HHS Public Access

Author manuscript

Circ Heart Fail. Author manuscript; available in PMC 2017 May 01.

Published in final edited form as:

Circ Heart Fail. 2016 May ; 9(5): e003023. doi:10.1161/CIRCHEARTFAILURE.115.003023.

Mortality Among Patients Hospitalized with Heart Failure and Diabetes Mellitus: Results from the National Inpatient Sample 2000 – 2010

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Abstract

Background—Case-fatality and hospitalization rates for U.S. heart failure (HF) patients have steadily decreased over the past several decades. Diabetes mellitus (DM), a risk factor for, and frequent co-existing condition with, HF continues to increase in the general population.

Methods and Results—We used the National Inpatient Sample to estimate overall as well as age-, sex-, and race/ethnicity-specific trends in HF hospitalizations, DM prevalence and in-hospital mortality among 2.5 million discharge records from 2000–2010 with HF as primary discharge diagnosis. Multivariable logistic and Poisson regression were used to assess the impact of the above demographic characteristics on in-hospital mortality. Age-standardized hospitalizations decreased significantly in HF overall and in HF with DM . Age-standardized in-hospital mortality with HF declined from 2000 to 2010 (4.57% to 3.09%, p_{trend} <0.0001), while DM prevalence in HF increased (38.9% to 41.9%, p_{trend} < 0.0001) as did comorbidity burden. Age-standardized in-hospital mortality in HF with DM also decreased significantly (3.53% to 2.27%, p_{trend} <0.0001). After adjusting for year, age and comorbid burden, males remained at 17% increased risk versus females, non-Hispanics remained at 12% increased risk versus Hispanics and whites had a 30% higher mortality versus non-white minorities. Absolute mortality rates were lower in younger versus older patients although the rate of decline was attenuated in younger patients.

Conclusions—In-hospital mortality in HF patients with DM significantly decreased over the past decade despite increases in DM prevalence and co-morbid conditions. Mortality rate decreases among younger patients were significantly attenuated and mortality disparities remain among important demographic sub-groups.

Keywords

heart failure; diabetes mellitus; mortality; hospitalization

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Disclosures

None.

There are nearly 5 million individuals in the United States (U.S.) with a diagnosis of heart failure (HF)[1] and HF is the principal diagnosis in >1 million hospitalizations annually[2]. Over the past decade, overall HF hospitalization and in-hospital mortality rates have declined[3–6]. Diabetes mellitus (DM), a disease that is increasing in prevalence[7–9], is a significant risk factor for the development of cardiovascular disease and amplifies the risk for the development of HF[10–12]. In addition, HF itself is considered an insulin-resistant state and is associated with significant risk for the future development of DM[13,14]. Given these relationships, it is not surprising that DM and HF may commonly coexist.

While the "true" population-based prevalence of DM in patients with HF (ambulatory or hospitalized) is unknown, prevalences range from 20–30% in clinical trial populations[15,16] to > 40% in recent registries of hospitalized patients[17–19]. What is clear is that the absolute number of individuals with HF will continue to increase world-wide[20] as well as in the U.S.[21] over the next decade while the number of individuals with DM will also continue to increase world-wide[22] and in the U.S.[23]. Given the increasing prevalence of DM and HF and comparatively worse clinical outcomes of concomitant HF and DM in the general population[18,24,25], we examined trends in hospitalizations and in-hospital mortality in patients with HF and DM from 2000–2010. We also describe the factors associated with in-hospital mortality with a focus on the impact of time, age, sex, race and ethnicity over this interval.

Methods

Data Source

The National Inpatient Sample (NIS), sponsored by the Agency for Healthcare Research and Quality (AHRQ) Healthcare Cost and Utilization Project (HCUP), is the largest all-payer inpatient database publicly available in the U.S. consisting of discharge data from over 1,000 hospitals across a majority of states and is designed to approximate a 20% stratified sample of US community hospitals[26].

The NIS provides discharge-level demographic and clinical characteristics that are searchable using International Classification of Diseases, ninth revision, clinical modification (ICD-9-CM) codes. Each annual release of the NIS includes patient-level hospital discharge abstracted data for 100% of discharges from the sample of hospitals in participating states. We used NIS security files to extract administratively coded comorbid conditions of patients as established by AHRQ. The study was considered exempt from formal review by the University of New Mexico institutional review board because the NIS is a public database without personal identifiers.

Data Quality

A summary data quality report is available for review for each year of the NIS[27]. Individual reports for the years 2000–2010 were reviewed by one of the authors (WKL). With the exception of data for race and ethnicity (see below) edit check failure rates were consistently < 0.5% for other key data elements.

Study population

A total of 71 million hospital discharges were reported to the NIS from 2000 to 2010. We analyzed data for patients ≥ 18 years of age. HF hospital stays were defined as those with a primary discharge diagnosis of HF on the basis of the following ICD-9-CM codes: 402.01; 402.11; 402.91; 404.01; 404.03; 404.11; 404.13; 404.91; 404.93; and 428. We excluded any record containing an ICD-9-CM code for acute coronary syndrome or acute myocardial infarction in order to obviate the confounding issue of acute ischemia on in-hospital outcome. The total number of HF hospitalizations was calculated as the sum over all HF ICD-9-CM codes. We then obtained the proportion of HF discharges that occurred over the same time interval with a diagnosis of type 2 DM , identified by ICD-9-CM code 250.0 to 250.9 with a fifth digit of 0 or 2 since the majority of diagnosed cases of DM in adults are of type 2

Data Analysis

Figure 1 shows the sequence of data analysis. We recorded the number of records for each year and stratified these records by age group (< 60, 60–69, 70–79, and ≥ 80 years) sex, race and ethnicity. We also computed a measure of medical co-morbidities employed by HCUP in NIS datasets-the Elixhauser co-morbidity index[28,29].

Statistical sampling weights provided by the NIS allow extrapolation to estimate hospital discharge rates for the nation After weighting, this reflects approximately 95% of hospital discharges within the U.S. [30]

Statistical Analysis

Hospitalizations are summarized as raw counts as well as counts per 100,000 adults (> 18 years of age) for that year obtained using the U.S. Census Bureau intercensal estimates for 2000–2010[31]. Categorical data are summarized as percents. The outcome of interest in our analysis was in-hospital mortality. In keeping with our stated objectives, exposure variables were year, age on admission, sex, the discharge-record specified race and ethnicity and the Elixhauser co-morbidity index. Survey analysis methods were employed that used hospital-level discharge weights provided by the NIS to estimate the number of HF hospitalizations and in-hospital mortality on a national level[32] Direct standardization of age was performed using the average of the 2000 and 2010 NIS data sets as the standard population. Age-standardized in-hospital mortality rates for HF with DM were calculated and reported (in percent) for the overall sample and stratified by sex. All other sub-group specific mortality rates are reported as crude mortality rates (CMR). Rates were plotted and smoothed for display using a Hamming window filter.

