# Epidemiology of Heart Failure

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## Introduction

Heart failure (HF) is described as an "emerging epidemic" or "the cardiovascular epidemic of the twenty-first Century" [1, 2]. Currently, it is estimated that 5.7 million Americans over 20 years have heart failure, a number anticipated to grow to over eight million by 2030 [3]. According to the National Heart, Lung, and Blood Institute (NHLBI), there are 870,000 new cases of heart failure per year [1]. The worldwide total is projected to be 78 million in 2030 [4]. While heart failure is a disease associated with aging, there are also significant racial, ethnic, and gender differences [3].



Heart failure is a clinical syndrome involving cardiac function, skeletal muscle, renal function, and neurohumoral dysfunction. Its presentation can be in acute and/or chronic states. There are many underlying causes in the clinical syndrome of heart failure, but outcomes are poor with an estimated 50 % mortality by 5 years, worse than many cancers [5].

The epidemiology of heart failure is well studied but obtaining accurate, high-quality data faces many difficulties. The clinical diagnosis of the HF syndrome is challenging alone, but new diagnostic technologies are emerging. The underlying causes of HF are changing with the widespread treatment of risk factors such as hypertension and coronary heart disease. The advent of new technologies for treatment, as described in other chapters in this book, presents a moving target for the understanding of HF trends.

## Definitions

Heart failure is not a disease in the traditional sense. It is a clinical syndrome that results from structural and functional disorders impairing the heart's ability to adequately perfuse the body [6]. Clinical history is manifested by fatigue, dyspnea, reduce exercise tolerance, and fluid retention. On physical examination, it is manifest by increased jugular venous pressure (JVP), pulmonary rales, S3 gallop, peripheral edema, and hepatomegaly. Laboratory testing may include chest X-ray, echocardiogram, and biochemical markers. The etiology of heart failure is also complex and includes ischemic heart disease, hypertension, cardiomyopathy, rheumatic heart disease, infectious diseases, congenital heart disease, arrhythmias, and many other disorders which affect the endocardium, myocardium, pericardium, heart valves and the great vessels [7]. The clinical diagnosis is based on history, physical exam, and laboratory values as accessed by the diagnosing clinician. Clinical judgment is important and opinion varies. There is no gold standard diagnostic tool [8].

The diagnosis of HF is further complicated by staging systems and functional classifications. The New York Heart Association (NYHA) functional classification is based on physical activity capacity ranging from no limitations to symptoms of heart failure at rest in an I–IV system [7]. This is widely used to classify the severity of the disease. The American College of Cardiology/American Heart Association system also includes symptoms but focuses on a continuum from heart failure risk factors to refractory HF requiring specialized interventions in an A–D scale [7]. Attempts to standardize the diagnosis of HF based on medical record data are frequently in conflict with expert cardiology panels where sensitivity and specificity are modest [8].

Further complicating the diagnosis of heart failure is the presence of numerous etiologies. These include ischemic heart disease, hypertension, cardiomyopathy, rheumatic heart disease, infectious diseases, congenital heart disease, arrhythmias, and many others. Many of these diseases also affect additional organs leading to complexity in making the diagnosis. There are also numerous risk factors for heart failure including age, sex, ethnicity, socioeconomic status, lifestyle factors, weight, smoking, diabetes, sedentary lifestyle, increased alcohol, diet, and others [3, 7, 9, 10].

These many factors present challenges for epidemiologists attempting to describe the epidemic in terms of incidence, prevalence, and mortality. Counting cases with the lack of a gold standard; comparing functional changes with treatment, underdiagnosis, missing data in charts; and evolving disease patterns in the population are challenging. This is particularly true when comparing different studies and attempting to chart trends in the disease and its outcomes [11].

An example of the challenges faced is found in the trends in in- and outpatient diagnoses of heart failure. Much of the literature is based on inpatient diagnoses, but in the last several decades, at least half and sometimes more of the diagnosis are made in the outpatient setting. Patients diagnosed in the outpatient setting have a modestly improved 5-year survival. This might be due to early diagnoses and/or better treatment. The inclusion of outpatient diagnoses in the studies leads to a perception of an increasing number of cases (incidence) and better outcomes [12].

## Incidence

Incidence is defined as the first diagnosis of HF. Evaluation depends on cohort studies starting with healthy people and long-term follow-up to detect cases or administrative data sets with long-term historical inpatient and outpatient data.

