence of HF has been increasing even as the age-standardized incidence of HF is trending downward.

In our study, the mortality rate among patients hospitalized for HF was 16%, which was higher than that in registry-based studies. In the Organized Program to Initiate Lifesaving Treatment in Hospitalized Patients With Heart Failure registry, in-hospital mortality was 2.9% in patients with HF with preserved ejection fraction and 3.9% in those with reduced ejection fraction.<sup>27</sup> In other HF registry studies in Japan and China, in-hospital mortality was 2.4–6.5%.<sup>28,29</sup> Even in the Korean Heart Failure Registry, in-hospital mortality was only 6.6%.<sup>30</sup> However, we examined in-hospital mortality for patients hospitalized for HF as the

primary diagnosis, which accounted for 2.85% of all patients with HF in 2020, and 79% of these patients were aged 70 years or older, which may explain the relatively high in-hospital mortality in our analyses.

Annual healthcare costs per patient with HF vary widely by country. The United States spends between \$10,832 and \$17,744 per person with HF per year, Germany spends €25,532, Italy spends €11,100, and Japan spends \$8,089.<sup>12</sup> Because we used claims data from the NHIS, in which most people in Korea must be enrolled, we were able to analyze the total costs and per capita costs for inpatient and outpatient care of patients with HF. In Korea, the estimated healthcare expenditure per patient with HF in 2020 was approximately \$1,855. Despite the exclusion of medication costs, this cost is very low compared to other countries of similar economic size, probably owing to Korea's unique health insurance system. However, the actual cost of diagnosing and managing HF is likely higher than our study suggests if non-reimbursed medical services are considered in addition to the cost of health insurance. Nonetheless, this study revealed an overall trend of increasing healthcare costs, and given the increasing number of patients with HF, as well as the introduction of new therapeutic agents, invasive and non-invasive treatments, such as device-based therapies, and the increasing adoption of various healthcare services, such as education and remote management of HF, we expect the healthcare cost for HF to continue to rise rapidly in Korea.

This study has several limitations. First, as the NHID is not a database for research purposes but rather for health insurance services and reimbursement, it lacks detailed variables about HF that are included in registry studies or prospective cohort studies of HF. In particular, it contains no information on left ventricular ejection fraction, making analysis by type of HF impossible. Second, as these data do not include examinations or treatments for HF that are not covered by the NHIS, healthcare costs were likely underestimated. Third, this article does not include data on prescriptions of medications for HF. These claims data could not provide accurate information on guideline-directed medical treatment of HF because the use of SGLT2i to treat HF is not covered by insurance and is not included in healthcare claims data, and it is not possible to differentiate between medications used according to HF type. Fourth, previous article reporting HF statistics in Korea provided statistics on device therapies and heart transplantation,<sup>2</sup> but this study did not report statistics for these treatments because official data were not available. Fifth, the validity of the HF diagnosis in the NHIS claims data was not verified. However, as the aim of this study was to provide information on the diagnosis and outcomes of HF that reflects real-world practice in Korea, we believe that it provides reliable statistics on the nationwide situation of

HF in Korea. In addition, as the prevalence of HF in this study did not differ much from that in other countries, the results are likely reliable.

In conclusion, although the incidence of HF in Korea did not change considerably from 2002 to 2020 and the prognosis of patients with HF improved, the number of patients with HF continued to increase owing to the increase in the older population and the improvement in survival rate, and the healthcare costs for patients with HF substantially increased. The results of this study provide useful information to patients and doctors and may alert healthcare professionals and policymakers to the increasing burden of HF in Korea.

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### ORCID iDs

Chan Joo Lee   
<https://orcid.org/0000-0002-8756-409X>  
 Hokyoo Lee   
<https://orcid.org/0000-0002-5034-8422>  
 Minjae Yoon   
<https://orcid.org/0000-0003-4209-655X>  
 Kyeong-Hyeon Chun   
<https://orcid.org/0000-0002-7798-658X>  
 Min Gyu Kong   
<https://orcid.org/0000-0003-1336-5319>  
 Mi-Hyang Jung   
<https://orcid.org/0000-0003-0224-5178>  
 In-Cheol Kim   
<https://orcid.org/0000-0002-5751-2328>  
 Jae Yeong Cho   
<https://orcid.org/0000-0002-9393-2821>  
 Jeehoon Kang   
<https://orcid.org/0000-0002-9078-2231>  
 Jin Joo Park   
<https://orcid.org/0000-0001-9611-1490>  
 Hyeon Chang Kim   
<https://orcid.org/0000-0001-7867-1240>  
 Dong-Ju Choi   
<https://orcid.org/0000-0003-0146-2189>  
 Jungkuk Lee   
<https://orcid.org/0000-0003-1874-449X>  
 Seok-Min Kang   
<https://orcid.org/0000-0001-9856-9227>

### Conflict of Interest

The authors have no financial conflicts of interest.

### Author Contributions

Conceptualization: Lee CJ, Park JJ, Kang SM, Choi DJ; Data curation: Lee CJ, Lee H, Yoon M, Chun KH, Kong MG, Jung MH, Kim IC, Cho JY, Kang J; Formal analysis: Lee J; Investigation: Lee CJ, Lee H, Yoon M, Chun KH, Kong MG, Jung MH, Kim IC, Cho JY, Kang J; Methodology: Lee CJ, Lee H, Yoon M, Chun KH, Kong MG, Jung MH, Kim IC, Cho JY, Kang J, Lee J; Project administration: Lee CJ, Kang SM; Resources: Lee CJ, Kang SM; Supervision: Lee CJ, Lee H, Kim HC, Kang SM; Validation: Lee H, Kim HC, Yoon M, Chun KH, Lee J; Visualization: Lee CJ, Lee H, Yoon M, Chun KH, Kong MG, Jung MH, Kim IC, Cho JY, Kang J; Writing - original draft: Lee CJ; Writing - review & editing: Lee CJ, Lee H, Yoon M, Chun KH, Kong MG, Jung MH, Kim IC, Cho JY, Kang J, Kang SM, Kim HC.

## SUPPLEMENTARY MATERIAL

### Supplementary Table 1

The KCD codes for comorbidities

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