In order to distinguish changes in population age and/or sex composition versus age/sex-independent factors driving the observed decrease in CMR over time, the method of rate decomposition was used[33]. Briefly, the difference in CMR from 2000 to 2010 can be viewed as the sum of a “composition effect” (reflecting the difference in the age and/or sex composition of the sample from 2000 to 2010) and a “rate effect” (reflecting differences in the distribution of stratum-specific mortality rates from 2000 to 2010) (Δ

$CMR_{2000–2010}$=composition effect+rate effect). Calculations were performed for age and sex, separately and combined.

P values are based on chi-square tests for all categorical row variables or chi-square rank based group means score statistics for continuous/ordinal row variables (equivalent to Wilcoxon tests). All such tests treat the column variable as nominal. Trends in categorical variables were tested using chi-square statistics. Multivariable logistic regression that accounted for survey methodology and hospital clustering was used to estimate the magnitude of association between clinical, temporal, and demographic covariates and in-hospital mortality. Year was modeled as a continuous linear variable. An interaction term, age (group) x sex, was added to the model to test for the influence of sex on the association between age and mortality. Estimated measures of association are expressed as odds ratios (ORs) and 95% CIs. Adjusted annual rates of change in mortality were estimated from a Poisson regression model which estimated linear time trends in in-hospital mortality and included all variables used in the logistic regression model. Hospital length of stay (days) was used as the offset (“exposure”) variable in the Poisson model.

A sensitivity analysis was performed in the subgroup of hospitals with >90% completion of race/ethnicity data since missing rates of the latter frequently exceeded 10% in the overall sample. Additional sensitivity analyses examining the impact of the inclusion of ICD-9-CM codes for non-acute ischemic heart disease (ICD-9-CM 412.X, 413.X, 414.X) on the associations between age, sex, race/ethnicity, time and comorbid burden and in-hospital mortality was performed. We assessed the frequency of any acute manifestation of ischemic heart disease (ICD-9-CM codes 410.0 to 410.8) using the clinical classifications software (CCS) provided by HCUP.

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A p value < 0.05 was considered statistically significant. All analyses were performed using SAS (version 9.1 or higher) or STATA (version 14)..

Results

Characteristics of HF hospitalizations from 2000 to 2010

Hospitalization with a primary diagnosis of HF steadily decreased from 227,595 in 2000 to 207, 593 in 2010 and translates to a decrease from 555/100,000 U.S. adults to 460/100,000 U.S. adults (p_{trend} <0.0001). (Supplemental Table 1). The overall prevalence of women was 52.5% and decreased from 55.4% in 2000 to 49.9% in 2010 (p_{trend} <0.0001). The mean (± SD) age of the sample was 72.6 ± 14.4 years and approximately two-thirds (65.4% in 2000 and 62.4% in 2010) were > 70 years of age. The majority were of white race (representing about 73 % in 2000 and 66 % in 2010) although non-white minority prevalence increased significantly from 27% to 34%. The prevalence of Hispanic ethnicity increased significantly from 5.3% in 2000 to 6.9% in 2010 (p_{trend} <0.0001). The mean (± SE) Elixhauser comorbidity index increased from 3.32±0.04 in 2000 to 5.67±0.07 in 2010 (p_{trend} <0.0001).

The prevalence of DM increased from 38.9% to 41.9% (p_{trend} <0.0001) from 2000 to 2010 (Supplemental Table 1)..

Characteristics of HF with DM hospitalizations from 2000 to 2010

The study sample consisted of 1,014,879 hospitalizations with HF and co-existing DM which translates to an estimated weighted 5 million hospitalizations. As seen in Table 1, there was a statistically significant decrease in the prevalence of HF with co-existing DM hospitalizations from 217/100,000 U.S. adults in 2000 to 193/100,000 U.S. adults in 2010 (p_{trend} <0.0001). The prevalence of females decreased from 57% in 2000 to 50% in 2010. Although the majority of the sample was > 70 years of age a significant minority was < 60 years of age and their prevalence increased over time. The prevalence of white race decreased from 68% in 2000 to 61% in 2010 (p_{trend} <0.0001) whereas the cumulative prevalence of non-white minorities increased from 32% to 39% (p_{trend} <0.0001). The prevalence of Hispanic ethnicity increased from 7.0% in 2000 to 9.2% in 2010 (p_{trend} <0.0001). The annual mean Elixhauser comorbidity index significantly increased from 2.88±0.04 to 5.46±0.07 (p_{trend} <0.0001).

In-hospital Mortality in HF from 2000 to 2010

There was a statistically significant decline in age-standardized in-hospital mortality from 4.57% in 2000 to 3.09% in 2010 (p_{trend} <0.0001) among the 2.5 million patients in the unweighted HF sample. This trend was similar for both sexes (4.71% and 3.07% for males in 2000 and 2001, respectively; 4.48% and 3.09% for females in 2000 and 2001, respectively, p_{trend} <0.0001). (Supplemental Figure 1). In order to better understand the driver(s) for the decrease in mortality, the method of rate decomposition (see Methods) was employed. For the entire HF population the “rate effect” was 1.4719 and the “composition effect” was 0.0006. The total, 1.4726, equals the difference in CMR from 2000 to 2010 and suggests that a change in stratum-specific risk for mortality is the main driver of the decrease in mortality and not a difference in age structure of the populations. Similar results were obtained when the analysis was limited to changes in sex distribution alone and age and sex distributions together.

In-hospital Mortality in HF with co-existing DM from 2000 to 2010

Overall and sex-specific crude and age-standardized mortality rates for HF with DM significantly decreased over this interval (Table 1, Figure 2). Rate decomposition indicated that for HF and DM the “rate effect” was 1.3511 and the “composition effect” was −0.0916. The sum of these 2 components, 1.2596, equals the difference in CMR for HF with DM from 2000 to 2010 and suggests that, as with the overall HF population, the main driver for the decrease in mortality is a change in inherent risk structure of the populations rather than a change in age structure of the populations. Similar results were obtained when the analysis was limited to changes in sex distribution alone and age and sex distributions together.

The overall decrease in in-hospital mortality was not shared equally among the selected sub-groups. As seen in Figures 3 and 4, larger decreases in case fatality rates were noted in the oldest groups when compared to their younger counterparts. Women exhibited smaller decreases in mortality over time with the largest decreases noted in the oldest group. Poisson

regression analysis indicated a lower overall mortality rate and rate of decline in younger age groups (Table 2). As seen in Figure 5 and Figure 6, declines in case fatality rates in Hispanics and non-Hispanics and whites vs. non-white minorities were noted with, however, persistent absolute differences between whites and non-white minorities.