Incidence is estimated at 2–5 per thousand person years with men having higher incidence than women. There are 500,000–870,000 new cases of HF per year in the United States [3, 10]. Lifetime risk is 20–30 % [3]. The Framingham Heart Study estimates 10 per thousand person years in those above 65 with increased rates in men compared to women and rising rates with age shown in Fig. 6.1. Incidence data are dependent on the age, sex, and race of the population. The ARIC cohort found the highest incidence in Black men and Black women with lower incidence in White men and White women (Fig. 6.2) [3]. The Cardiovascular Health Study found an incidence of 19.3 per thousand person years in those greater or equal to age 65 [10]. The MESA study found

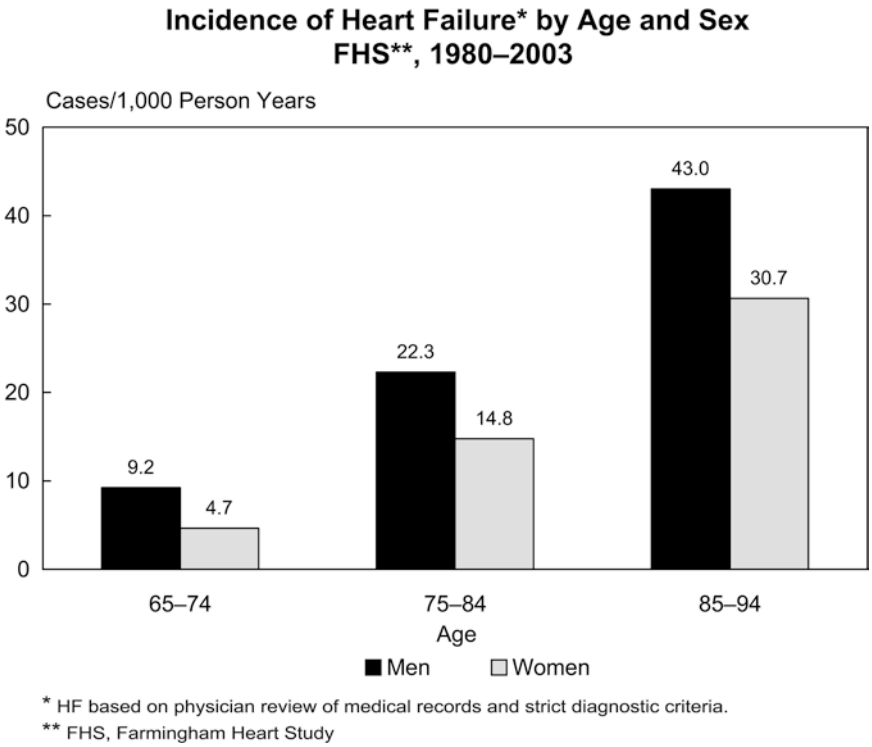



**Fig. 6.1** The incidence of heart failure in men and women approximately doubles with each 10-year increase from ages 65–74 to 85–94; however, it triples for women between ages 65–74 and 75–84. *Source*: National Heart, Lung, and Blood Institute. Incidence and Prevalence: 2006 Chart Book on Cardiovascular and Lung Diseases. Bethesda, MD: National Institutes of Health; 2006

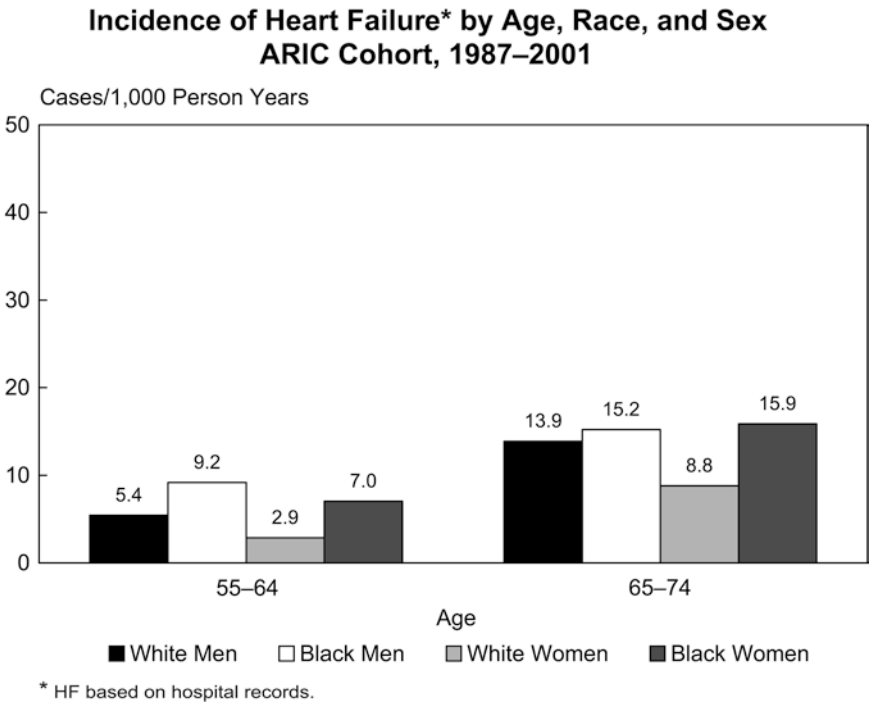



**Fig. 6.2** For ages 55–64 and 65–74, the incidence of heart failure is higher in Black women than in White women. *Source*: National Heart, Lung, and Blood Institute. Incidence and Prevalence: 2006 Chart Book on Cardiovascular and Lung Diseases. Bethesda, MD: National Institutes of Health; 2006

the highest incidence in African-American men followed by Hispanic then White. Chinese had the lowest incidence [13].

