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Heterogeneous Trends in Burden of Heart Disease Mortality by Subtypes in the United States, 1999-2018: Observational Analysis of Vital Statistics

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Abstract (Word Count = 356; Limit = 400)

Objective: To describe trends in the burden of subtypes of heart disease mortality from 1999-2018, in order to inform targeted prevention strategies and reduce disparities.

Design: Serial cross-sectional analysis of cause-specific heart disease mortality rates using national death certificate data in the overall population as well as stratified by race-sex, age, and geography.

Setting: United States, 1999-2018

Participants: 12.9 million decedents from total heart disease (49% women, 12% black, and 19% <65 years old).

Main Outcome Measures: Age-adjusted mortality rates (AAMR) and years of potential life lost (YPLL) for each heart disease subtype, and the respective mean annual percentage change (APC).

Results: Total heart disease deaths fell from 752,192 to 596,577 from 1999-2011, then increased to 655,381 in 2018. From 1999 to 2018, the proportion of total heart disease deaths attributed to ischemic heart disease decreased from 73% to 56%, while the proportion attributed to heart failure (8% to 13%) and hypertensive heart disease (4% to 9%) increased. Among heart disease subtypes, AAMR was consistently highest from ischemic heart disease in all subgroups (race-sex, age, and region). After 2011, AAMR from heart failure and hypertensive heart disease increased at the fastest rate compared with other subtypes. The fastest increases in heart failure were in black men (mean APC +4.9% [95% confidence interval +4.0 to +5.8]), whereas fastest increases in hypertensive heart disease occurred in white men (mean APC +6.3% [+4.9 to +9.4]). The burden of YPLL was greatest from ischemic heart disease, but black-white disparities in YPLL were driven by heart failure and hypertensive heart disease. In 2018, heart disease deaths resulted in approximately 3.8 million potential years of life lost.

Conclusions: Since 2011, trends in AAMR and YPLL from ischemic heart disease decelerated. For almost all other subtypes of heart disease, AAMR and YPLL became stagnant or increased. Heart failure and hypertensive heart disease account for greatest increases in premature deaths and the largest black-white disparities, and have offset declines in ischemic heart disease. Early and targeted primary and

secondary prevention and control of heart disease risk factors with a focus toward high-risk groups is

needed to address these suboptimal trends beginning earlier in life.

Print Abstract (Word Count = 257; Limit = 300)

Study question: What are the trends in the burden of total heart disease and heart disease subtype deaths in the United States (U.S.) from 1999-2018?

Methods: Serial cross-sectional analysis of total and cause-specific heart disease deaths using age-adjusted mortality rates (AAMR) and years of potential life lost (YPLL) from national death certificate data in the overall population (12.9 million decedents) as well as stratified by race-sex, age, and geography in the U.S., 1999-2018.

Study answer and limitations: Among heart disease subtypes, AAMR was consistently highest from ischemic heart disease in all subgroups (age, race-sex, and region). After 2011, AAMR from heart failure and hypertensive heart disease increased at the fastest rate compared with other subtypes. The fastest increases in heart failure were in black men (mean APC +4.9% [95% confidence interval +4.0 to +5.8]), whereas fastest increases in hypertensive heart disease occurred in white men (mean APC +6.3% [+4.9 to +9.4]). The burden of YPLL was greatest from ischemic heart disease, but black-white disparities in YPLL were driven by heart failure and hypertensive heart disease. In 2018, heart disease deaths resulted in approximately 3.8 million potential years of life lost. Findings are limited by potential misclassification on death certificates.

What this study adds: Our study adds that trends in heart disease subtype AAMR and YPLL have slowed, stagnated, or increased since 2011.

Funding, competing interests, data sharing: Study was funded by the U.S. National Institutes of Health, the authors have no competing interests, and vital statistics data are publicly available from the U.S. Centers for Disease Control.

Print Abstract Figure: Age-adjusted mortality rates due to total and cause-specific heart disease deaths in the US, 1999-2018
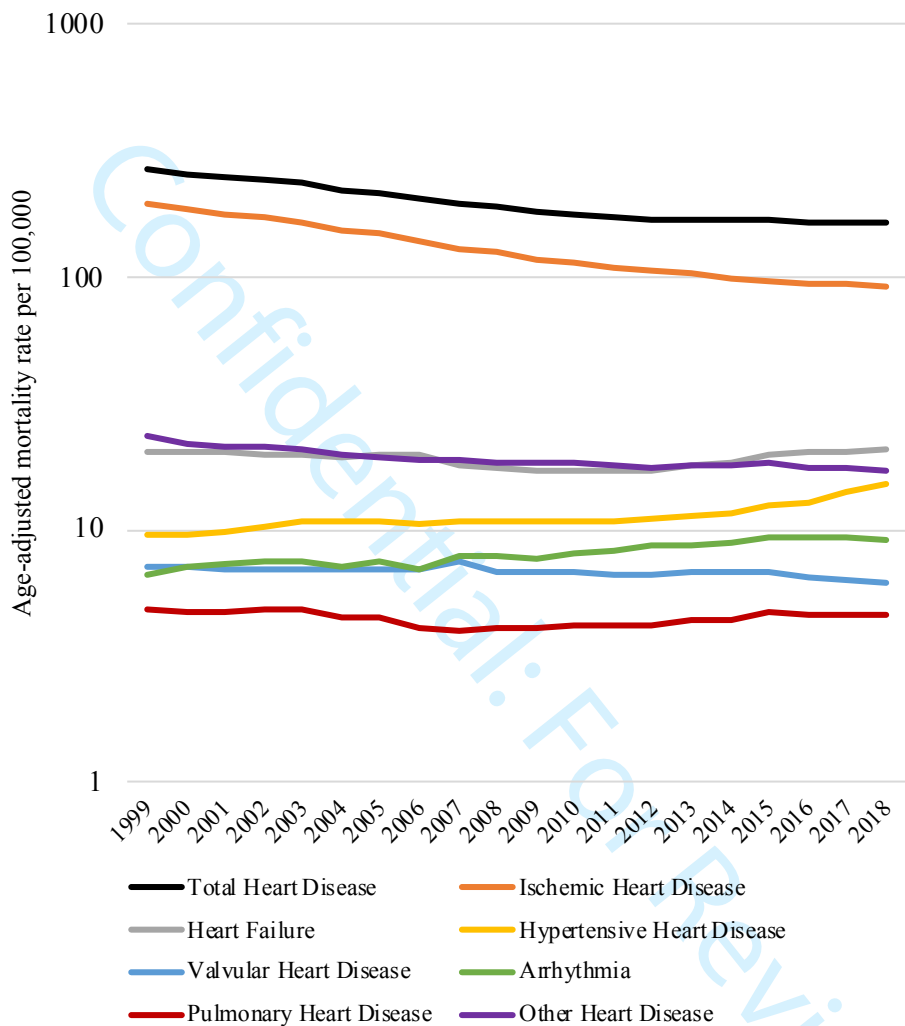
Age-adjusted mortality rates are displayed on a logarithmic scale.

Summary Box

Section 1 (What is already known):

- Surveillance data from national death certificates show that declines in total heart disease mortality have slowed since 2011 in the United States.

- Advances in medical and surgical therapies may have led to heterogeneous patterns in death rates for specific subtypes of heart disease.

- A detailed understanding of how mortality from subtypes of heart disease contributes to total heart disease mortality patterns will inform implementation of multi-level prevention interventions.

Section 2 (What this study adds):

- In the United States, increases in heart failure and hypertensive heart disease mortality occurred parallel to declines in ischemic heart disease death rates, resulting in 3.5 million years of potential life lost from total heart disease in 2018 and warranting focus on reducing the growing burden of heart disease risk factors.

- Black men had the highest burden of mortality from leading subtypes of heart disease, but the greatest increases midlife mortality due to heart disease subtypes were observed in black women (heart failure) and white women (hypertensive heart disease), indicating the need to enhance prevention in high risk populations to reduce disparities and promote health equity.

Introduction

Age-adjusted mortality rates (AAMR) due to heart diseases declined by more than 50% in the United States (US) in the second half of the 20th century from a peak of 307 per 100,000 in 1950.[1] This fall was predominantly driven by rapid declines in mortality from ischemic heart disease, as a result of progress in prevention (e.g. decline in smoking rates) and evidence-based treatments (e.g. statins, anti-platelet agents, and anti-hypertensives).[1-3] While mortality rates continued to decline after 2000,[4] recent data demonstrated that heart disease AAMR plauteaued in 2011.[2 5 6] Furthermore, some indicators now suggest a trend reversal with increasing heart disease death rates in certain population subgroups such as middle-aged Americans,[7 8] as well as by region in the US,[9] thus undoing decades of progress in heart disease prevention and treatment and contributing to decreases in overall US life expectancy.[10] Similar trends have also been observed in other high-income countries.[11]

However, subtypes of heart disease are heterogeneous in their pathophysiology and contribution toward preventable deaths. Recent analysis indicates that the stagnation in total heart disease mortality rates in 2011 was driven by a slowing in the decline of ischemic heart disease deaths, and increases in heart failure mortality rates.[12 13] Further detailed characterization of patterns for each subtype of heart disease deaths across subgroups that are responsible for the observed changes in heart disease mortality rates would inform targeted prevention and treatment efforts. We therefore investigated trends across race-sex, age, and geographic groups in cause-specific heart disease deaths (ischemic heart disease, heart failure, hypertensive heart disease, valvular heart disease, arrhythmia, pulmonary heart diseaes, and other heart diseases) using national death certificate data from 1999 to 2018. We calculated complementary metrics to quantify deaths due to subtypes of heart disease, including age-adjusted mortality rates (AAMR), years of potential life lost (YPLL), and mean annual percent changes (APC) in AAMR and YPLL from heart disease subtypes to better evaluate the burden of avoidable heart disease mortality.

Methods

Using mortality data from the Centers for Disease Control and Prevention's Wide-Ranging Online Data for Epidemiologic Research (WONDER) database of death certificates, we identified all decedents from 1999 to 2018 by International Classification of Diseases (ICD)-10 code with an underlying (main) cause of death from total heart disease, which comprised of heart disease subtypes classified as: ischemic heart disease (ICD-10 code I20-I25), heart failure (I50), hypertensive heart disease (I11, I13), valvular heart disease (I34-I38), arrhythmia (I47-I49), pulmonary heart disease (I26-I28), and other heart diseases (I00-I09, I30-I33, I40-I46, I51, which includes acute and chronic rheumatic heart disease, pericardial diseases, acute myocarditis, and unspecified cardiomyopathy and cardiac arrest not otherwise defined). Deaths classified using ICD-9 codes prior to local ICD-10 implementation were re-coded internally by the CDC using ICD-10 codes for the CDC WONDER database. The CDC WONDER database includes all death certificates filed in the US and less than 0.01% of death certificates are missing data on age of decedent. No data were suppressed due to low counts in subgroup analyses. The percentage of each heart disease subtype's contribution to total heart disease was calculated overall.

Trends were examined in the overall population (all race groups), separately by race-sex groups (black women, white women, black men, white men), and stratified by age at death (<45 years, 45-64 years, ≥65 years) for the main analysis. The race-sex analysis was limited to black and white individuals because other race/ethnic groups (Asian Americans, Native Americans, Hispanic Americans) were either too small (e.g., Native Americans) or less reliably identified (e.g., Hispanic American, Asian Americans) in CDC WONDER.[14][15] The "black" categorization is used on death certificates in the US, and only designates race but not ethnicity. In supplemental analyses, trends in heart disease subtypes were evaluated by census region (Northeast, Midwest, South, and West) and county-level urbanization (rural: micropolitan, noncore regions; urban: large central metro, large fringe metro, medium metro, small metro regions).[16]

We calculated AAMR per 100,000 population adjusted using the 2000 US standard population overall and stratified by race-sex, age, and geographic subgroups.[15] YPLL was calculated using standard

methods previously employed with average life expectancy as the reference age for the main analysis and

a standard reference age of 85 years for the secondary analysis.[17][18] Specifically, average life expectancy

between 1999-2018 for the overall US population (78 years) and individually for race-sex subgroups (77

years was used as the reference age for black women, 81 years for white women, 71 years for black men,

and 76 years for white men) was obtained from US vital statistics reports.[19][20] Race-sex specific life

expectancies were used in the primary analysis to calculate the absolute number of years of potential life

lost by decedents in the US during the study period in the context of current life expectancy estimates. For

each year of analysis, YPLL was calculated by multiplying number of deaths from heart disease subtypes

by the difference between the reference age and the midpoint age at death within each 5-year age group in

each of a series of 5-year age group decrements from the reference age. This result was divided by the

total 5-year age group population, then multiplied by 100,000 to obtain YPLL per 100,000 population.