Demographic, temporal and clinical factors associated with in-hospital death were assessed using multivariable regression (Table 3) with the results supporting significant disparities within and among our selected sub-groups. Males remained at 17% increased risk compared to females (OR, 1.17; 95% CI, 1.14 to 1.20); white populations remained at 30% higher risk compared to non-white minorities (OR, 1.30; 95% CI, 1.26 to 1.34); non-Hispanics remained at 12% increased risk compared to Hispanics (OR, 1.12; 95% CI, 1.06 to 1.19) and older patients (≥80 years) remained at 4 times higher risk compared to their younger counterparts <60 years (OR, 4.08; 95% CI, 3.87 to 4.29). There was no significant interaction between age and sex on the association of either with in-hospital mortality ($p_{interaction}$=0.19).

Analysis of the above associations for only those records containing ICD-9-CM codes specific to ischemic heart disease yielded no meaningful differences in effect size (difference in magnitude of beta coefficients < 2 %) between models. Additionally, there was minimal variation in the frequency of acute coronary syndromes coded in a secondary position with an average rate for the interval of 3.1%.

Sensitivity analysis confined to those hospitals with >90% data completion for race/ethnicity confirmed the above-mentioned significant trends in prevalences over time. As well, Poisson regression utilizing data from hospitals with >90% complete records yielded similar results to those in Table 3.

Discussion

Using a nationally representative all-payer inpatient sample of U.S. hospital admissions from 2000–2010 our observations support the following conclusions. *First*, the total number of hospitalizations with a primary diagnosis of HF decreased over this interval. *Second*, the prevalence of DM as well as a measure of the burden of co-morbidities among hospitalized HF patients increased. *Third*, despite the increased prevalence of DM and co-morbid burden there was a 36% decrease in age-standardized in-hospital mortality among HF with DM. *Fourth*, in-hospital mortality rates varied by age, sex, race and ethnicity. *Fifth*, the decrease in in-hospital mortality rate is the result of a change in the stratum-specific risk (for mortality) rather than a change in age and/or sex structure of the 2000 and 2010 samples.

Reduction in in-hospital mortality in HF patients with co-existing DM

Several studies have now documented a decrease in hospitalization rates in the U.S for patients with HF over a time interval similar to the current study[3–6]. The inclusion of hospitalizations in all adults, i.e., greater than 18 years of age, distinguishes the current study from prior Medicare-derived data[3,6] and the focus on the DM sub-group distinguishes the current study from prior NIS studies[4,5]. The inclusion of patient hospitalizations with age <

65 years allows for analysis of an important group of relatively younger patients who comprised one-fifth of all HF hospitalizations in the NIS database. .

Our study was limited to hospitalized patients. Nevertheless, secular changes in the management and characteristics of HF patients from 2000–2010 are relevant to these data. A decrease in HF-related hospitalization rates and in-hospital mortality was first reported from the Medicare and Medicaid population beginning in 1998[3] but reflects changes beginning prior to that date. The period from 2000–2010 was a period of increasing attention to improved management strategies for all HF patients[34,35] which would likely impact hospitalization and in-hospitality mortality rates. The observed trend in the current study is consistent with the time frame for the "diffusion" of evidence-based and clinical trial data into mainstream practice[36], and reflects the many changes in the timing and extent of pharmacotherapy for HF. Improved adherence to contemporary guideline-based therapies for HF and DM in conformance with national guidelines[37]over this time interval may also have contributed to improved in-hospital outcomes in HF and DM patients. Changes in the underlying cardiovascular risk profile of patients presenting with HF and DM[7,38], whether a cohort effect or a true indicator of intensified risk factor recognition and treatment, is another possible explanation for the reduction in in-patient mortality- a finding supported by our rate decomposition analysis.

Similar[39]or lower[40] in-hospital crude mortality rates in patients with HF and DM compared to those with HF without DM have been previously observed. Of note is the similarity of our current observations in hospitalized patients to trends in the U.S. population from 2005–2011[38]In this latter study while hospitalizations and mortality rates declined in DM patients, including those with HF, decreases in event rates and mortality were lower or absent in those without DM. Thus, although hospitalized patients are a highly selected group from the general population, the above-noted secular trends may be powerful enough to beneficially impact this selected group of patients.

In-hospital mortality trends in HF with DM by age, sex, race and ethnicity

Our study also indicated that the reduction in in-hospitality mortality over time varied by age, sex, race and ethnicity. The current national focus on disparities in health care and health outcomes was the main driver for these additional analyses. Of particular concern is the lack of concordance in trends in-hospital mortality rates between younger and older age groups, notwithstanding higher event rates in the latter. Continuing increases in the incidence of obesity and DM, both contributors to the development of HF, in the young will likely further adversely impact these trajectories and could reverse much of the gain in survival noted to date. At the beginning of this study, females had higher rates of HF as well as HF with DM hospitalizations than males. However, the reverse trend was found by the end of the study period. These results are consistent with previous studies that suggested that the prevalence of HF in males is increasing in comparison to females[2]. Age standardized in-patient HF with DM mortality rates in both sexes decreased from 2000 to 2010. However the age standardized mortality in males remained higher than females throughout the study period until around 2006 and then became more comparable to females by the end of the study period.

Concordance in trends for in-hospital mortality between Hispanic and non-Hispanics was observed- findings similar to prior reports from a national HF registry[41]. In the adjusted logistic regression model Hispanics were at diminished risk for in-patient mortality compared to non-Hispanics. Racial differences in in-hospital mortality persist notwithstanding overall similar declines in both white and non-white groups. Lower mortality rates in the composite non-white minority group have been observed previously and remain unexplained[41] but may be of relevance as the relative proportions of whites and non-whites in the U.S. changes over the next several decades[42].