It is clear that early in the heart failure epidemic, the diagnosis and incidence were increasing [1]. However, analysis of later trends differs. In Olmsted County, incidence is stable or falling slightly [7]. In a study of the Kaiser Health System from 2000 to 2005, rates were stable combining both in- and outpatient diagnoses [14]. A study of Medicare records from 1994 to 2003 found a small decline of 32 per thousand to 29 per thousand person years in those 65 years or older (Fig. 6.3) [15]. These trends included both in- and outpatient diagnoses. Declines occurred equally among different age groups [15].

Incidence data, in addition to dependency on site, source, and quality of diagnoses, is also a reflection of other factors. These include increased survival from acute myocardial

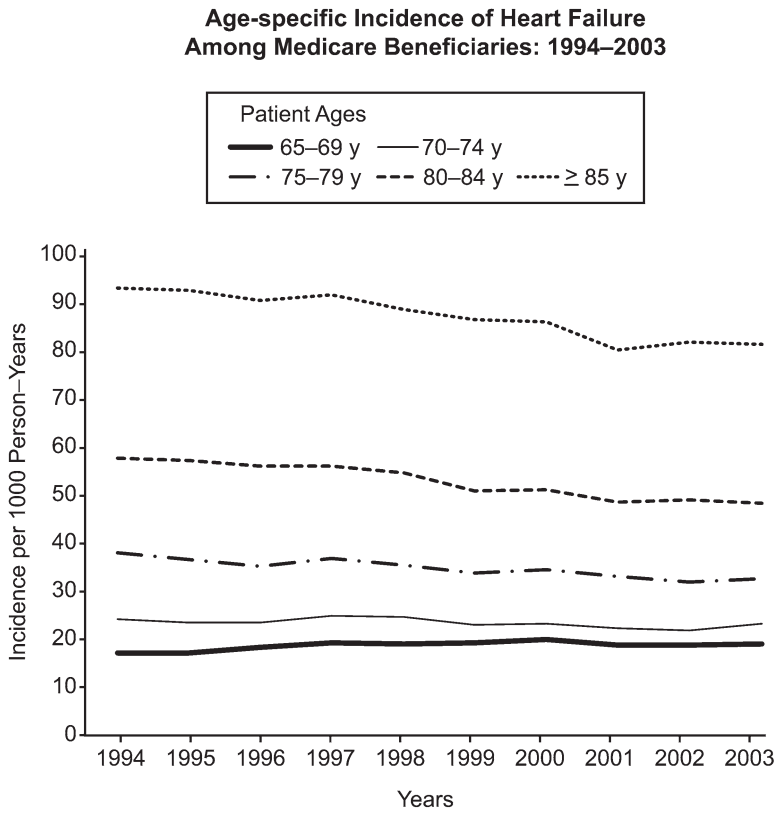



**Fig. 6.3** Age-specific incidence of heart failure among Medicare beneficiaries from January 1, 1994, through December 31, 2003. From 1994 through 2003, the incidence of heart failure increased slightly among the youngest Medicare beneficiaries and declined among older beneficiaries [15]



infarction. Damaged myocardium and reduced ejection fraction is the result of an infarction leading to diminished pumping capacity. Increasingly sensitive diagnostic instruments and better clinician awareness of the diagnosis lead to earlier case finding and appropriate classification. Improved treatment and control of hypertension, lipids, and smoking should lead to decreasing heart failure rates through less atherosclerosis or other mechanisms. These factors in combination influence the ongoing trends.

## Prevalence

It is estimated that 5.7 million Americans currently have heart failure according to the National Health and Nutrition Examination Survey (NHANES) [3]. This is projected to reach 8 million individuals by 2030. It is similarly estimated that 78 million individuals worldwide will have heart failure in 2030 [4]. Most estimates suggest the prevalence in the United States is 2–3 % of the general adult population [10, 16]. However, there are widely varying estimates in different reports. These differences are a function of the age sampled, the case definition, and the site (in- or outpatient) of case finding.

According to NHANES in 2009–2012, heart failure is a disease associated with aging. In the youngest adult age group (20–39 years), under 1 % are afflicted, while for those 80 years and above, over 10 % report the condition (Fig. 6.4). Heart failure prevalence also affects men differently than women (Fig. 6.5). As shown in Fig. 6.5, Blacks have significantly higher rates than Whites and men higher rates than women.