After age standardizing YPLL with the 2000 US standard population, the sum of YPLL in each 5-year

age group provided cause-specific YPLL per 100,000 in the total population and race-sex subgroups, for

each year of analysis. YPLL was calculated for total heart disease, ischemic heart disease, heart failure,

and hypertensive heart disease. Because of relatively few deaths due to other heart diseases subtypes,

YPLL was also calculated for a category of "remainder heart disease subtypes" that comprised the

remainder of the underlying heart disease cause of death codes. YPLL was also calculated for total heart

disease, from a reference age of 85 years for the overall population and all race-sex subgroups, to provide

a comparison of the burden of YPLL that is not dependent on underlying differences in life expectancy by

race or sex.

Temporal trends in AAMR and YPLL were characterized by fitting log-linear regression models

using Joinpoint Regression Program (National Cancer Institute).[21] Log-transformed data were used as

certain subtypes of heart disease had relatively few deaths. Based on previously published methodological

guidelines, Joinpoint Regression was applied to identify inflection points in the trend of total heart disease

AAMR across the study period from 1999 to 2018. These guidelines recommend that for trends data

containing 17 to 21 time points, the analysis should be allowed to identify up to three inflection points in

trends across time.[22] Therefore, the Joinpoint Regression statistical software was allowed to identify up to three trend inflections where significant temporal variation existed in the trend ($p<0.05$) given the inclusion of 20 years of data included in the current analysis. Fewer than the maximum allowed number of inflection points could be identified if the magnitude of variation between trends was greatest with fewer inflection points. In our analysis, one inflection point was identified in the trend of total heart disease AAMR at the year 2011 (consistent with previously published trends identified with Joinpoint Regression[5]). The temporal intervals between 1999 and 2011, and 2011 to 2018, were therefore subsequently evaluated in all heart disease subtype analyses (age, race-sex, regional, and urbanization subgroups) to provide a standard comparison.

These temporal intervals were then used for AAMR and YPLL for each subgroup analysis to calculate mean annual percent change (mean APC), weighted in order to account for differences in number and time point of trend inflection points in subgroup models. Mean APC from 1999 to 2011, and from 2011 to 2018, was calculated by the Joinpoint Regression statistical software by determining the weighted average of the APC between each time point, with weights equal to the length of each individual model's inter-inflection point trend. In other words, mean APCs based on the linear trend segments identified are dependent on each subgroup model's number of identified inflection points (i.e., if a subgroup trend is optimized with 0 inflection points, indicating 1 linear trend across the entire study period from 1999 to 2018, mean APC before and after 2011 would be the same).

As a supplemental analysis, AAMR and YPLL from heart failure as a contributing cause of cardiovascular deaths was evaluated using the CDC WONDER multiple cause of death files, in order to more broadly characterize quantify the burden of heart failure-related mortality. These metrics were calculated as previously described, for deaths defined as any mention of heart failure (ICD-10 code I50) on death certificates with cardiovascular disease (ICD-10 code I00-I78) listed as underlying cause of death.[23]

This study was determined exempt from review by the Northwestern University institutional review board. As the results are based on publicly available national vital statistics, neither patients nor

the general public were directly involved in the conduct of this analysis and direct dissemination is not

applicable.

Patient Involvement

No patients were involved in setting the research question or the outcome measures, nor were

they involved in developing plans for design or implementation of the study. No patients were asked to

advise on interpretation or writing up of results. There are no plans to disseminate the results of the

research to study participants or the relevant patient community.

Results

Study Population

Between 1999 and 2018 there were 12.9 million deaths from total heart disease in the overall US

population in all race groups, of whom 49.1% (6.3 million) were women, 11.6% (1.5 million) were black,

and 86.2% (11.1 million) were white. From 1999 to 2018, ischemic heart disease accounted for a

declining proportion of total heart disease deaths (from 73.0% to 55.8%), alongside increasing proportion

of total heart disease deaths from heart failure (7.6% to 12.8%), hypertensive heart disease (3.6% to

9.2%), valvular heart disease (2.7% to 3.7%), arrhythmia (2.5% to 5.6%), pulmonary heart disease (1.8%

to 2.8%), and other heart disease (8.7% to 10.3%); see Figure 1 and Supplemental Table 1. Overall, 2.6%

of decedents were <45 years old, 16.3% were 45-64 years old, and 81.2% were ≥65 years old. The

proportion of deaths among middle-aged decedents (45-64 years) increased from 13.7% in 1999 to 17.3%

in 2018.

Total heart disease AAMR declined from 266.5 (95% confidence interval 265.8 to 267.1) per

100,000 in 1999, to 163.6 (163.2 to 164.0) per 100,000 in 2018 (Table 1). Trends in AAMR declines (i.e.

mean APC) of total heart disease AAMR decelerated, from -3.7% per year (95% confidence interval -3.8

to -3.5) before 2011 to -0.7% per year (-1.1 to -0.3) after 2011 for all decedents. AAMR from ischemic

heart disease declined from 194.6 (194.1 to 195.1) per 100,000 in 1999, to 109.2 (108.8 to 109.5) per

100,000 in 2011, but further declined only to 90.9 (90.6 to 91.2) per 100,000 in 2018. Mean APC from

ischemic heart disease mortality slowed from -4.7% per year (-5.1 to -4.2) before 2011 to -2.6% per year

(-3.3 to -2.0) after 2011. Trends in heart failure mortality rates reversed and increased (overall mean APC

-1.7% per year [-2.5 to -0.8] before 2011, versus +3.5% per year [+2.6 to +4.5] after 2011), reflecting a

decline in AAMR from 20.3 (20.1 to 20.4) per 100,000 in 1999, to 16.9 (16.8 to 17.1) per 100,000 in

2011, which rose to 20.8 (20.7 to 20.9) per 100,000 again by 2018. Overall, mean APC of hypertensive

heart disease mortality rates accelerated from +1.2% per year (+0.7 to +1.7) before 2011 to +4.8% per

year (+3.3 to +6.3) after 2011. Absolute number of deaths from and AAMR of valvular heart disease,

arrhythmia, and pulmonary heart disease were relatively low in comparison to ischemic heart disease,

heart failure, and hypertensive heart disease. While AAMR from valvular heart disease decreased from

2011 to 2018 (from 6.7 [6.6 to 6.8] to 6.1 [6.0 to 6.2] per 100,000, mean APC -1.6% per year [-2.8 to -

0.4]), AAMR from arrhythmia and pulmonary heart disease increased to 9.1 (9.0 to 9.2) per 100,000 and

4.6 (4.6 to 4.7) per 100,000, respectively.

In secondary analyses, AAMR trends for HD subtypes were similar by census region in the US,

although AAMR from total and heart disease subtypes were highest in the American South compared to

other US census regions, and generally higher in rural counties compared with urban counties

(Supplemental Figures 1 and 2, respectively).

Trends in Heart Disease Mortality Rates by Race-Sex

Black men had the highest AAMR from total heart disease (260.3 [205.6 to 207.1] per 100,000 in

2018), which was reflected primarily in high AAMR from ischemic heart disease (138.1 [136.2 to 139.9]

per 100,000 in 2018), heart failure (28.9 [28.0 to 29.8] per 100,000), and hypertensive heart disease (35.3

[34.4 to 36.3] per 100,000). Trends in AAMR from total heart disease and ischemic heart disease slowed

similarly after 2011 in black and white men and women (Figure 2 and Supplemental Table 2). All race-

sex groups experienced a reversal of heart failure mortality trends after 2011. Notably, after 2011 mean

APC of heart failure mortality rates was highest in black men (+4.9% per year [+4.0 to +5.8]) compared

with black women, white men, and white women. Acceleration of hypertensive heart disease mortality

rates was highest in white women (mean APC +5.6% per year [+4.3 to +7.0]) and white men (mean APC

+6.3% per year [+4.9 to 9.4]) after 2011. Although mean APC of hypertensive heart disease mortality

rates was lower in black women and black men, absolute AAMR was higher in black compared with

white decedents.

Trends in Heart Disease Mortality Rates by Age

AAMR was lowest for decedents <45 years old at time of death across the study period (Table 2).

In this youngest age stratification, AAMR from total heart disease was 8.7 (8.6 to 8.9) per 100,000 in

2018, predominantly attributable to ischemic heart disease (AAMR 3.2 [3.1 to 3.3] per 100,000 in 2018)

and hypertensive heart disease (AAMR 1.4 [1.4 to 1.5] per 100,000). AAMR of hypertensive heart

disease mortality rates continued to worsen, but decelerated from mean APC +4.8% per year (+3.7 to

+5.9) before 2011 to +2.3% per year (+1.9 to +2.8) after 2011. However, mean APC of heart failure

mortality rates accelerated after 2011, and mean APC of valvular heart disease indicated reversal from

decreasing AAMR to increasing AAMR. Secondary analysis of AAMR patterns in race-sex groups in

decedents age <45 years is shown in Supplemental Table 3.

For decedents age 45-64 years at time of death (Table 2), AAMR from total heart disease

declined from 1999 to 2011 (from 164.1 [163.2 to 165.2] to 121.0 [120.2 to 121.7] per 100,000; mean

APC -2.5% per year [-2.8 to -2.2]), but remained generally unchanged between 2011 to 2018 (to 122.3

[121.6 to 123.0] per 100,000; mean APC +0.2%/year [-0.1 to +0.4]). AAMR was highest for ischemic

heart disease (73.1 [72.6 to 73.7] per 100,000 in 2018), hypertensive heart disease (15.2 [15.0 to 15.5] per

100,000 in 2018), and heart failure (6.8 [6.7 to 7.0] per 100,000 in 2018). Mean APC of ischemic heart

disease mortality rates decelerated after 2011, but accelerated for hypertensive heart disease mortality

rates (mean APC +3.0% per year [+2.6 to +3.5]) and heart failure mortality rates (+5.7% per year [+4.4 to

7.0]). Secondary analysis of AAMR patterns in race-sex groups in decedents age 45-64 years is shown in Supplemental Table 4.

Decedents aged ≥65 years had the highest AAMR for all types of heart disease compared with younger decedents (Table 2). AAMR for total heart disease declined from 1767.0 (1762.5 to 1771.4) per 100,000 in 1999, to 1115.6 (1112.4 to 1118.8) per 100,000 in 2011 (mean APC -3.7% per year [-4.3 to -3.1]), but further declined only to 1034.6 (1031.7 to 1037.4) per 100,000 between 2011 to 2018 (mean APC -1.1% per year [-1.6 to -0.6]). Similar to mortality patterns at younger ages, hypertensive heart disease mortality rate trends accelerated after 2011, and heart failure trends reversed from decreasing to increasing AAMR. Secondary analysis of AAMR patterns in race-sex groups in decedents age ≥65 years is shown in Supplemental Table 5. In the subset of deaths between age 65-84, similar mortality patterns were observed (Supplemental Table 6).

Trends in Years of Potential Life Lost due to Subtypes of Heart Disease

Estimated YPLL per 100,000 population is shown in Table 3 and Supplemental Figure 3. YPLL from total heart disease in the overall US population was estimated to be 1068 years per 100,000 population in 2018. Of all the heart disease subtypes, YPLL in 2018 was highest for ischemic heart disease (578 years per 100,000), followed by hypertensive heart disease (132 years per 100,000) then heart failure (64 years per 100,000). YPLL due to ischemic heart disease was similar in white and black men, but 1.3-fold higher in black women compared with white women. For ischemic heart disease, mean APC of YPLL decelerated from -3.8% per year (-3.9 to -3.7) overall before 2011 to -1.6% per year (-1.8 to -1.4) after 2011 with similar trends in all race-sex groups. YPLL from hypertensive heart disease was 2.9-fold higher in black women (219 years per 100,000) and 2.3-fold higher in black men (305 per 100,000) compared with white women and men in 2018, respectively. However, faster increases in YPLL over the study period was observed in white women (mean APC +4.2% per year [0.9 to 7.7] after 2011) and white men (+3.3% per year [3.0 to 3.5] after 2011). For heart failure, YPLL changed from either decreasing or stagnant prior to 2011, to increasing after 2011. Black women and men had a 2-fold higher

YPLL due to heart failure compared with white women and men, with highest mean APC of YPLL in

black women (+5.8% per year [4.5 to 7.2]) and black men (+6.6% per year [5.0 to 8.3]).