Limitations

The NIS remains the largest publicly available database with a statistically sound sampling design allowing for accurate identification of trends in specific diseases. However, analyses and conclusions from this large administrative database have a number of caveats. Observations reflect admissions and not unique patients. Thus, the current unit of analysis is the admission. Given the inability to account for multiple admissions for a given patient in the NIS, our observations and conclusions may be confounded by the non-trivial risk for repeat hospitalization. Thus, our reported rates may be viewed as over-estimates of a per patient admission rate. Mortality rates, however, are unlikely to be affected (a patient can only die once). Misclassification (under-or over-coding) cannot be completely ruled out without more extensive and rigorous data verification although the large number of patients in the database strongly mitigates against substantial misclassification bias[43]. Prior studies have shown excellent positive and negative predictive capability for ICD-9-CM codes for HF[44]. Our analysis could be biased by “upcoding” or “Diagnosis-related group (DRG) creep,” which may have resulted in over-reporting of comorbidities However, the impact of such would likely have been uniform across the groups, would be unlikely to bias CMRs, and would bias the results of comparisons toward the null if applied non-differentially It is even more unlikely that the highly statistically significant trend in hospitalizations and mortality from 2000–2010 is attributable to “downward” coding bias given the consistent trends across all sub-groups, the concordance with other published studies and the fact that there was no meaningful modification or revision of ICD-9-CM codes for HF or DM over the study interval. However, the possibility of bias against coding of comorbid or chronic conditions on discharge abstracts of patients who die is acknowledged[45]Given the statistically significant and uniform increases in the prevalence of DM and the Elixhauser index over time, the extent of systematic undercoding is admittedly unquantifiable but likely small.

Data quality assessment of the NIS is performed annually and ensures the internal validity of the data. Our data are also in agreement with a report from the National Hospital Discharge Survey, a separate and independent (from NIS) analysis of hospitalization for heart failure in the U.S. over the same time interval from the Centers for Disease Control and Prevention[46].

We were only able to assess in-hospital mortality and do not have data on longer-term outcomes that may be more relevant, particularly for younger patients. Observational studies may not be able to fully adjust for residual or unmeasured confounding that might affect our estimates for the reported associations between in-hospital mortality and included

covariates. Therefore, inferences based on these observational data can only be viewed as associational and hypothesis-generating and not causal in nature. Selection (survival) bias must be considered operational in all cross-sectional studies. In the absence of a prospective cohort design it is certain that hospitalized patients represent just the fraction of all HF patients, with and without DM, that survived to hospitalization. We indeed observed such a potential source of bias in our data noting that the risk ratio for mortality in HF with DM (data not shown) declined over the age spectrum (higher ratio in the younger age groups which decreases with age), consistent with a (non-testable) hypothesis in this dataset that it is the older subjects with HF and DM who survive to hospitalization[40]. The absence of specific data on pre- or in-hospital medical therapy for HF and DM in the NIS database precludes further analysis regarding the impact of prevalent treatment on outcomes. The absence of information on pre-hospitalization functional classification, e.g., NYHA Class and left ventricular function, precludes stratification on these important measures. However, modest differences in-hospital mortality between patients with preserved and depressed left ventricular function would not likely affect the observed trends or rates in the absence of large changes in the proportion of these entities over time[47].

Finally, these observations pertain to the HF population in the U.S. and may not be generalizable to other HF populations in other countries. In a recent overview of HF hospitalization on a global scale[48], it was pointed out that, at least within RCTs, there is much variability in HF hospitalization rates and that outside of the clinical trial universe, the lack of standardized, non-administrative HF-specific registries represent a major limitation to assessing and comparing HF hospitalization rates within and between countries. .Population-based and registry data from several European countries with integrated health information systems indicate a decrease in HF hospitalization rates[48] consistent with the data herein, but such trends have not been seen in other European countries.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Sources of Funding

WKL was supported, in part, by the Robert S. Flinn Foundation for Cardiovascular Research. HTD was supported, in part, by NIH Clinical Translational Science Award grant no. UL1TR001449 to the University of New Mexico.

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Clinical Perspective

Given the increasing incidence and prevalence of obesity and diabetes mellitus (DM)- both being risk factors for heart failure (HF)- the impact of DM on HF outcomes warrants close study. Using a nationally representative all-payer inpatient sample of U.S. hospital admissions from 2000–2010 our observations indicate that the total number of hospitalizations with a primary diagnosis of HF decreased while the prevalence of DM as well as a measure of comorbidity burden increased. Despite the increased prevalence of DM and co-morbid burden there was a 36% decrease in age-standardized in-hospital mortality among HF with DM. The decrease in in-hospital mortality was the result of a change in the stratum-specific risk for mortality rather than a change in age and/or sex structure of the 2000 and 2010 samples. However, in-hospital mortality rates varied by age, sex, race and ethnicity and emphasize the need to survey relevant strata within an overall population as well.