It is also clear that prevalence rose during the past decades. Curtis et al. using Medicare data (65 years and above) found prevalence of 90 per thousand person years in 1994 which rose to 121 per thousand person years in 2003 [15]. Data from the Kaiser Health Plan found the prevalence rising in their population for both men and women with men having a higher rate than women. Their rates range from 1.01 to 2.12 % of their patient population [14].

The study of a French population found a prevalence of 0.9 % for those aged 55–64 rising to 17.4 % prevalence in those 85 years and above [16]. A more recent study of Medicare on the prevalence of 13 % as shown in Table 6.1, in a 5 % sample of Medicare records, prevalence is steadily rising [15].

There are a number of factors thought to be acting in increasing prevalence in the setting of flat or declining incidence. Better recovery from acute myocardial infarction is cited as one [3], but there is also improved survival from sudden death episodes, better methods of treatment, and a better recognition of the disease [3]. All of these factors improve survival; however, part of the increased prevalence may be a function of a so-called "lead time bias" where more sensitive diagnostic measures lead to a discovery of earlier cases which have a longer life post diagnoses.

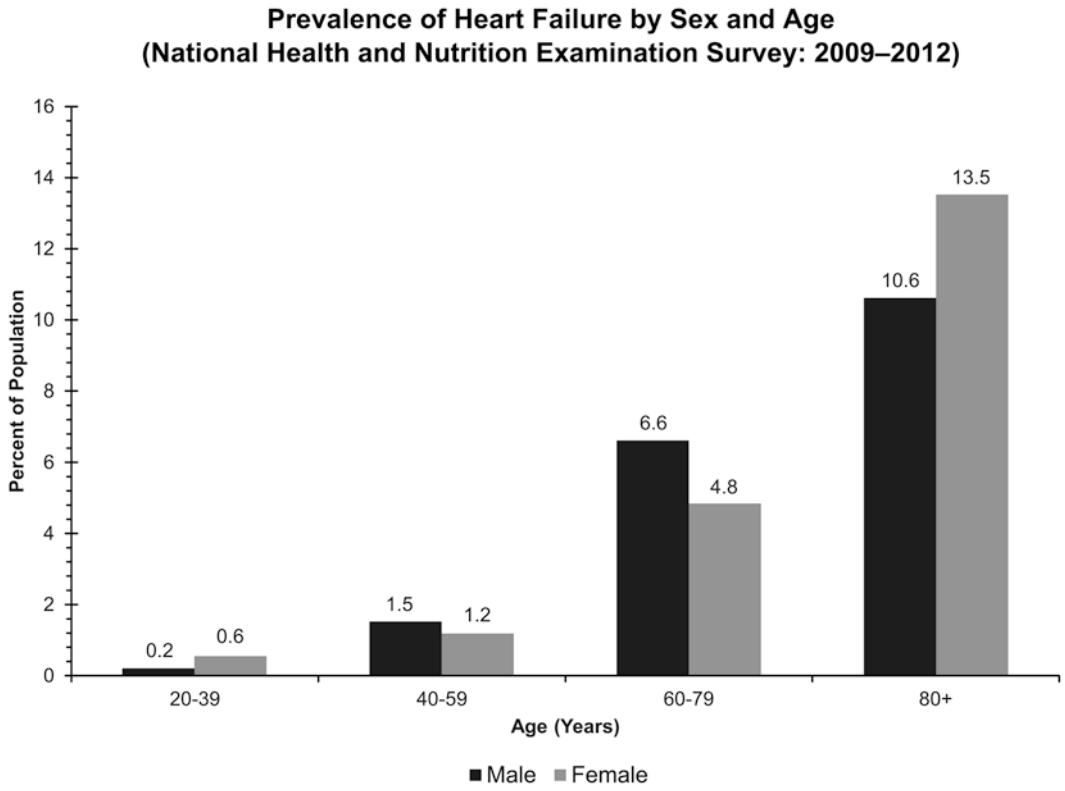
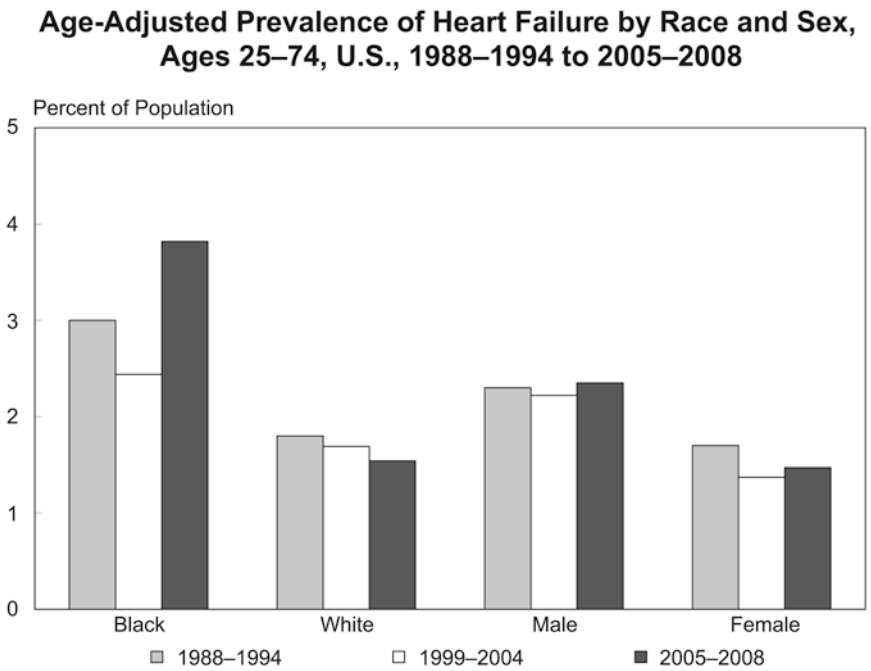