YPLL from total heart disease was also calculated from age 85 as the reference for all subgroups

(Supplemental Table 7). The burden of YPLL was higher in all groups, but similar patterns were observed

compared to YPLL measured from subgroup-specific life expectancy. Black men had the highest number

of YPLL from total heart disease across the study period. Analysis of trends showed declining YPLL in

all race-sex subgroups from 1999 to 2011, followed by slowing or stagnation from 2011 to 2018.

Finally, in secondary analysis, AAMR and YPLL from heart failure was assessed as a

contributing cause of cardiovascular death (Supplemental Table 8). Similar patterns were observed as

compared to heart failure as an underlying cause of death: AAMR and YPLL trends reversed from

decreasing between 1999 to 2011, to increasing after 2011 through 2018, for all race-sex and age groups.

A summary table of contemporary heart disease mortality statistics in the overall population by

each of the metrics (total number of decedents by subtype, percent contribution of each subtype to total

heart disease deaths, AAMR by subtype, and YPLL by subtype) for 2018 is provided in Supplemental

Table 9.

Discussion

Principal Findings

Changing mortality patterns in heart disease subtypes in the US are reflected overall by a plateau

in total heart disease AAMR since 2011, within which deceleration of ischemic heart disease mortality

rates are coupled with increases in heart failure and hypertensive heart disease mortality rates in all race-

sex groups. In particular, black men had both the highest AAMR and fastest increase in mortality rates

due to heart failure compared with other groups. While hypertensive heart disease mortality rates

increased for all race-sex groups, fastest increases in hypertensive heart disease AAMR were observed in

white women and men between 2011-2018. However, AAMR for hypertensive heart disease remained about 2 times higher in black compared with white populations by 2018.

Our estimates of the burden of heart disease expressed as YPLL translate into approximately 3.5 million potential years of life lost overall in 2018 due to total heart disease, but this burden was borne disproportionately in different race-sex groups and attributed to different heart disease subtypes. Although overall YPLL from total heart disease declined across the study period, premature mortality evaluated by YPLL increased from 2 of the top 3 subtypes of heart disease deaths: hypertensive heart disease and heart failure, reflected by an 80% and a 31% increase in YPLL from hypertensive heart disease and heart failure, respectively, from 1999-2018. While heart failure AAMR was higher than for hypertensive heart disease, YPLL from hypertensive heart disease was higher, indicating that hypertensive heart disease-related deaths are occurring at younger ages. Patterns of AAMR from less common causes of heart disease (arrhythmia, pulmonary heart disease, and other heart disease) were either stagnant or increased from 2011 to 2018. Valvular heart disease was the only subtype where mortality rates declines accelerated after 2011, although relative burden of deaths from valvular heart disease remained low.

Comparison with Other Studies

These findings align with recent data showing contemporaneous slowing in the decline of cardiometabolic disease mortality rates, and recent surveillance of heart disease mortality that showed that the growth in the population of older Americans age ≥65 years during this time was associated with an increase in the number of heart disease deaths, despite a stagnant or slowly declining AAMR.[6][13] Our results build on these reports by providing broader and detailed mortality patterns of the range of heart disease subtypes as underlying cause of death, particularly highlighting the rapid growth and high burden of death overall from hypertensive heart disease, increasing heart failure and hypertensive heart disease mortality rates at younger ages reflected in a high magnitude of YPLL from these causes, and worrisome patterns in mortality from arrhythmia and pulmonary heart disease. These findings likely represent a combination of changing patterns of heart disease incidence and survival over the last 2 decades.

While overall declines in total heart disease mortality may be attributed to improved diagnosis and management over the last decades, the observed recent patterns of heart disease mortality overall may be due to the growing burden of cardiometabolic risk factors for heart disease. Obesity, diabetes, and hypertension likely play a sizeable role in the observed changes in recent heart disease mortality rates in the US, where the prevalence of obesity now exceeds 42%,[24] the prevalence of both prediabetes and diabetes approaches 50%,[25] and the prevalence of hypertension is approximately 30%.[26] Recent trends in assessment of cardiovascular health in the US project continued worsening in prevalences of poor levels of diet quality, physical inactivity, obesity, and diabetes in the coming decades.[27-30] Furthermore, regional differences in prevalence of these modifiable risk factors likely account for a substantial portion differences by region in the burden of heart disease in the US.[31] Such trends will likely result in continued increases in mortality from heart disease subtypes such as heart failure and hypertensive heart disease if current trends continue without intervention, given the direct association of these subtypes with cardiometabolic risk factors.[32-34]

The observed differences in heart disease mortality by race may partly reflect underlying and pervasive disparities in cardiovascular health and burden of heart disease.[27] Specifically, obesity, diabetes, and hypertension in the US remain most prevalent in black Americans, and rates of control remain lower in black compared with white Americans.[35] Differences in patterns of guideline-recommended medication use, including medication prescription, optimization, and adherence, especially for hypertension, likely contribute to racial disparities in heart disease morbidity and mortality.[36-39] A growing body of evidence supports that racial differences in cardiovascular health and heart disease mortality are in large part representative of disparities in many other factors, including a range of social determinants of health, socioeconomic status and access to care,[40] burden of the drug abuse epidemic in the US,[41] and structural and systemic racism that require individual and policy-level changes to address and reduce persistent health inequities.[42 43] We also observed that disparities by race are compounded by differences in heart disease mortality rates between men and women, wherein men have higher rates of heart disease mortality, and the burden of mortality is highest in black men. Sex differences may be due to a range of

factors, from differences in risk factor prevalence (such as tobacco use[44]), to social determinants such as healthcare utilization.[45]

Strengths and Limitations of Study

The principal strength of our analysis is investigation of contemporary nationwide mortality data attributed to leading subtypes of heart disease and differences among race-sex, age, and geographic subgroups. These data allow for evaluating changes and disparities in cause-specific cardiovascular mortality patterns, which contribute to the observed increases in total heart disease deaths in the past decade and disproportionally burden black Americans. Limitations of our analysis include incomplete race/ethnic data. Our investigation focuses on the most reliable data available, to evaluate trends in white and black subgroups who represent approximately 90% of the US population.[14] Given evidence that reporting methods for Hispanic ethnicity and Asian or Native American may lead to misclassification, underestimation of mortality rates in these groups,[46] and that data for disaggregated Asian American and Hispanic Americans subgroups were not available, these groups were not reported. Additionally, death certificate data are subject to potential miscoding and misclassification.[47 48] However, these data provide the most comprehensive assessment of cause-specific heart disease mortality rates on a national level. Importantly, these data may not necessarily reflect the clinical progression of heart diseases, such as from ischemic heart disease to heart failure. Specifically, as the clinical syndrome of heart failure represents a mode of death frequently attributable to hypertension, ischemic heart disease, valvular heart disease, or diabetes as the underlying cause,[49] our primary analysis may underestimate the burden of heart failure-related mortality, and do not identify heart failure patients who had preceding nonfatal ischemic heart disease or hypertensive heart disease. Notably, similar patterns were seen in our secondary analysis evaluating trends in mortality rates from heart failure as a contributing cause of cardiovascular death. Finally, the 'Other heart disease' category reflects a heterogenous mix of heart disease that may have dissimilar pathophysiology.

Conclusions and Policy Implications

   Future research and public health strategies should focus on dissemination and implementation of interventions that focus on prevention and management of heart disease in the highest risk populations in order to promote equity, clinical quality improvement to optimize primary and secondary prevention, and policies to improve diet quality and facilitate physical activity. For primary prevention, simulation modeling for prevention of heart disease in high-income settings has been conducted in the United Kingdom and suggests that a strategy of enhanced screening for heart disease targeted toward the highest risk groups, combined with adoption of population-wide structural policies for smoking cessation, reduction in sugar sweetened beverage consumption, and salt reduction in foods, could maximize reductions in heart disease mortality and inequalities.[50 51] Additionally, community-level interventions tailored to address risk factors in disproportionately burdened race-sex groups have also proven effective in the U.S., such as a barber- and pharmacist-led intervention targeting hypertension control in black male patrons of black-owned barbershops.[52] Enhanced secondary prevention strategies may additionally mitigate mortality across the spectrum of heart disease subtypes. Increasing prescription of and adherence to guideline-recommended medical therapy as applicable for lipids, blood pressure, diabetes, with antiplatelet agents,[53] or for heart failure with reduced ejection fraction,[54] may also help address the worrisome observed trends in mortality rates. Ultimately, a comprehensive multi-level, multi-stakeholder approach focused on prevention of modifiable risk factors, adherence to evidence-based secondary prevention strategies, and focus on disproportionately burdened groups is urgently needed to curb worrisome trends in heart disease deaths in the US.

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Patient Consent

Not applicable.

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Transparency Statement:

The lead author Dr. Nilay Shah and senior author Dr. Sadiya Khan affirm that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as originally planned have been explained.

Figure Titles and Legends

Figure 1. Proportion of total heart disease deaths attributable to each heart disease subtype in the US, 1999-2018. Proportion of total heart disease deaths due to each individual subtype or cateogry. Proportion of heart disease deaths due to ischemic heart disease decreased, while proportion of heart disease deaths due to all other causes increased, predominantly from heart failure and hypertensive heart disease, which were the second and third leading cause of heart disease death. Actual number of deaths are shown in Supplemental Table 1.

Figure 2. Age-adjusted mortality rates due to total and leading heart disease subtypes in black and white women and men in the US, 1999-2018. Age-adjusted mortality rates shown for (A) total heart disease, (B) ischemic heart disease, (C) heart failure, and (D) hypertensive heart disease in black and white women and men. Dashed line represents temporal inflection point in total heart disease identified by Joinpoint regression. Average annual percentage change of age-adjusted mortality rates before and after 2011 are listed in Supplemental Table 2.

TABLES

Table 1. Trends in age-adjusted mortality rates attributed to total and each heart disease subtype in the overall US population, 1999-2018

	Age-adjusted mortality rate per 100,000 (95% CI)			Mean annual percent change (95% CI)	
	1999 (N = 725,192)	**2011** (N = 596,577)	**2018** (N = 655,381)	**1999-2011**	**2011-2018**
Total Heart Disease	266.5 (265.8 to 267.1)	173.7 (173.3 to 174.2)	163.6 (163.2 to 164.0)	-3.7 (-3.8 to -3.5)*	-0.7 (-1.1 to -0.3)*
Ischemic Heart Disease	194.6 (194.1 to 195.1)	109.2 (108.8 to 109.5)	90.9 (90.6 to 91.2)	-4.7 (-5.1 to -4.2)*	-2.6 (-3.3 to -2.0)*
Heart Failure	20.3 (20.1 to 20.4)	16.9 (16.8 to 17.1)	20.8 (20.7 to 20.9)	-1.7 (-2.5 to -0.8)*	3.5 (2.6 to 4.5)*
Hypertensive Heart Disease	9.6 (9.5 to 9.7)	10.8 (10.7 to 10.9)	15.1 (15.0 to 15.2)	1.2 (0.7 to 1.7)*	4.8 (3.3 to 6.3)*
Valvular Heart Disease	7.2 (7.1 to 7.3)	6.7 (6.6 to 6.8)	6.1 (6.0 to 6.2)	-0.4 (-0.6 to -0.1)*	-1.6 (-2.8 to -0.4)*
Arrhythmia	6.7 (6.6 to 6.8)	8.2 (8.1 to 8.3)	9.1 (9.0 to 9.2)	1.7 (1.4 to 2.0)*	1.7 (1.4 to 2.0)*
Pulmonary Heart Disease	4.8 (4.8 to 4.9)	4.2 (4.1 to 4.3)	4.6 (4.6 to 4.7)	-0.9 (-2.1 to 0.2)	1.5 (1.0 to 1.9)*
Other Heart Disease	23.2 (23.0 to 23.4)	17.8 (17.6 to 17.9)	17.1 (16.9 to 17.2)	-2.0 (-2.3 to -1.6)*	-0.7 (-1.0 to -0.4)*

CI: Confidence interval. *Indicates that the mean annual percent change is significantly different from zero, p<0.05. Mean annual percentage change shown for AAMR for the specified time range.