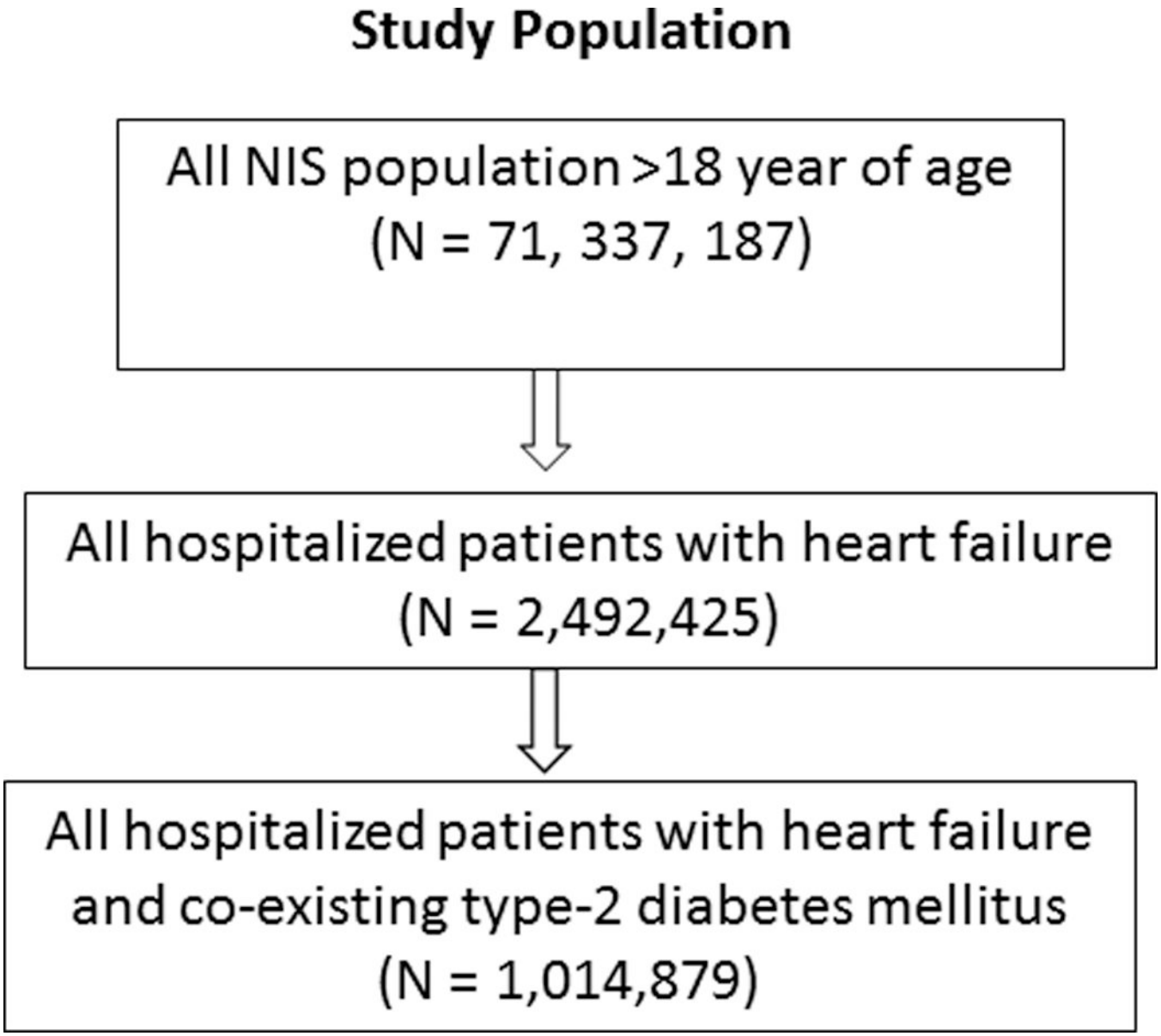

Figure 1.
Data Analysis Sequence

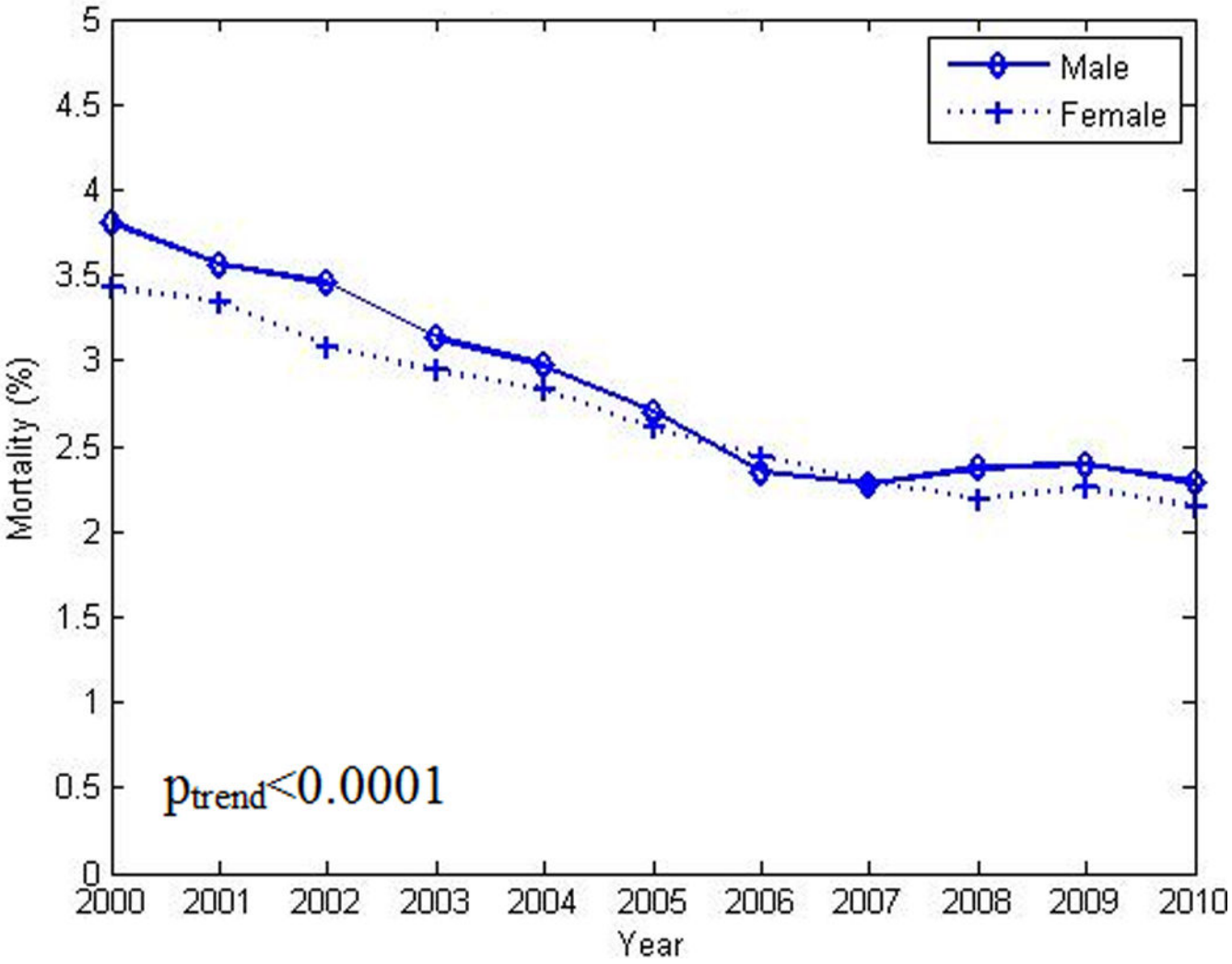

Figure 2.

Decrease in age-standardized in-hospital mortality rate among men and women with heart failure and co-existing diabetes from 2000 to 2010. $p_{overall}$ χ^2 <0.0001. $p_{linear\ trend}$ <0.0001