**Fig. 6.4** Prevalence of heart failure by sex and age between 2009 and 2012. National Health and Nutrition Examination Survey: 2009–2012. *Source*: National Center for Health Statistics and National Heart, Lung and Blood Institute [3]

**Fig. 6.5** From 1988–1994 to 2005–2008, the prevalence of HF increased in Blacks (except the decrease in 1999–2004) and decreased slightly in Whites; it remained stable in males but decreased slightly in females [18]




## Mortality

Heart failure is a deadly disease. Death is frequently associated with other illnesses, but in many cases heart failure is the underlying cause. The analysis of data from Scotland finds that heart failure has a higher mortality rate than the four leading causes of cancer combined [17]. The 2008 death certificate data found 88/100,000 population mentions of heart failure with 17/100,000 population as the underlying cause of death [18]. Data from Olmsted County found 60 % 5-year

**Table 6.1** Prevalence of heart failure in the Medicare 5 % sample by sex and year[a]

| Year | Female | Male | Total |
|---|---|---|---|
| 1994 | 86,450 (86.3) | 53,390 (95.4) | 139,840 (89.9) |
| 1995 | 94,726 (94.0) | 58,456 (103.7) | 153,182 (97.9) |
| 1996 | 101,024 (100.4) | 62,520 (110.4) | 163,544 (104.4) |
| 1997 | 105,932 (105.6) | 66,309 (117.1) | 172,241 (110.3) |
| 1998 | 109,381 (109.7) | 68,942 (122.6) | 178,323 (114.9) |
| 1999 | 111,230 (112.4) | 70,465 (125.6) | 181,695 (117.8) |
| 2000 | 113,068 (114.4) | 72,133 (127.9) | 185,201 (119.9) |
| 2001 | 114,593 (114.4) | 74,177 (128.3) | 188,770 (120.1) |
| 2002 | 116,732 (114.6) | 76,376 (128.2) | 193,108 (120.2) |
| 2003 | 118,485 (115.1) | 78,709 (129.2) | 197,194 (121.0) |

[a]Data are given as number (rate). Rates shown are per 1000 eligible Medicare beneficiaries
$P < 0.01$ for females, males, and the overall group for all years [15]



mortality after diagnosis [19]. Similar data are observed in other industrialized countries including the Netherlands, Australia, Scotland, and Canada [19–22]. Heart failure is frequently associated with sudden death and increases with increasing NYHA severity classification [23].

Heart failure rates as underlying cause of death by race are shown in Fig. 6.6. Blacks have the highest rate followed by Whites, American Indians, Hispanics, and Asians. Men have higher rates of heart failure as the underlying cause than women. Heart failure death is strongly associated with age as shown in Fig. 6.7. Heart failure diagnosed in an inpatient admission has a significantly worse prognosis than heart failure diagnosed as an outpatient [24]. However, the prognosis in both is poor at 5 years. There is 90 % mortality at 10 years [5].

The trends for heart failure mortality have improved. This begins within hospital mortality where a 10.9 % rate in 1980–1984 fell to 6.5 % in 2000–2004 [25]. However, 30-day mortality improvement after hospitalization was less dramatic with 12.8 % mortality in 1993 and a 10.7 % mortality in 2006. Clearly, more patients were dying at home [26]. Overall, Medicare data in all adults 65 and older hospitalized found an 8.5 % mortality in 1993 and 4.3 % in 2006 [26]. Similar trends were observed elsewhere including Australia where 1-year mortality fell from 22 % in 1990–1993 to 17 % in 2002–2005 [20]. Similar declines were noted in Sweden and Scotland [22, 27].

Heart failure is a deadly disease with few living beyond 10 years after diagnosis. Improved acute care has reduced in-hospital mortality. Prolonged care has also reduced mortality. The combination has resulted in increased prevalence in heart failure under the care of health systems.