Table 2. Trends in age-adjusted mortality rates attributed to total and each heart disease subtype by age at death in the overall US population, 1999-2018

Heart disease subtype	Age at Death	Age-adjusted mortality rates per 100,000 (95% CI)			Mean annual percent change (95% CI)	
		1999	**2011**	**2018**	**1999-2011**	**2011-2018**
Total Heart Disease	**<45**	10.3 (10.1 to 10.4)	9.0 (8.9 to 9.2)	8.7 (8.6 to 8.9)	-1.0 (-1.5 to -0.5)*	-0.3 (-0.7 to 0.1)
	45-64	164.1 (163.1 to 165.2)	121.0 (120.2 to 121.7)	122.3 (121.6 to 123.0)	-2.5 (-2.8 to -2.2)*	0.2 (-0.1 to 0.4)
	≥65	1767.0 (1762.5 to 1771.4)	1115.6 (1112.4 to 1118.8)	1034.6 (1031.7 to 1037.4)	-3.7 (-4.3 to -3.1)*	-1.1 (-1.6 to -0.6)*
Ischemic Heart Disease	**<45**	4.9 (4.8 to 5.0)	3.8 (3.7 to 3.9)	3.2 (3.1 to 3.3)	-1.9 (-2.6 to -1.3)*	-2.3 (-2.7 to -1.9)*
	45-64	121.1 (120.2 to 121.9)	79.3 (78.7 to 79.9)	73.1 (72.6 to 73.7)	-3.4 (-3.6 to -3.3)*	-1.4 (-1.6 to -1.2)*
	≥65	1301.6 (1297.7 to 1305.4)	704.7 (702.2 to 707.3)	573.8 (571.7 to 575.9)	-4.9 (-5.4 to -4.4)*	-3.0 (-3.4 to -2.3)*
Heart Failure	**<45**	0.2 (0.2 to 0.3)	0.3 (0.3 to 0.3)	0.4 (0.4 to 0.5)	2.8 (0.5 to 5.0)*	5.1 (2.7 to 7.6)*
	45-64	4.8 (4.6 to 4.9)	4.5 (4.4 to 4.7)	6.8 (6.7 to 7.0)	-0.6 (-1.2 to -0.1)*	5.7 (4.4 to 7.0)*
	≥65	150.8 (149.5 to 152.2)	124.5 (123.5 to 125.6)	150.4 (149.3 to 151.5)	-1.7 (-2.6 to -0.9)*	3.3 (2.4 to 4.3)*
Hypertensive Heart Disease	**<45**	0.7 (0.7 to 0.8)	1.2 (1.1 to 1.2)	1.4 (1.4 to 1.5)	4.8 (3.7 to 5.9)*	2.3 (1.9 to 2.8)*
	45-64	8.1 (7.9 to 8.3)	12.1 (11.8 to 12.3)	15.2 (15.0 to 15.5)	3.9 (2.1 to 5.6)*	3.0 (2.6 to 3.5)*
	≥65	57.6 (56.8 to 58.4)	58.0 (57.3 to 58.7)	85.5 (84.7 to 86.3)	0.3 (-0.2 to 0.8)	5.4 (3.6 to 7.2)*
Valvular Heart Disease	**<45**	0.3 (0.3 to 0.4)	0.2 (0.2 to 0.2)	0.3 (0.3 to 0.3)	-3.9 (-6.0 to -1.8)*	7.1 (1.4 to 13.2)*
	45-64	2.5 (2.4 to 2.6)	2.1 (2.0 to 2.2)	2.2 (2.1 to 2.3)	-1.6 (-3.2 to 0.1)	1.0 (-2.0 to 4.0)
	≥65	51.0 (50.2 to 51.7)	48.1 (47.4 to 48.8)	42.7 (42.1 to 43.3)	-0.3 (-0.5 to 0.0)*	-1.9 (-3.2 to -0.6)*
Arrhythmia	**<45**	0.4 (0.4 to 0.4)	0.4 (0.4 to 0.4)	0.4 (0.3 to 0.4)	-0.3 (-1.0 to 0.4)	-0.3 (-1.0 to 0.4)
	45-64	3.2 (3.0 to 3.3)	3.4 (3.3 to 3.5)	3.9 (3.8 to 4.1)	0.5 (-0.9 to 2.0)	2.2 (1.0 to 3.4)*
	≥65	45.7 (45.0 to 46.4)	56.6 (55.9 to 57.3)	63.1 (62.4 to 63.8)	1.8 (1.5 to 2.1)*	1.8 (1.5 to 2.1)*
Pulmonary Heart Disease	**<45**	0.9 (0.8 to 0.9)	0.7 (0.6 to 0.7)	0.7 (0.7 to 0.8)	-1.8 (-3.0 to -0.6)*	0.3 (-0.9 to 1.5)
	45-64	4.6 (4.5 to 4.8)	4.0 (3.8 to 4.1)	4.3 (4.2 to 4.5)	-1.8 (-2.5 to -1.0)*	1.4 (0.4 to 2.4)*
	≥65	25.7 (25.2 to 26.2)	23.0 (22.5 to 23.4)	25.3 (24.8 to 25.7)	-0.7 (-2.1 to 0.7)	1.7 (1.1 to 2.2)*
Other Heart Disease	**<45**	2.8 (2.7 to 2.9)	2.4 (2.3 to 2.5)	2.4 (2.3 to 2.4)	-1.3 (-1.7 to -1.0)*	-0.1 (-1.0 to 0.8)
	45-64	19.8 (19.4 to 20.2)	15.6 (15.3 to 15.8)	16.6 (16.4 to 16.9)	-1.9 (-2.6 to -1.2)*	0.9 (0.5 to 1.4)*
	≥65	134.5 (133.3 to 135.8)	100.7 (99.7 to 101.7)	93.8 (92.9 to 94.6)	-2.2 (-2.6 to -1.7)*	-1.0 (-1.3 to -0.6)*

CI: Confidence interval. *Indicates that the mean annual percent change is significantly different from zero, p<0.05. Mean annual percentage change shown for AAMR for the specified time range.

Table 3. Trends in age-standardized years of potential life lost per 100,000 population due to total and each heart disease subtype in the overall population and race-sex subgroups in the US, 1999-2018

Heart disease subtype	Race-Sex Group	Years of Potential Life Lost (per 100,000 population)			Mean annual percent change (95% CI)	
		1999	2011	2018	1999-2011	2011-2018
Total Heart Disease	Overall	1494	1080	1068	-2.7 (-2.9 to -2.6)*	0.1 (-0.2 to 0.4)
	Black women	1824	1215	1210	-3.5 (-3.8 to -3.3)*	-0.1 (-0.7 to 0.6)
	White women	1064	754	744	-2.8 (-3.0 to -2.7)*	0.1 (-0.3 to 0.4)
	Black men	2183	1549	1602	-2.7 (-3.3 to -2.2)*	0.3 (-0.3 to 0.9)
	White men	1677	1244	1205	-2.5 (-2.6 to -2.3)*	-0.5 (-0.7 to -0.2)*
Ischemic Heart Disease	Overall	1025	645	578	-3.8 (-3.9 to -3.7)*	-1.6 (-1.8 to -1.4)*
	Black women	983	543	479	-5.0 (-5.5 to -4.4)*	-1.6 (-2.0 to -1.1)*
	White women	696	418	373	-4.1 (-4.3 to -3.9)*	-1.5 (-1.9 to -1.1)*
	Black men	1254	770	716	-3.8 (-4.3 to -3.3)*	-1.1 (-1.7 to -0.5)*
	White men	1247	816	723	-3.5 (-3.7 to -3.4)*	-1.7 (-2.0 to -1.5)*
Heart Failure	Overall	49	45	64	-1.0 (-1.7 to -0.3)*	5.5 (4.8 to 6.1)*
	Black women	79	70	103	-1.2 (-2.4 to 0.1)	5.8 (4.5 to 7.2)*
	White women	50	43	53	-1.4 (-2.9 to 0.1)	3.9 (2.6 to 5.2)*
	Black men	71	74	116	0.8 (-0.8 to 2.5)	6.6 (5.0 to 8.3)*
	White men	43	39	57	-0.9 (-1.4 to -0.5)*	5.5 (4.5 to 6.6)*
Hypertensive Heart Disease	Overall	73	107	132	3.4 (2.6 to 4.2)*	3.2 (2.4 to 4.1)*
	Black women	210	207	219	0.0 (-0.4 to 0.3)	0.0 (-0.4 to 0.3)
	White women	39	57	76	3.4 (2.5 to 4.3)*	4.2 (0.9 to 7.7)*
	Black men	237	271	305	1.6 (0.7 to 2.5)*	0.6 (0.2 to 0.9)*
	White men	57	105	134	5.4 (4.7 to 6.0)*	3.3 (3.0 to 3.5)*
Remainder Heart Disease Subtypes	Overall	346	283	293	-1.6 (-2.0 to -1.3)*	0.5 (-0.7 to 1.7)
	Black women	551	394	409	-2.7 (-3.1 to -2.4)*	0.4 (-0.4 to 1.2)
	White women	279	236	241	-1.5 (-1.8 to -1.1)*	0.8 (0.2 to 1.3)*
	Black men	620	435	465	-2.7 (-3.9 to -1.5)*	0.7 (0.1 to 1.4)*
	White men	331	284	291	-1.1 (-1.4 to -0.8)*	0.3 (0.0 to 0.7)

CI: Confidence interval. Mean annual percentage change shown for YPLL for the specified time range.
*Indicates that the mean annual percent change is significantly different from zero, p<0.05.

FIGURES

Figure 1. Proportion of total heart disease deaths attributable to each heart disease subtype in the US, 1999-2018
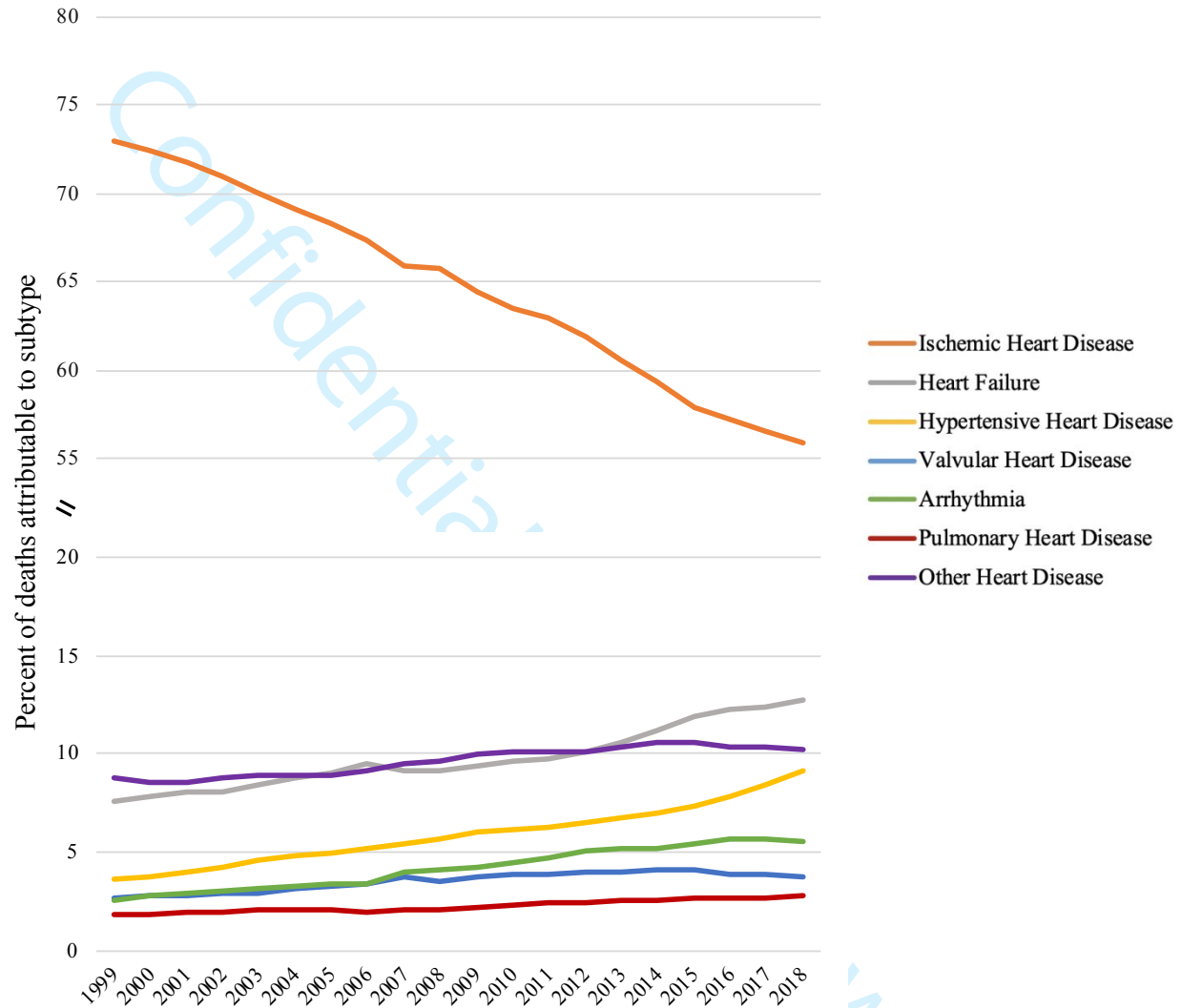
Proportion of total heart disease deaths attributable to heart disease subtypes is graphed on a Y-axis that includes a scale break.