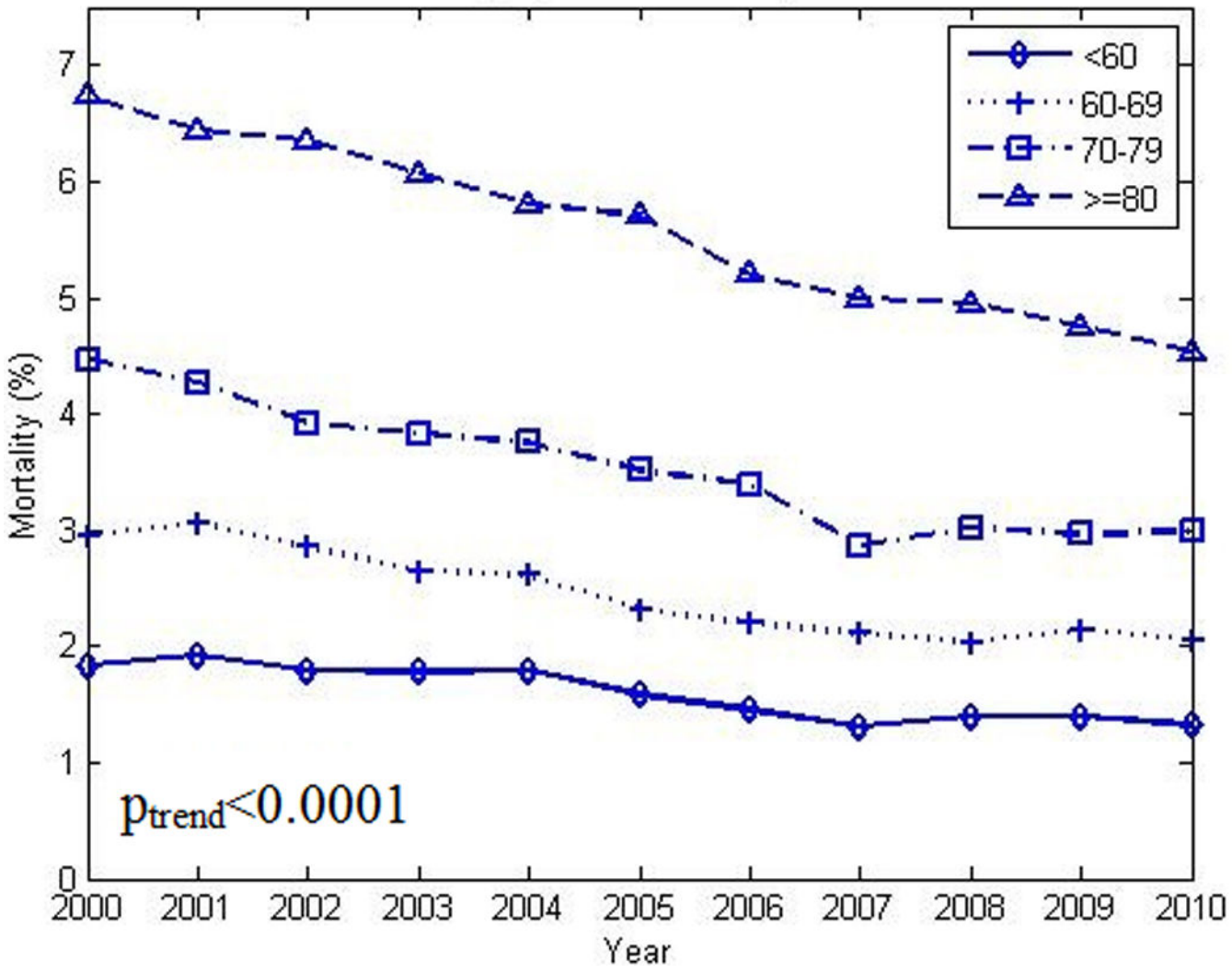

Figure 3.

Decrease in crude in-hospital mortality rate among patients with heart failure and co-existing diabetes in different age groups (see text) from 2000 to 2010. $p_{overall}$ χ^2 <0.0001. $p_{linear\ trend}$ <0.0001 (for each stratum)

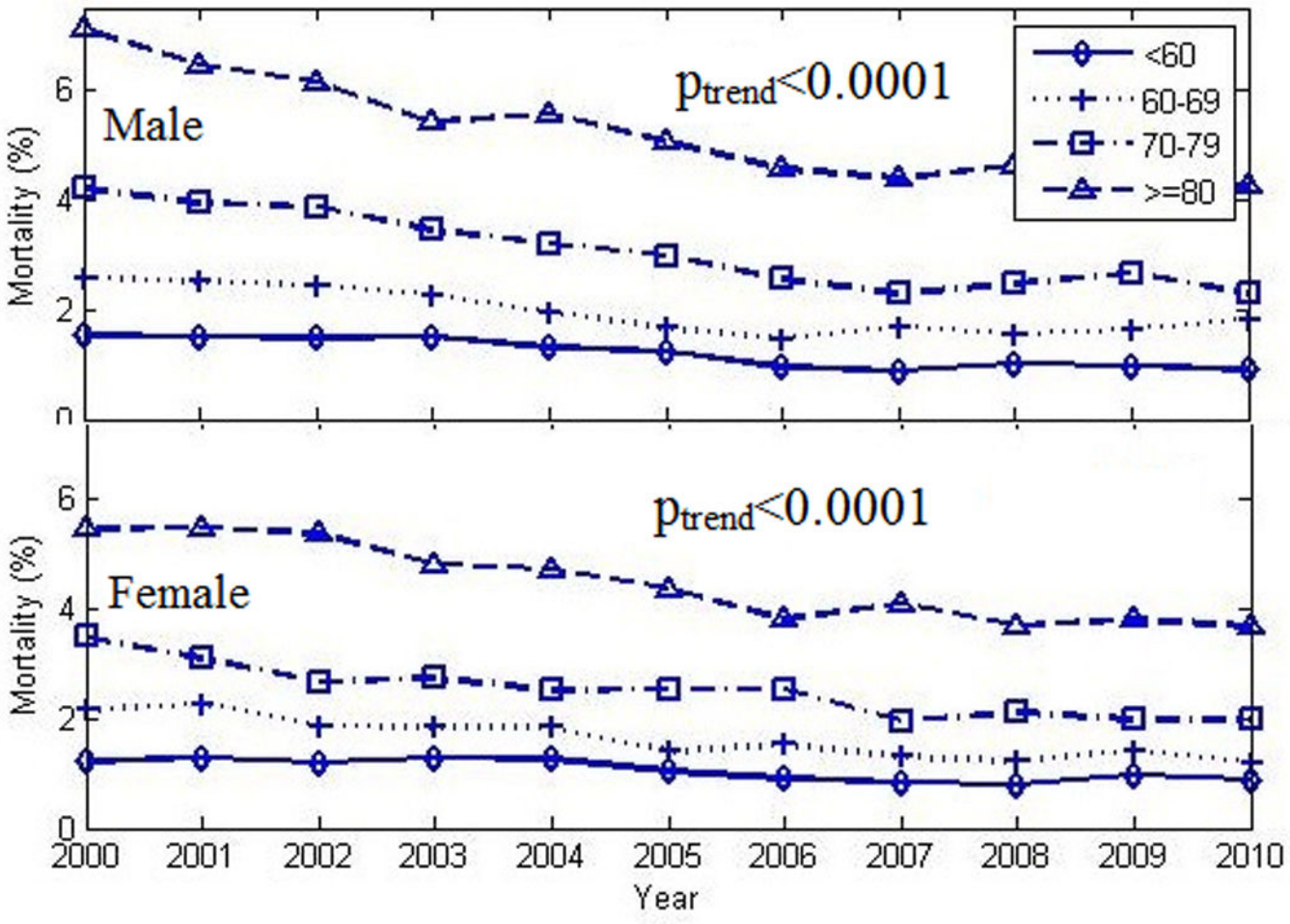

Figure 4.