## Heart Failure: Preserved and Reduced Ejection Fraction

With the widespread availability of imaging to measure ejection fraction, it became apparent that many patients with signs and symptoms of heart failure did not have reduced ejection fraction associated with pump failure. This was initially termed diastolic heart failure in the clinical presentation and was associated with an ejection fraction above 45 % [19]. The pathologic findings associated with preserved ejection fraction are concentric remodeling of the left ventricle and left ventricular hypertrophy [28]. In recent years, considerable work has occurred to better define heart failure with preserved ejection fraction (HFpEF) in comparison to those patients with reduced ejection fraction (HFrEF). Depending on the inclusion criteria, it is estimated that 13–74 % of all heart failure is HFpEF [10, 29]. When ascertaining prevalence, definitions become an important issue. Various authoritative sources have suggested anywhere from an ejection fraction of less than 35 % to less than 45 % defines HFrEF [7].

There has been considerable increase in our understanding of HFpEF. Those with this condition are more likely to be older women. They have a history of hypertension, diabetes, atrial fibrillation, sleep apnea, renal disease, and pulmonary disease [30]. They are less likely to have a history of coronary heart disease [31].

While outcomes for HFpEF are somewhat better than HFrEF, they both carry substantial morbidity and mortality. Individuals with HFpEF are more likely to die of noncardiovascular disease than those with reduced ejection fraction [31].

The improvement in outcomes observed in heart failure is attributable mainly to reduction in death rate from HFrEF. HFpEF continues to have a poor outcome, and efforts to improve survival and treatment have lagged [10].

## Heart Failure Hospitalizations

Most epidemiologic data comes from hospitalized patients. Despite the increasing awareness of outpatient diagnoses forming at least half of heart failure incidence, the availability of hospital and insurance records and discharge codes makes this a commonly used resource. As shown in Fig. 6.8, hospitalizations for heart failure rose steadily from 1980 among those age 45–64 and 65 and older. In the older group, heart failure peaked in 1998 and then fluctuated through 2009. The absolute number of discharges for heart failure was similar in 2010 (1,023,800) compared to 2000 (1,008,000) despite the fact that the population aged significantly during that time [3]. Some argue that the "epidemic" seen in the earlier years is a function of increasing hospitalization and survival not increased incidence [32]. Noteworthy is that in-hospital case-fatality rates for heart failure have been steadily falling [25]. As shown in Fig. 6.9, this trend is consistent for both younger (45–64 years) and older (≥65 years) patients [3]. While inpa-

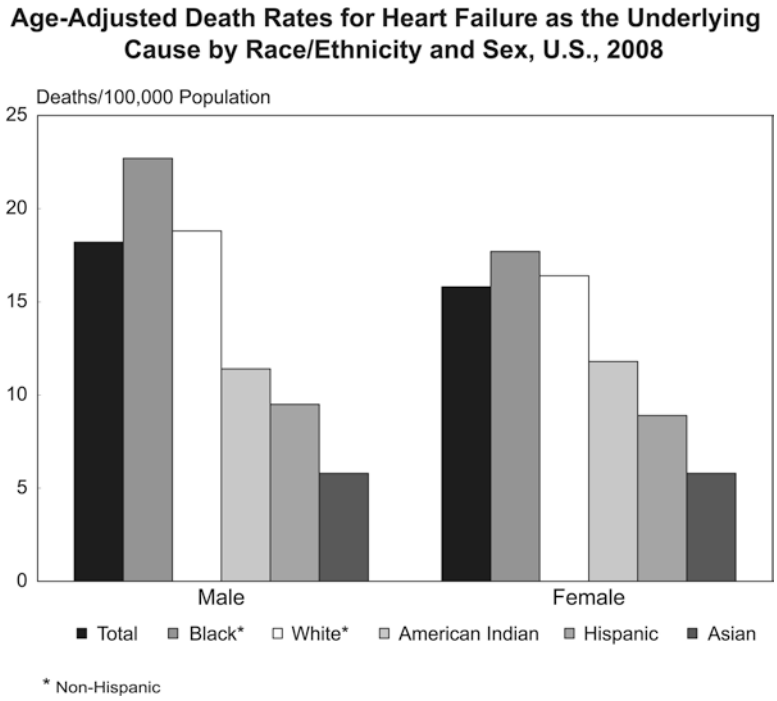



**Fig. 6.6** In 2008, death rates for HF as the underlying cause were slightly higher in males than in females. Within sex groups, death rates were highest in non-Hispanic Blacks and non-Hispanic Whites and lowest in Asians [18]