Figure 2. Age-adjusted mortality rates due to total and leading heart disease subtypes in black and white women and men in the US, 1999-2018.

A. Total heart disease

B. Ischemic heart disease

C. Heart failure

D. Hypertensive heart disease

Black women — White women — Black men — White men
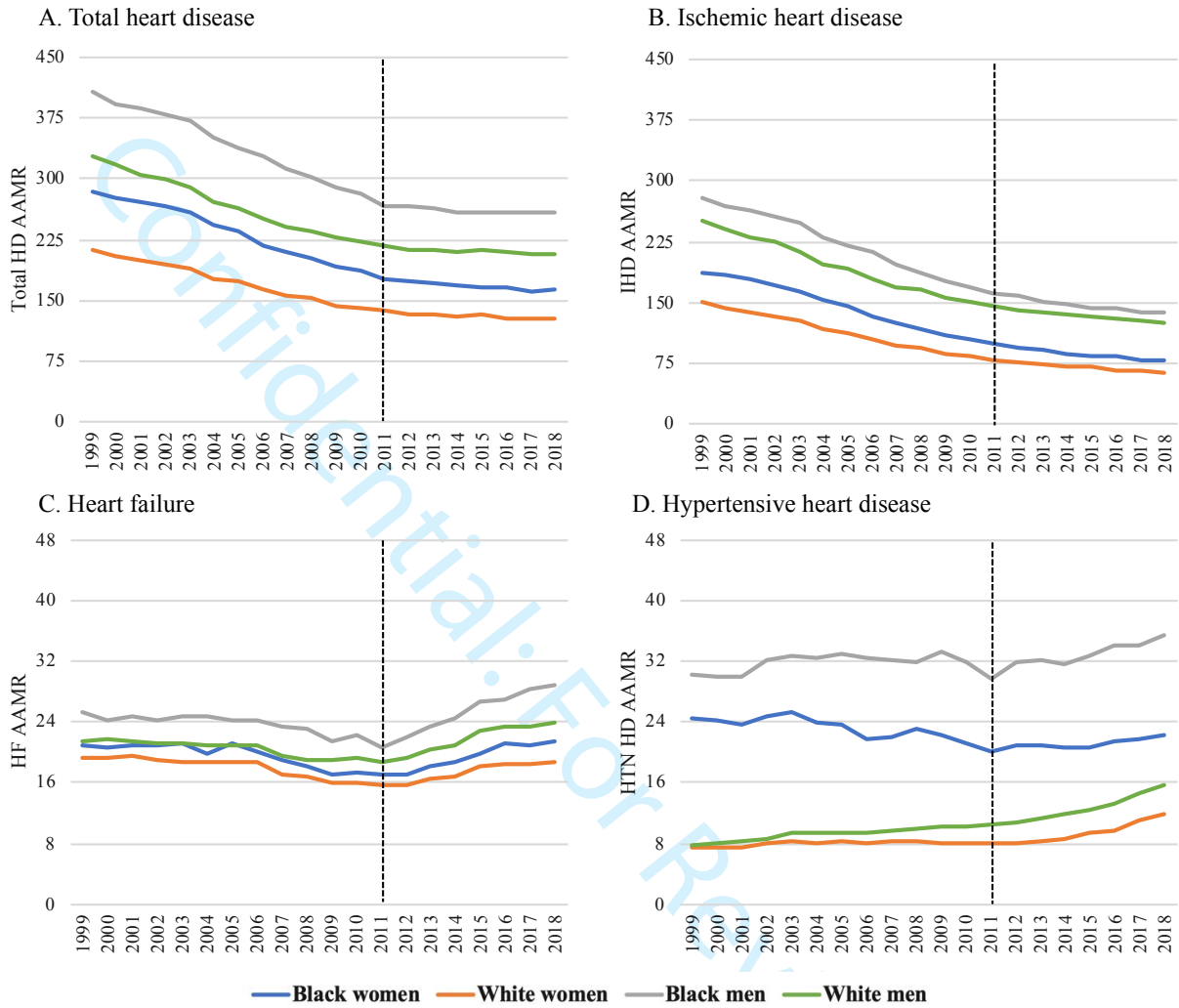
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Heterogeneous Trends in Burden of Heart Disease Mortality by Subtypes in the United States, 1999-2018: Observational Analysis of Vital Statistics

Supplementary Material

Supplemental Table 1. Number of deaths from total heart disease and heart disease subtypes in the US in 1999, 2011, and 2018

	1999	2011	2018
Total Heart Disease	725,192	596,577	655,381
Ischemic Heart Disease	529,659	375,295	365,744
Heart Failure	54,913	58,309	83,616
Hypertensive Heart Disease	26,029	37,270	60,041
Valvular Heart Disease	19,612	23,141	24,337
Arrhythmia	18,309	28,033	36,417
Pulmonary Heart Disease	13,244	14,206	18,026
Other Heart Disease	63,426	60,323	67,200

Supplemental Table 2. Trends in age-adjusted mortality rates from total and cause-specific heart disease deaths stratified by race-sex subgroups of all ages in the US, 1999-2018

Heart Disease Subtype	Race-Sex Group	AAMR per 100,000 (95% CI)			Mean Annual Percent Change (95% CI)	
		1999	2011	2018	1999-2011	2011-2018
Total Heart Disease	Black women	283.7 (281.0 to 286.5)	176.2 (174.3 to 178.1)	162.2 (160.6 to 163.9)	-3.9 (-4.3 to -3.5)*	-1.2 (-1.6 to -0.8)*
	White women	212.8 (212.0 to 213.5)	136.5 (135.9 to 137.0)	126.6 (126.1 to 127.1)	-3.8 (-4.1 to -3.6)*	-0.9 (-1.3 to -0.4)*
	Black men	407.2 (402.8 to 411.6)	266.1 (263.1 to 269.2)	259.5 (256.9 to 262.1)	-3.4 (-3.6 to -3.2)*	-0.5 (-1.0 to 0.0)
	White men	327.1 (325.9 to 328.3)	216.9 (216.0 to 217.7)	206.3 (205.6 to 207.1)	-3.4 (-3.9 to -2.9)*	-0.6 (-1.0 to -0.3)*
Ischemic Heart Disease	Black women	188.0 (185.7 to 190.2)	99.7 (98.3 to 101.2)	77.9 (76.8 to 79.1)	-5.3 (-5.6 to -4.9)*	-3.3 (-3.7 to -3.0)*
	White women	150.5 (149.9 to 151.1)	80.1 (79.6 to 80.5)	63.7 (63.4 to 64.1)	-5.1 (-5.6 to -4.6)*	-3.3 (-3.7 to -2.9)*
	Black men	278.7 (275.1 to 282.4)	161.5 (159.1 to 163.8)	138.1 (136.2 to 139.9)	-4.4 (-4.7 to -4.1)*	-2.3 (-2.9 to -1.7)*
	White men	251.2 (250.2 to 252.2)	146.5 (145.8 to 147.2)	125.6 (125.0 to 126.2)	-4.4 (-4.8 to -3.9)*	-2.2 (-2.6 to -1.9)*
Heart Failure	Black women	20.9 (20.1 to 21.6)	17.0 (16.4 to 17.6)	21.5 (20.9 to 22.1)	-1.6 (-2.5 to -0.7)*	3.5 (2.8 to 4.2)*
	White women	19.3 (19.1 to 19.5)	15.8 (15.6 to 15.9)	18.7 (18.5 to 18.9)	-1.7 (-2.5 to -0.9)*	2.6 (2.1 to 3.2)*
	Black men	25.3 (24.1 to 26.4)	20.7 (19.8 to 21.6)	28.9 (28.0 to 29.8)	-1.3 (-2.2 to -0.4)*	4.9 (4.0 to 5.8)*
	White men	21.4 (21.1 to 21.7)	18.8 (18.5 to 19.0)	23.8 (23.6 to 24.1)	-1.3 (-1.7 to -0.9)*	3.8 (2.8 to 4.8)*
Hypertensive Heart Disease	Black women	24.4 (23.6 to 25.2)	20.2 (19.6 to 20.9)	22.3 (21.7 to 22.9)	-1.4 (-1.8 to -1.0)*	0.7 (-1.0 to 2.3)
	White women	7.4 (7.3 to 7.6)	8.1 (8.0 to 8.2)	11.8 (11.6 to 11.9)	0.9 (0.5 to 1.3)*	5.6 (4.3 to 7.0)*
	Black men	30.2 (29.1 to 31.4)	29.7 (28.7 to 30.6)	35.3 (34.4 to 36.3)	0.3 (-0.5 to 1.1)	1.8 (0.9 to 2.6)*
	White men	7.8 (7.6 to 8.0)	10.4 (10.2 to 10.5)	15.7 (15.5 to 15.9)	2.5 (2.0 to 3.0)*	6.3 (4.9 to 9.4)*
Valvular Heart Disease	Black women	5.1 (4.8 to 5.5)	4.0 (3.7 to 4.3)	3.8 (3.5 to 4.1)	-1.8 (-2.1 to -1.5)*	-1.8 (-2.1 to -1.5)*
	White women	7.1 (7.0 to 7.2)	6.7 (6.6 to 6.8)	6.1 (6.0 to 6.2)	-0.4 (-0.6 to -0.2)*	-1.5 (-2.5 to -0.4)*
	Black men	5.4 (4.9 to 5.9)	4.2 (3.8 to 4.6)	4.2 (3.8 to 4.5)	-1.5 (-2.0 to -0.9)*	-1.5 (-2.0 to -0.9)*
	White men	7.8 (7.6 to 8.0)	7.6 (7.5 to 7.8)	6.9 (6.7 to 7.0)	0.1 (-0.2 to 0.4)	-1.6 (-3.1 to 0.0)
Arrhythmia	Black women	6.5 (6.1 to 6.9)	6.5 (6.2 to 6.9)	7.0 (6.7 to 7.4)	0.4 (-1.4 to 2.3)	0.9 (-0.1 to 1.9)
	White women	6.2 (6.1 to 6.3)	8.1 (8.0 to 8.3)	8.8 (8.7 to 9.0)	2.0 (1.7 to 2.3)*	2.0 (1.7 to 2.3)*
	Black men	8.9 (8.2 to 9.6)	8.2 (7.7 to 8.8)	9.3 (8.8 to 9.8)	0.1 (-0.3 to 0.5)	0.1 (-0.3 to 0.5)
	White men	7.4 (7.2 to 7.5)	8.5 (8.3 to 8.7)	10.1 (9.9 to 10.2)	1.0 (0.5 to 1.6)*	2.7 (2.3 to 3.2)*
Pulmonary Heart Disease	Black women	8.9 (8.4 to 9.4)	7.0 (6.6 to 7.4)	8.3 (7.9 to 8.7)	-1.5 (-2.2 to -0.8)*	1.1 (0.4 to 1.8)*
	White women	4.6 (4.5 to 4.7)	4.3 (4.2 to 4.4)	4.6 (4.5 to 4.7)	-0.7 (-1.5 to -0.2)*	1.4 (1.1 to 1.8)*
	Black men	8.4 (7.8 to 9.0)	6.4 (6.0 to 6.9)	7.3 (6.9 to 7.7)	-2.1 (-3.0 to -1.2)*	1.3 (0.2 to 2.4)*
	White men	4.5 (4.3 to 4.6)	3.7 (3.6 to 3.8)	4.1 (4.0 to 4.2)	-1.8 (-2.5 to -1.0)*	2.1 (1.1 to 3.0)*
Other Heart Disease	Black women	29.9 (29.1 to 30.8)	21.7 (21.0 to 22.3)	21.3 (20.7 to 21.9)	-2.4 (-2.7 to -2.1)*	-0.7 (-1.5 to 0.1)
	White women	17.6 (17.4 to 17.9)	13.4 (13.2 to 13.6)	12.8 (12.6 to 13.0)	-2.2 (-2.7 to -1.7)*	-0.6 (-2.6 to 1.6)
	Black men	50.2 (48.8 to 51.7)	35.4 (34.3 to 36.5)	36.4 (35.5 to 37.4)	-2.5 (-2.9 to -2.2)*	0.1 (-0.8 to 0.9)
	White men	27.1 (26.8 to 27.4)	21.4 (21.1 to 21.7)	20.2 (20.0 to 20.4)	-1.8 (-2.2 to -1.4)*	-0.7 (-1.0 to -0.4)*