Decrease in crude in-hospital mortality rate among patients with heart failure and co-existing diabetes in different age groups (see text) stratified by sex, from 2000 to 2010. $p_{overall}$ χ^2 <0.0001. $p_{linear\ trend}$ <0.0001 (for each stratum)

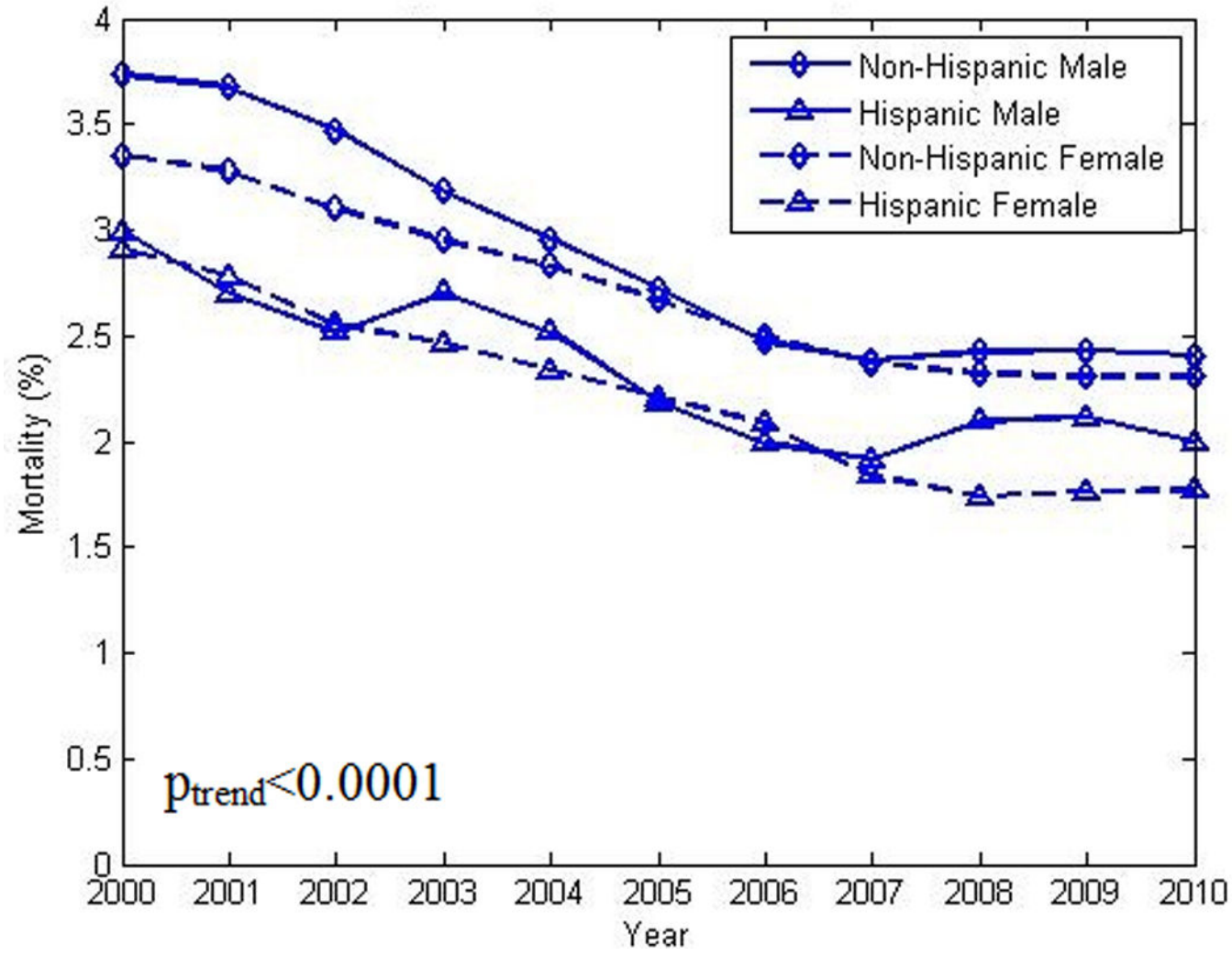

Figure 5.

Decrease in in-hospital crude mortality rate in patients with heart failure and co-existing diabetes, by sex and ethnicity (Hispanic vs non-Hispanic), from 2000 to 2010. $p_{overall}$ χ^2 <0.0001. $p_{linear\ trend}$ <0.0001 (for each stratum)