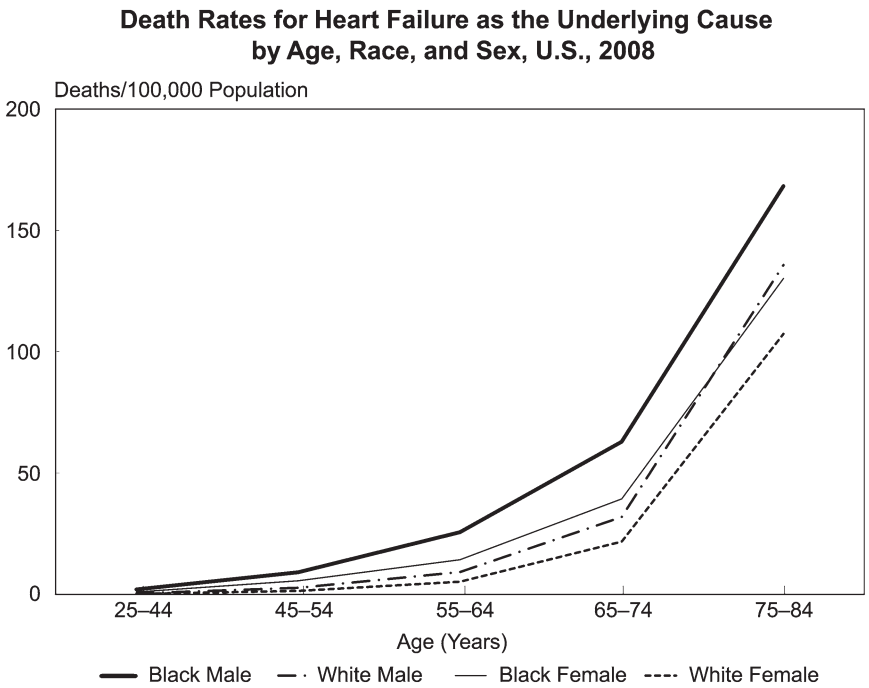



**Fig. 6.7** In 2008, HF mortality as the underlying cause increased with age. Within sex groups, rates were higher in Blacks than in Whites; and within racial groups, rates were higher in males than in females [18]

tient mortality is improving, one result is increased readmissions. A study in Toronto, Canada, found that annual readmission for cardiovascular disease was 967 per thousand person years among those with ischemic heart failure [33]. For those with nonischemic heart failure, the rate was 621 per thousand person years. So while most hospitalized patients survive the episode, they are highly likely to be rehospitalized with 25 % returning to the hospital in 30 days [7].

In the United States, the advent of diagnostic related groups (DRG) or payments for diagnoses has led to increasing use of classifications for illnesses resulting in higher insurance payments [15]. HF is among the higher reimbursement DRGs. This has led to financial penalties for hospitals where patients return for hospitalization within a 1-month time. This financial disincentive may result in a decline in heart failure admissions.

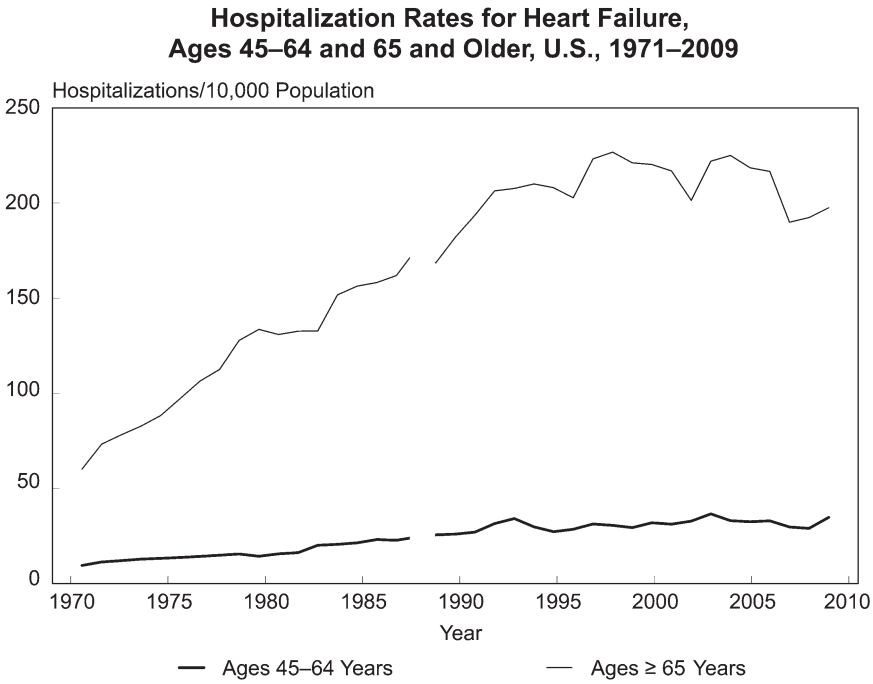



**Fig. 6.8** From 1971 to 1993, hospitalization rates for HF increased in those aged 45–64 years and then remained stable through 2009. For those aged 65 years and older, rates peaked in 1998 and then fluctuated through 2009 [18]