CI: Confidence interval. AAMR: Age-adjusted mortality rate per 100,000 population. Mean annual percentage change shown for AAMR for the specified time range. *Indicates that the mean annual percent change is significantly different from zero, p<0.05.

Supplemental Table 3. Trends in age-adjusted mortality rates from total and cause-specific heart disease deaths stratified by race-sex subgroups in decedents <45 years in the US, 1999-2018

Heart Disease Subtype		AAMR per 100,000			Mean Annual Percent Change (95% CI)	
		1999	2011	2018	1999-2011	2011-2018
Total Heart Disease	**Black women**	15.6	12.2	12.1	-2.2 (-2.7 to -1.8)*	0.0 (-1.2 to 1.3)
	White women	5.2	4.9	4.9	-0.7 (-1.2 to -0.3)*	0.5 (-0.3 to 1.3)
	Black men	27.4	22.6	23.4	-1.0 (-1.2 to -0.7)*	-1.0 (-1.2 to -0.7)*
	White men	12.5	11.1	10.2	-1.0 (-1.5 to -0.4)*	-0.9 (-1.6 to -0.1)*
Ischemic Heart Disease	**Black women**	4.9	3.2	3.0	-2.8 (-3.3 to -2.3)*	-2.8 (-3.3 to -2.3)*
	White women	2.0	1.7	1.5	-0.8 (-2.1 to 0.4)	-2.2 (-4.6 to 0.2)
	Black men	11.3	8.4	7.8	-2.0 (-2.3 to -1.7)*	-2.0 (-2.3 to -1.7)*
	White men	7.2	5.6	4.4	-2.1 (-2.6 to -1.5)*	-3.2 (-3.4 to -3.0)*
Heart Failure	**Black women**	0.5	0.7	0.8	2.1 (-5.0 to 9.6)	1.7 (-1.9 to 5.5)
	White women	0.1	0.1	0.2	0.2 (-2.8 to 3.2)	0.2 (-2.8 to 3.2)
	Black men	0.7	1.0	1.7	2.8 (0.0 to 5.6)*	8.8 (5.7 to 12.0)*
	White men	0.2	0.2	0.4	2.8 (1.4 to 4.2)*	2.8 (1.4 to 4.2)*
Hypertensive Heart Disease	**Black women**	2.2	2.6	2.6	0.6 (0.1 to 1.1)*	0.6 (0.1 to 1.1)*
	White women	0.2	0.4	0.6	4.7 (3.6 to 5.8)*	4.7 (3.6 to 5.8)*
	Black men	3.6	4.6	5.1	1.8 (1.3 to 2.3)*	1.8 (1.3 to 2.3)*
	White men	0.7	1.2	1.5	5.2 (3.7 to 6.7)*	2.7 (2.0 to 3.3)*
Valvular Heart Disease	**Black women**	0.5	0.4	0.3	-4.5 (-6.1 to -2.8)*	-4.5 (-6.1 to -2.8)*
	White women	0.3	0.2	0.2	-0.2 (-1.9 to 1.5)	-0.2 (-1.9 to 1.5)
	Black men	0.6	0.3	0.5	-4.1 (-5.6 to -2.5)*	3.6 (-4.9 to 12.8)
	White men	0.3	0.3	0.3	-0.1 (-0.1 to -0.1)*	0.8 (0.8 to 0.8)*
Arrhythmia	**Black women**	0.6	0.4	0.4	-1.6 (-2.8 to -0.4)*	-1.6 (-2.8 to -0.4)*
	White women	0.3	0.3	0.3	-0.4 (-1.6 to 0.8)	-0.4 (-1.6 to 0.8)
	Black men	0.8	0.9	0.8	0.2 (-0.6 to 1.1)	0.2 (-0.6 to 1.1)
	White men	0.4	0.4	0.4	-0.5 (-4.6 to 3.9)	0.1 (-1.1 to 1.3)
Pulmonary Heart Disease	**Black women**	2.2	1.7	1.8	-1.0 (-1.6 to -0.3)*	-1.0 (-1.6 to -0.3)*
	White women	0.8	0.7	0.7	-2.1 (-3.6 to -0.7)*	0.5 (-1.2 to 2.3)
	Black men	1.5	1.3	1.4	-0.8 (-1.8 to 0.2)	-0.8 (-1.8 to 0.2)
	White men	0.7	0.5	0.6	-1.7 (-2.7 to -0.8)*	3.2 (1.3 to 5.1)*
Other Heart Disease	**Black women**	4.7	3.3	3.2	-3.1 (-3.7 to -2.5)*	-0.7 (-2.2 to 0.9)
	White women	1.5	1.4	1.4	0.1 (-0.5 to 0.3)	0.1 (-0.5 to 0.3)
	Black men	8.8	6.0	6.1	-2.6 (-5.1 to 0.0)*	-0.4 (-0.4 to 1.2)
	White men	3.0	2.9	2.6	-0.8 (-1.0 to -0.5)*	-0.8 (-1.0 to -0.5)*

CI: Confidence interval. AAMR: Age-adjusted mortality rate per 100,000 population. Mean annual percentage change shown for AAMR for the specified time range. Total includes all decedents of all race/ethnicity groups. *Indicates that the mean annual percent change is significantly different from zero, p<0.05.

Supplemental Table 4. Trends in age-adjusted mortality rates from total and cause-specific heart disease deaths stratified by race-sex subgroups in decedents 45-64 years in the US, 1999-2018

Heart Disease Subtype		AAMR per 100,000			Mean Annual Percent Change (95% CI)	
		1999	2011	2018	1999-2011	2011-2018
Total Heart Disease	Black women	209.1	137.8	140.9	-3.4 (-4.2 to -2.6)*	0.3 (-0.4 to 1.0)
	White women	83.7	63.1	64.5	-2.2 (-2.5 to -2.0)*	0.5 (0.1 to 0.9)*
	Black men	414.1	278.8	288.1	-3.3 (-3.6 to -3.1)*	0.3 (-0.3 to 0.9)
	White men	222.2	166.2	165.3	-2.4 (-2.7 to -2.1)*	-0.1 (-0.4 to 0.2)
Ischemic Heart Disease	Black women	124.6	70.3	63.9	-4.9 (-5.6 to -4.1)*	-1.2 (-1.8 to -0.6)*
	White women	57.7	37.9	35.6	-3.3 (-3.5 to -3.0)*	-0.8 (-1.2 to -0.3)*
	Black men	273.2	160.4	149.7	-4.2 (-4.6 to -3.8)*	-1.1 (-1.6 to -0.5)*
	White men	176.0	118.3	108.3	-3.2 (-3.4 to -3.0)*	-1.4 (-1.7 to -1.2)*
Heart Failure	Black women	9.0	7.9	12.3	-1.2 (-3.0 to 0.6)	7.0 (5.1 to 8.9)*
	White women	3.2	3.0	4.0	-1.5 (-2.2 to -0.7)*	4.5 (2.7 to 6.4)*
	Black men	14.1	13.4	21.0	0.4 (-1.1 to 2.0)	6.5 (4.9 to 8.2)*
	White men	5.1	4.8	7.3	-0.6 (-1.3 to 0.1)	5.8 (4.2 to 7.5)*
Hypertensive Heart Disease	Black women	24.7	23.5	26.1	0.0 (-1.4 to 0.5)	0.0 (-1.4 to 0.5)
	White women	3.5	5.5	7.2	4.1 (3.7 to 4.5)*	4.1 (3.7 to 4.5)*
	Black men	41.0	45.8	51.4	1.3 (-0.4 to 2.9)	1.0 (0.4 to 1.6)*
	White men	7.3	13.6	17.6	5.6 (4.9 to 6.3)*	3.6 (3.3 to 3.9)*
Valvular Heart Disease	Black women	4.1	2.7	1.7	-2.4 (-3.1 to -1.6)*	-2.4 (-3.1 to -1.6)*
	White women	1.9	1.5	1.6	-1.6 (-2.2 to -1.1)*	0.7 (-0.6 to 1.9)
	Black men	5.2	3.7	4.0	-2.4 (-3.2 to -1.6)*	-2.4 (-3.2 to -1.6)*
	White men	2.7	2.7	2.7	0.1 (-0.3 to 0.6)	0.1 (-0.3 to 0.6)
Arrhythmia	Black women	4.5	4.1	4.6	-0.1 (-0.7 to 0.6)	-0.1 (-0.7 to 0.6)
	White women	2.1	2.5	2.5	1.2 (0.7 to 1.7)*	1.2 (0.7 to 1.7)*
	Black men	7.9	6.7	8.4	-1.8 (-2.9 to -0.7)*	3.2 (1.5 to 5.0)*
	White men	3.9	4.1	5.1	0.5 (-0.3 to 1.3)	3.4 (2.6 to 4.1)*
Pulmonary Heart Disease	Black women	11.3	8.4	8.7	-2.0 (-3.0 to -0.9)*	0.8 (-0.3 to 1.8)
	White women	4.2	3.6	3.7	-2.1 (-2.8 to -1.4)*	1.6 (-0.3 to 3.6)
	Black men	9.9	8.1	8.3	-2.1 (-3.1 to -1.2)*	1.9 (0.7 to 3.1)*
	White men	4.4	3.8	4.1	-1.4 (-2.2 to -0.6)*	1.9 (1.1 to 2.7)*
Other Heart Disease	Black women	31.2	21.1	22.7	-2.7 (-3.2 to -2.1)*	0.5 (-0.9 to 1.9)
	White women	11.2	9.2	9.6	-1.3 (-1.8 to -0.8)*	1.0 (0.5 to 1.5)*
	Black men	63.5	41.2	45.2	-3.0 (-3.4 to -2.6)*	1.0 (0.0 to 2.0)*
	White men	23.1	19.1	20.1	-1.3 (-1.7 to -0.9)*	0.4 (0.0 to 0.7)*

CI: Confidence interval. AAMR: Age-adjusted mortality rate per 100,000 population. Mean annual percentage change shown for AAMR for the specified time range. *Indicates that the mean annual percent change is significantly different from zero, p<0.05.