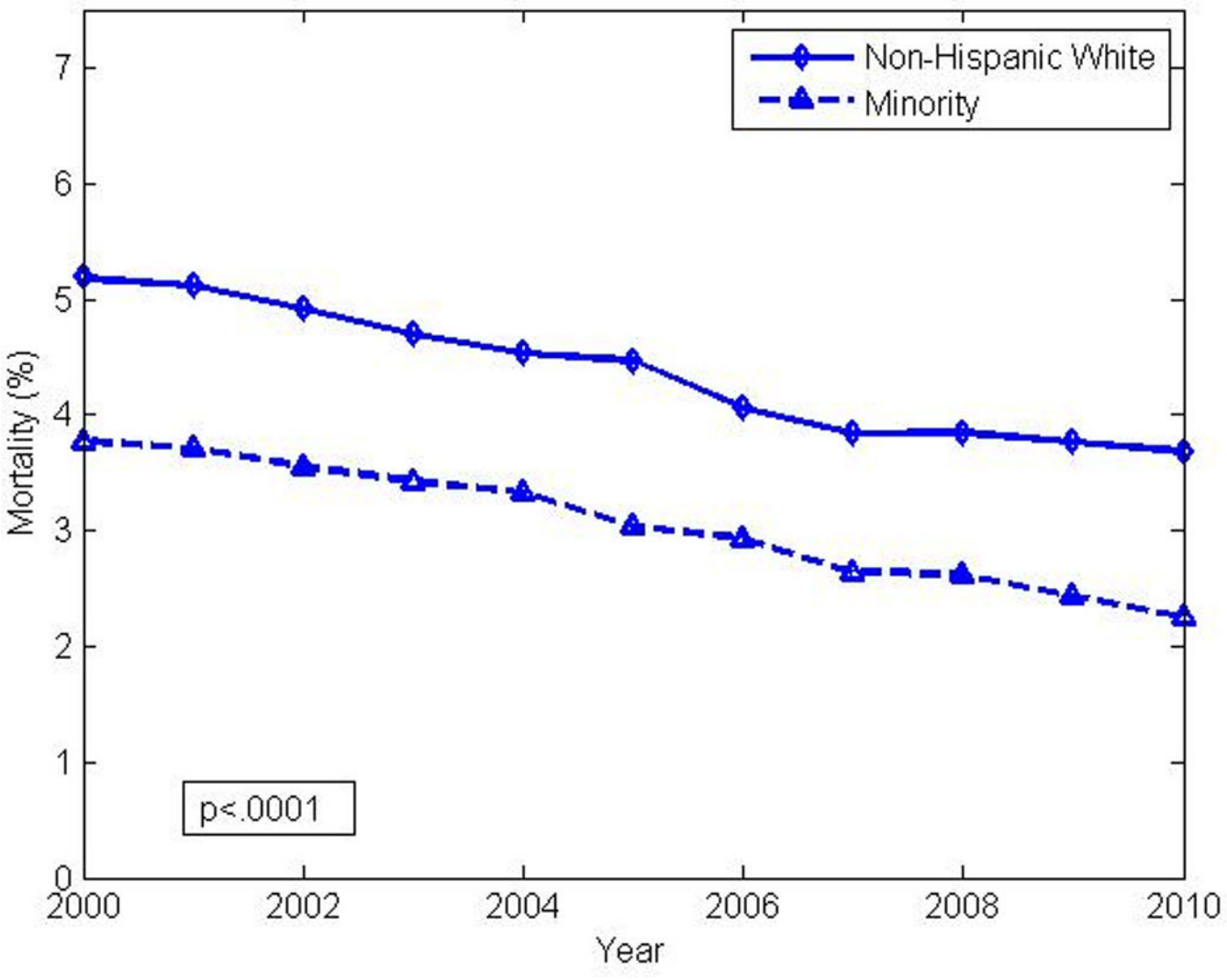

Figure 6.

Decrease in in-hospital crude mortality rate in patients with heart failure and co-existing diabetes, by race (non-Hispanic white vs. composite non-white minority) from 2000 to 2010. $p_{overall}$ χ^2 <0.0001. $p_{linear\ trend}$ <0.0001 (for each stratum)

Table 1

Characteristics among Patients with Heart Failure and Co-existing Diabetes Mellitus from 2000 to 2010

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	$P_{linear\ trend}$	$P_{overall}$ X^2
N (Sample)	88855	90786	95278	99786	97055	93189	93909	89727	89527	89685	87184		
N (Weighted)	435K	452K	460K	479K	469K	456K	459K	444K	438K	454K	436K		
HF/100,000	217	222	224	230	223	214	213	204	199	204	193	<0.0001	
Sex (%)													**<0.0001**
Male	43.1	43.6	44.1	44.9	46.0	47.5	47.9	48.4	49.3	49.9	50.4	<0.0001	
Female	56.9	56.4	55.9	55.1	54.0	52.5	52.0	51.6	50.7	50.1	49.6	<0.0001	
Age (%)													**<0.0001**
<60	18.4	18.2	19.1	19.4	19.6	19.6	20.5	20.3	19.6	20.1	20.3	<0.0001	
60–69	24.3	23.3	23.2	23.7	23.6	22.9	22.3	23.1	23.0	23.3	23.1	<0.0001	
70–79	33.7	33.5	32.8	31.5	31.2	30.3	29.6	28.9	28.5	28.2	27.2	<0.0001	
≥80	23.6	25.1	25.0	25.4	25.6	27.2	27.6	27.6	28.9	28.5	29.3	<0.0001	
Race (%)													**<0.0001**
White	68.3	67.7	64.9	62.6	63.4	67.3	61.9	61.7	63.9	63.2	60.8	<0.0001	
Black	18.7	18.5	20.7	20.5	21.6	17.4	21.2	22.2	20.6	20.6	23.6	<0.0001	
Hispanic	9.1	10.2	9.9	12.6	10.7	10.9	12.1	10.6	9.7	10.2	10.3	<0;0001	
Asian	1.6	1.6	1.9	2.0	1.9	1.7	1.9	2.1	2.1	2.1	2.2	<0.0001	
AI/NA	0.4	0.4	0.4	0.2	0.5	0.4	0.8	0.8	0.8	0.6	0.8	<0.0001	
Other	1.9	1.6	2.1	2.2	1.9	2.3	2.0	2.6	2.9	3.4	2.3	-	
Ethnicity (%)													**0.0021**
Non-Hispanic	92.9	92.4	92.8	90.7	92.1	92.0	90.9	92.0	92.1	91.1	90.8	<0.0001	
Hispanic	7.0	7.6	7.2	9.3	7.9	8.0	9.1	7.9	7.9	8.9	9.2	<0.0001	
Elixhauser comorbidity index													
Mean (SE)	2.88 (0.04)	3.03 (0.04)	3.30 (0.06)	4.44 (0.06)	4.99 (0.07)	5.53 (0.09)	6.46 (0.10)	0.50 (0.09)	4.89 (0.06)	5.25 (0.06)	5.46 (0.07)	<0.0001	

HF = Heart Failure, AI/NA = American Indian/Native Alaskan, SE = Standard error

Table 2

In-hospital mortality in patients with heart failure and co-existing diabetes mellitus. Results from Poisson regression model

Variable	IRR	SE	p-value	95% Confidence Interval
Age ≥ 80 yr	1.00	-	-	-
Age 70–79 yr	0.58	0.01	<0.0001	0.56–0.59
Age 60–69 yr	0.39	0.01	<0.0001	0.38–0.40
Age <60 yr	0.27	0.01	<0.0001	0.25–0.27
Female (vs. male)	0.81	0.01	<0.0001	0.79–0.83
Hispanic (vs. non-Hispanic)	0.86	0.02	<0.0001	0.82–0.89
Year (per year from 2000)	0.95	0.01	<0.0001	0.94–0.94
Elixhauser comorbidity index (per 1 unit increase)	1.03	0.01	<0.0001	1.03–1.04

Abbreviations: IRR, incidence rate ratio; SE, standard error

Table 3

Factors associated with in-hospital mortality in patients with heart failure and co-existing diabetes mellitus. Results from a logistic regression model.

Factor		
	Odds Ratio	**Confidence Interval (95%)**
Sex		
Male (vs. Female)	1.17	1.14–1.20
Age (yrs)		
< 60	1.00	N/A
60–69	1.51	1.43–1.59
70–79	2.29	2.18–2.42
≥ 80	4.08	3.87–4.29
Race		
White (vs Non-White Minority)	1.3	1.26–1.34
Ethnicity		
Non-Hispanic (vs Hispanic)	1.12	1.06–1.89
Year	0.92	0.92–0.93
Elixhauser comorbidity index	1.06	1.06–1.07