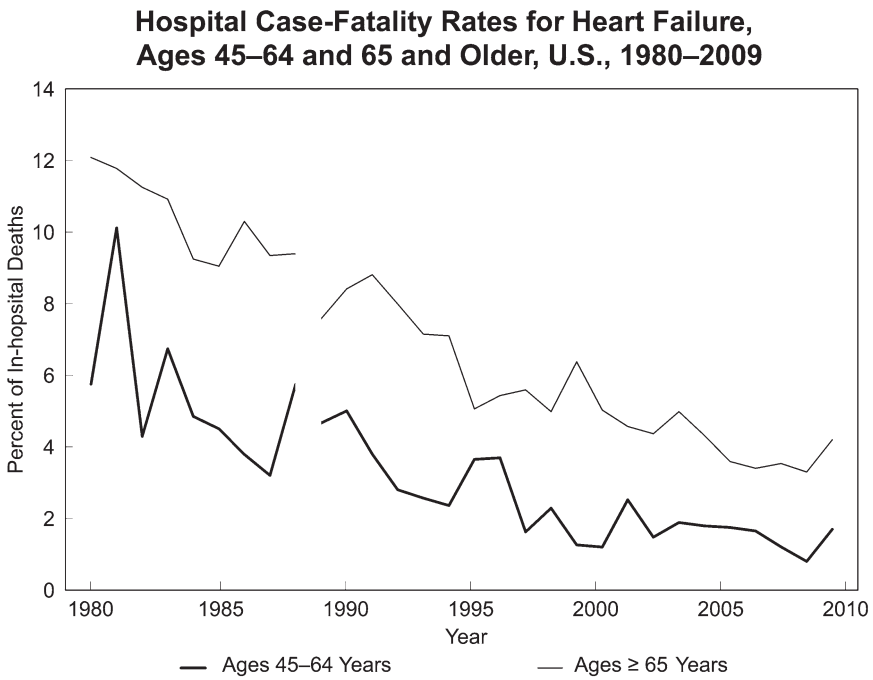



**Fig. 6.9** From 1980 to 2009, hospital case-fatality rates for HF were rather erratic for those aged 45–64 years and those aged 65 years and older; overall however, the rates declined appreciably for both groups during the period [18]

## International Trends

Heart failure is a worldwide problem. It is estimated that 23 million people were affected in 2011 [10], but HF is projected to increase as lifespan is extended and coronary heart disease becomes more common in many countries [15]. It is estimated that in 2030, there will be 78 million cases worldwide [4].

The etiologies of heart failure vary by region of the world. While ischemic heart disease is responsible for the majority of heart failure in Europe and North America, it constitutes a smaller portion in East Asia and Latin America [34]. In sub-Saharan Africa, ischemic heart disease is estimated to underlie only 10 % of heart failure [34]. However, cardiomyopathies, rheumatic heart disease, congenital heart disease, hypertension, and endomyocardial fibrosis account for a significant proportion of the clinical disease [3]. Rheumatic heart disease is still an important issue in Southeast Asia, and Chagas disease is an important factor in heart disease in South America [6].

**Table 6.2** Underlying conditions associated with heart failure

| |
|---|
| • Arrhythmias |
| • Congenital heart disease |
| • Coronary heart disease |
| • Diabetes |
| • Genetic disorders |
| • Heart valve diseases |
| • Hypertension |
| • Infections (bacterial, viral, parasitic) |
| • Radiation therapy |
| • Toxic (chemotherapy) |
| • Unknown |

## Disease Associations

The syndrome of heart failure is associated with many diseases. Table 6.2 lists some of these conditions. Among the most common is coronary heart disease with its resulting damage to the myocardium [9]. Hypertension is also strongly related to heart failure and is more commonly found in HFpEF. Other causes include heart valve diseases, such as rheumatic disease, which, while less common in industrialized countries, is widely observed in much of the rest of the world. Recent growth areas in heart failure are conditions associated with the treatment of cancer. The effective treatment of many juvenile cancers with chemotherapy and radiation results in heart disease among middle-age survivors [35]. This is most probably due to cardiotoxic chemotherapies such as anthracyclines or chest radiation. Diabetes is also increasing. The Framingham Heart Study found that diabetes increased the likelihood of heart failure by two times in men and five times in women [36].

## Risk Factors

There are a number of risk factors associated with the occurrence of heart failure. Some may be in the causal chain, others merely associated. Lifestyle factors such as weight, smoking, sedentary lifestyle, alcohol abstinence, reduced breakfast cereal consumption, and reduced fruits and vegetable consumption are all associated with an increased likelihood of heart failure [3]. These may be associated with low socioeconomic status, also predictive of heart failure [9]. Unmodifiable risk factors such as age, sex, and ethnicity are all predictive.

Disease states known to be associated with heart failure include heart valve disorders, sleep apnea, diabetes, hypertension, and renal and pulmonary diseases [8, 14]. It is of interest that statistical adjustment for blood pressure and diabetes eliminated Black/White ratio differences in one study suggesting that the racial differences are secondary to these factors [13].

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