Supplemental Table 5. Trends in age-adjusted mortality rates from total and cause-specific heart disease deaths stratified by race-sex subgroups in decdents ≥65 years in the US, 1999-2018

Heart Disease Subtype		AAMR per 100,000			Mean Annual Percent Change (95% CI)	
		1999	2011	2018	1999-2011	2011-2018
Total Heart Disease	**Black women**	1797.1	1089.0	973.7	-4.1 (-4.5 to -3.7)*	-1.6 (-2.0 to -1.2)*
	White women	1509.8	943.7	863.1	-4.1 (-4.3 to -3.8)*	-1.1 (-1.7 to -0.6)*
	Black men	2353.2	1499.5	1426.5	-3.6 (-3.9 to -3.4)*	-0.9 (-1.2 to -0.6)*
	White men	2133.2	1366.5	1289.3	-4.2 (-4.2 to -3.1)*	-0.8 (-1.1 to -0.4)*
Ischemic Heart Disease	**Black women**	1243.0	649.2	489.0	-5.2 (-5.6 to -4.9)*	-4.0 (-4.5 to -3.5)*
	White women	1079.3	558.0	434.1	-5.5 (-5.9 to -5.0)*	-3.4 (-3.9 to -2.9)*
	Black men	1667.2	952.4	789.1	-4.7 (-5.1 to -4.2)*	-2.7 (-3.2 to -2.3)*
	White men	1641.3	922.5	780.7	-4.7 (-5.2 to -4.2)*	-2.4 (-2.8 to -2.0)*
Heart Failure	**Black women**	146.6	117.3	144.3	-1.8 (-2.7 to -0.8)*	3.2 (2.4 to 4.0)*
	White women	146.3	118.7	140.0	-1.8 (-2.6 to -0.9)*	2.6 (2.0 to 3.1)*
	Black men	171.7	135.2	183.1	-1.7 (-2.2 to -1.3)*	4.1 (3.1 to 5.2)*
	White men	159.0	139.1	173.6	-1.3 (-1.8 to -0.9)*	3.6 (2.6 to 4.7)*
Hypertensive Heart Disease	**Black women**	138.5	105.7	117.6	-2.0 (-2.4 to -1.6)*	0.6 (-1.0 to 2.3)
	White women	51.6	52.2	77.8	0.3 (0.0 to 0.6)	5.8 (4.3 to 7.3)*
	Black men	148.5	130.4	162.9	-0.6 (-2.4 to 1.2)	2.5 (1.4 to 3.6)*
	White men	45.3	51.8	85.1	1.2 (0.6 to 1.9)*	7.4 (5.7 to 9.1)*
Valvular Heart Disease	**Black women**	30.7	24.8	24.3	-1.5 (-1.9 to -1.2)*	-1.5 (-1.9 to -1.2)*
	White women	51.5	49.2	44.1	-0.3 (-0.5 to 0.1)*	-1.7 (-2.9 to -0.5)*
	Black men	30.6	25.0	23.7	-1.1 (-1.7 to -0.4)*	-1.1 (-1.7 to -0.4)*
	White men	55.3	54.1	47.8	0.1 (-0.2 to 0.5)	-1.9 (-3.6 to -0.1)*
Arrhythmia	**Black women**	40.1	42.2	45.5	0.7 (-1.3 to 2.6)	1.0 (-0.1 to 2.0)
	White women	44.0	58.7	64.1	2.1 (1.8 to 2.4)*	2.1 (1.8 to 2.4)*
	Black men	52.5	48.5	54.4	0.1 (-0.4 to 0.6)	0.1 (-0.4 to 0.6)
	White men	49.2	57.8	68.9	1.2 (0.6 to 1.8)*	2.8 (2.3 to 3.3)*
Pulmonary Heart Disease	**Black women**	42.4	33.5	40.9	-1.3 (-2.1 to -0.5)*	2.2 (0.7 to 3.8)*
	White women	25.9	25.3	26.2	0.0 (-1.3 to 1.3)	1.5 (1.2 to 1.8)*
	Black men	45.1	32.6	35.9	-2.1 (-3.4 to -0.9)*	0.9 (-0.6 to 2.5)
	White men	26.6	21.7	22.3	-1.8 (-2.7 to -0.9)*	2.1 (1.0 to 3.2)*
Other Heart Disease	**Black women**	157.7	117.3	112.1	-2.3 (-2.6 to -1.9)*	-1.1 (-1.9 to -0.3)*
	White women	112.3	82.6	76.9	-2.5 (-3.0 to -1.9)*	-1.0 (-3.2 to 1.1)
	Black men	240.5	176.8	177.3	-2.4 (-2.8 to -1.9)*	-0.1 (-1.2 to 1.0)
	White men	158.5	120.9	111.0	-2.1 (-2.6 to -1.6)*	-1.0 (-1.4 to -0.6)*

CI: Confidence interval. AAMR: Age-adjusted mortality rate per 100,000 population. Mean annual percentage change shown for AAMR for the specified time range. *Indicates that the mean annual percent change is significantly different from zero, $p < 0.05$.

Supplemental Table 6. Trends in age-adjusted mortality rates from total and cause-specific heart disease deaths stratified by race-sex subgroups in decedents 65-84 years in the US, 1999-2018

Heart Disease Subtype		AAMR per 100,000			Mean Annual Percent Change (95% CI)	
		1999	2011	2018	1999-2011	2011-2018
Total Heart Disease	Total	1166.1	696.5	641.5	-4.3 (-4.7 to -3.8)*	-1.0 (-1.3 to -0.8)*
	Black women	1300.3	743.4	675.7	-4.8 (-5.0 to -4.6)*	-1.4 (-1.9 to -0.8)*
	White women	889.4	524.8	466.5	-4.5 (-4.7 to -4.3)*	-1.4 (-1.9 to -0.9)*
	Black men	1862.9	1171.2	1144.1	-3.8 (-4.0 to -3.6)*	-0.7 (-1.2 to -0.1)*
	White men	1498.8	892.6	833.2	-4.2 (-4.5 to -3.8)*	-0.9 (-1.2 to -0.7)*
Ischemic Heart Disease	Total	879.6	459.2	381.0	-5.3 (-5.7 to -4.9)*	-2.7 (-2.9 to -2.4)*
	Black women	898.9	444.5	343.9	-5.8 (-6.5 to -5.0)*	-3.5 (-4.1 to -3.0)*
	White women	646.9	321.1	252.4	-5.7 (-6.1 to -5.2)*	-3.5 (-3.9 to -3.2)*
	Black men	1329.7	746.8	644.2	-4.8 (-5.5 to -4.2)*	-2.2 (-2.8 to -1.5)*
	White men	1180.7	626.5	533.8	-5.1 (-5.5 to -4.7)*	-2.2 (-2.5 to -1.9)*
Heart Failure	Total	76.6	61.6	74.0	-2.0 (-2.7 to -1.3)*	3.0 (1.2 to 4.8)*
	Black women	92.4	69.6	88.0	-2.4 (-3.1 to -1.7)*	4.0 (2.3 to 5.7)*
	White women	67.9	54.0	60.7	-2.0 (-2.9 to -1.0)*	2.1 (1.5 to 2.8)*
	Black men	111.3	91.8	128.2	-1.3 (-1.8 to -0.8)*	4.4 (3.2 to 5.6)*
	White men	86.1	71.0	88.6	-1.7 (-2.1 to -1.3)*	3.6 (2.6 to 4.6)*
Hypertensive Heart Disease	Total	35.8	34.4	49.0	-0.2 (-0.7 to 0.4)	4.8 (4.2 to 5.5)*
	Black women	103.5	72.1	79.1	-2.6 (-3.1 to -2.1)*	0.6 (-0.6 to 1.9)
	White women	27.9	26.1	37.1	-0.5 (-1.1 to 0.1)	5.3 (3.1 to 7.5)*
	Black men	124.0	107.5	133.9	-0.4 (-1.0 to 0.2)	1.7 (0.2 to 3.2)*
	White men	30.3	33.8	52.7	1.0 (-0.1 to 2.2)	6.2 (5.6 to 6.9)*
Valvular Heart Disease	Total	28.8	23.3	20.1	-1.6 (-1.8 to -1.4)*	-1.6 (-1.8 to -1.4)*
	Black women	21.5	16.1	15.4	-2.3 (-2.7 to -2.0)*	-2.3 (-2.7 to -2.0)*
	White women	27.6	23.1	19.2	-1.5 (-1.7 to -1.3)*	-2.6 (-3.7 to -1.5)*
	Black men	24.0	16.4	15.7	-1.6 (-2.3 to -0.9)*	-1.6 (-2.3 to -0.9)*
	White men	32.5	26.8	23.4	-1.2 (-1.5 to -0.9)*	-1.2 (-1.5 to -0.9)*
Arrhythmia	Total	27.2	30.7	33.5	1.0 (-1.3 to 3.4)	1.9 (1.4 to 2.4)*
	Black women	27.3	25.9	29.6	-0.2 (-0.7 to 0.3)	-0.2 (-0.7 to 0.3)
	White women	24.2	29.7	30.5	1.3 (1.0 to 1.6)*	1.3 (1.0 to 1.6)*
	Black men	39.2	33.9	40.8	0.2 (-0.4 to 0.9)	0.2 (-0.4 to 0.9)
	White men	31.0	34.1	39.1	0.9 (-0.2 to 2.0)	1.8 (0.3 to 3.4)*
Pulmonary Heart Disease	Total	20.9	17.4	18.3	-1.3 (-2.7 to 0.1)	1.0 (0.5 to 1.6)*
	Black women	36.2	27.7	33.9	-1.8 (-2.5 to -1.0)*	2.1 (0.6 to 3.6)*
	White women	20	17.7	18.1	-0.7 (-2.3 to 0.9)	0.6 (0.2 to 1.0)*
	Black men	38.2	27.2	31.7	-2.2 (-3.6 to -0.8)*	1.6 (-0.2 to 3.4)
	White men	19.8	15.8	16.4	-2.3 (-3.2 to -1.4)*	1.5 (0.3 to 2.6)*
Other Heart Disease	Total	97.2	69.8	65.6	-2.6 (-2.9 to -2.2)*	-1.1 (-1.4 to -0.8)*
	Black women	120.5	87.5	85.8	-2.5 (-3.1 to -2.0)*	-0.6 (-1.8 to 0.6)
	White women	74.9	53	48.4	-2.7 (-3.2 to -2.2)*	-1.2 (-1.6 to -0.8)*
	Black men	196.5	147.5	149.6	-2.5 (-3.7 to -1.3)*	0.2 (-1.2 to 1.7)
	White men	118.4	84.5	79.1	-2.6 (-3.0 to -2.2)*	-1.1 (-1.5 to -0.8)*

CI: Confidence interval. AAMR: Age-adjusted mortality rate per 100,000 population. Mean annual percentage change shown for AAMR for the specified time range. *Indicates that the mean annual percent change is significantly different from zero, p<0.05.

Supplemental Table 7. Years of potential life lost from total heart disease (using age 85 as the referent) in the overall US population and in race-sex subgroups, 1999-2018.

	Race-Sex Group	Years of Potential Life Lost (per 100,000 population)			Mean Annual Percent Change (95% CI)	
		1999	2011	2018	1999-2011	2011-2018
Total Heart Disease	**Total**	2512.0	1731.0	1694.8	-3.1 (-3.2 to -2.9)*	-0.4 (-0.6 to -0.1)*
	Black women	3179.9	2030.5	1988.9	-3.7 (-4.5 to -2.9)*	-0.3 (-0.7 to 0.1)
	White women	1495.8	1025.1	995.7	-3.1 (-3.3 to -3.0)*	-0.2 (-0.5 to 0.2)
	Black men	5597.2	3779.2	3864.5	-3.1 (-3.5 to -2.8)*	0.1 (-0.3 to 0.6)
	White men	3305.7	2285.0	2211.6	-3.0 (-3.2 to -2.9)*	-0.4 (-0.7 to -0.2)*

CI: Confidence interval. Mean annual percentage change shown for years of potential life lost for the specified time range. *Indicates that the mean annual percent change is significantly different from zero, p<0.05.

Supplemental Table 8. Heart failure-related cardiovascular mortality trends by race, sex, and age in the US, 1999-2018

|	Race-Sex Group	AAMR or YPLL per 100,000			Mean Annual Percent Change (95% CI)	
		1999	2011	2018	1999-2011	2011-2018
AAMR (All Ages)	**Total**	74.6	53.3	58.1	-2.8 (-3.5 to -2.1)*	1.3 (0.6 to 1.9)*
	Black women	67.6	48.5	53.3	-2.9 (-3.7 to -2.2)*	1.7 (0.8 to 2.6)*
	White women	67.5	47.3	50.3	-3.0 (-4.0 to -2.1)*	0.9 (0.1 to 1.7)*
	Black men	82.1	61.3	73.6	-2.4 (-2.8 to -1.9)*	2.7 (2.2 to 3.2)*
	White men	86.3	63.2	70.4	-2.5 (-3.2 to -1.9)*	1.5 (1.2 to 1.9)*
AAMR (<45)	**Total**	0.8	0.9	1.2	0.0 (-1.4 to 1.4)	4.9 (3.1 to 6.7)*
	Black women	1.9	1.7	2	-0.6 (-1.2 to 0.0)*	2.0 (0.9 to 3.2)*
	White women	0.5	0.5	0.6	-1.5 (-2.9 to -0.2)*	4.2 (1.5 to 6.9)*
	Black men	2.6	3.1	4.3	1.1 (-1.4 to 3.7)	4.8 (2.8 to 6.9)*
	White men	0.8	0.8	1.1	-0.1 (-1.9 to 1.8)	4.5 (2.8 to 6.3)*
AAMR (45-64)	**Total**	20.1	15.1	20.2	-2.5 (-2.8 to -2.3)*	4.3 (3.7 to 5.0)*
	Black women	32	25.1	32	-2.1 (-3.1 to -1.0)*	3.8 (2.7 to 4.9)*
	White women	12.3	8.9	11.1	-3.2 (-3.7 to -2.8)*	3.7 (2.6 to 4.8)*
	Black men	52.8	41.4	58	-1.6 (-2.5 to -0.7)*	4.8 (3.8 to 5.9)*
	White men	24.1	17.6	23.6	-2.7 (-3.0 to -2.5)*	4.5 (3.9 to 5.1)*
AAMR (≥65)	**Total**	550.5	390.6	418.4	-2.9 (-3.6 to -2.1)*	1.0 (0.4 to 1.6)*
	Black women	468.7	330.8	354.8	-3.1 (-3.9 to -2.3)*	1.4 (0.5 to 2.3)*
	White women	510	356.2	375.4	-3.0 (-4.0 to -2.1)*	0.8 (0.0 to 1.6)*
	Black men	543.7	396.4	458.6	-2.6 (-3.1 to -2.1)*	2.2 (1.6 to 2.8)*
	White men	636	465.3	509.9	-2.6 (-3.3 to -1.8)*	1.3 (0.9 to 1.7)*
YPLL	**Total**	203	150	189	-2.8 (-3.1 to -2.5)*	3.7 (3.3 to 4.1)*
	Black women	284	218	268	-2.3 (-3.1 to 1.6)*	3.3 (2.5 to 4.1)*
	White women	189	131	152	-3.2 (-4.3 to -2.1)*	2.3 (1.4 to 3.2)*
	Black men	257	226	312	-1.0 (-1.8 to -0.2)*	4.8 (3.9 to 5.7)*
	White men	195	140	178	-2.9 (-3.1 to -2.7)*	3.9 (3.4 to 4.3)*

CI: Confidence interval. AAMR: Age-adjusted mortality rate per 100,000 population. YPLL: Years of potential life lost per 100,000 population. Mean annual percentage change shown for AAMR or YPLL for the specified time range. *Indicates that the mean annual percent change is significantly different from zero, p<0.05.

Supplemental Table 9. Summary of complementary mortality statistics (total number, relative proportion, age-adjusted mortality rate, and years of potential life lost) for total and cause-specific heart disease deaths in the US for 2018

|	Number of decedents	Percent of Total Heart Disease deaths	AAMR per 100,000 (95% CI)	YPLL per 100,000
Total Heart Disease	655381	100%	163.6 (163.2 to 164.0)	1068
Ischemic Heart Disease	365744	55.8%	90.9 (90.6 to 91.2)	578
Heart Failure	83616	12.8%	20.8 (20.7 to 20.9)	64
Hypertensive Heart Disease	60041	9.2%	15.1 (15.0 to 15.2)	132
Valvular Heart Disease	24337	3.7%	6.1 (6.0 to 6.2)	293*
Arrhythmia	36417	5.6%	9.1 (9.0 to 9.2)	
Pulmonary Heart Disease	18026	2.8%	4.6 (4.6 to 4.7)	
Other Heart Disease	67200	10.3%	17.1 (16.9 to 17.2)	

AAMR: Age-adjusted mortality rate per 100,000; CI: confidence interval; YPLL: years of potential life lost. Data displayed are overall (in all race, sex, age, and geography groups). *Aggregate YPLL for "remainder heart disease subtypes."

Supplemental Figure 1. Age-adjusted mortality rates due to total and cause-specific heart disease deaths by county-level urbanization in the US, 1999-2018

A. Rural

B. Urban
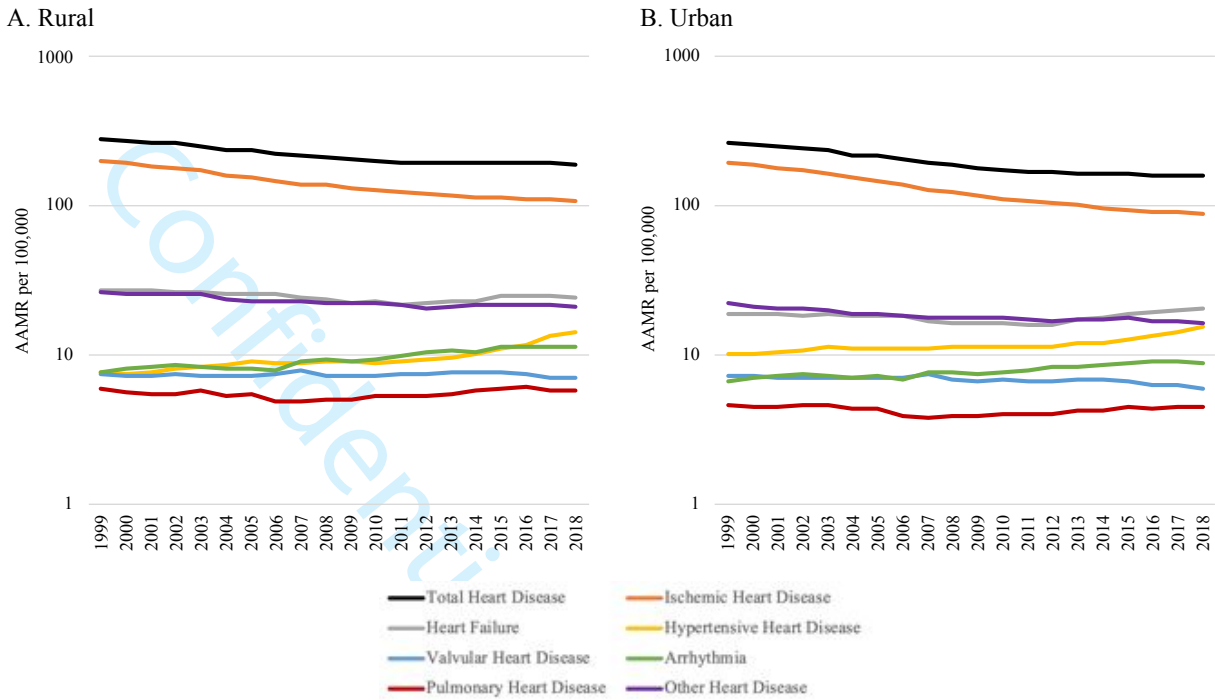
AAMR: Age-adjusted mortality rates. AAMR is displayed on a logarithmic scale.

Supplemental Figure 2. Age-adjusted mortality rates due to total and cause-specific heart disease deaths by census region in the US, 1999-2018
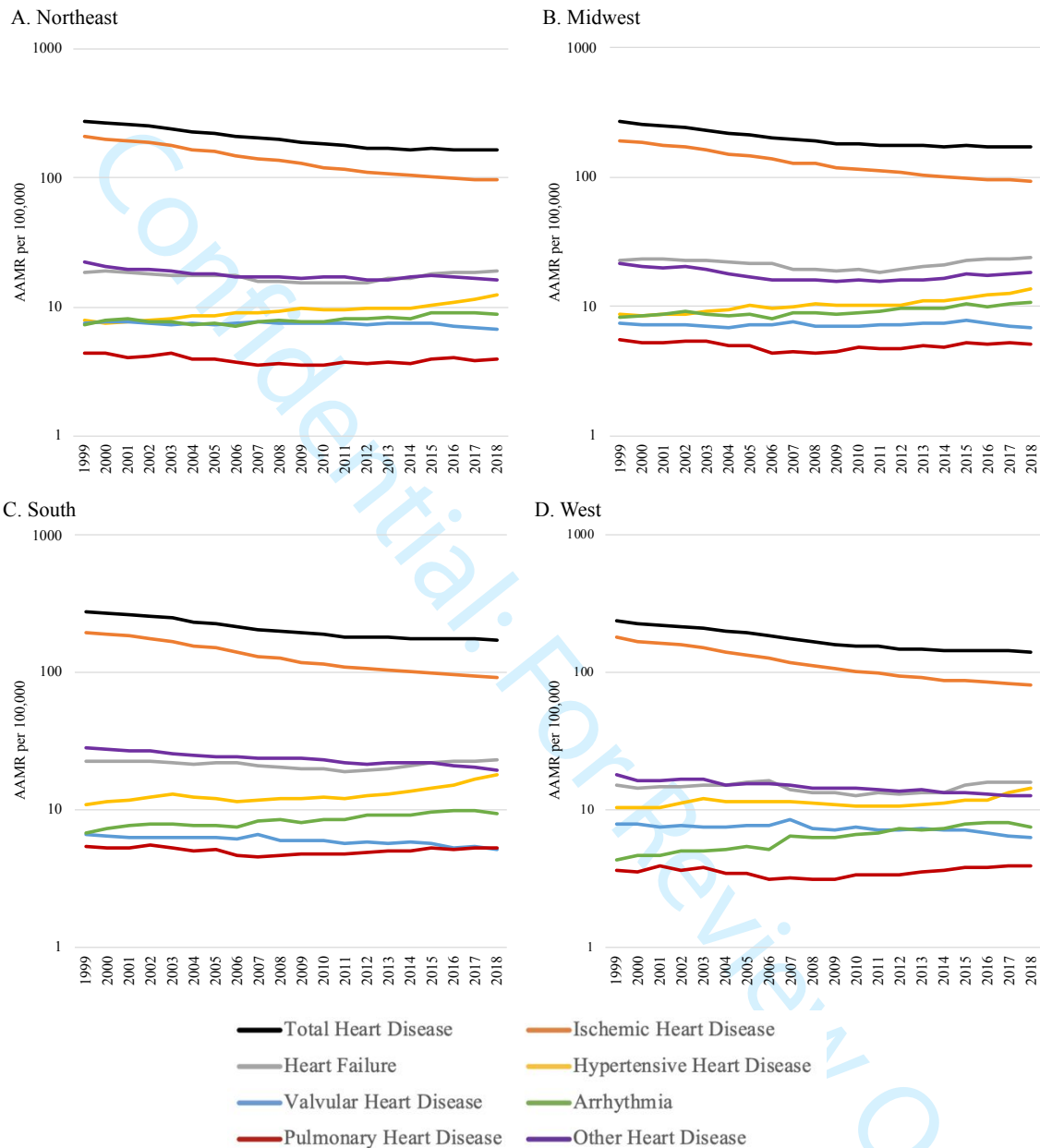
AAMR: Age-adjusted mortality rates. AAMR is displayed on a logarithmic scale. The Northeast region includes Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont. The Midwest region includes Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin. The South region includes Alabama, Arkansas, Delaware, the District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia. The West region includes Alaksa, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

Supplemental Figure 3. Age-standardized years of potential life lost per 100,000 population attributable to total heart disease, ischemic heart disease, heart failure, and hypertensive heart disease in the total population and stratified by race-sex subgroups in the US, 1999-2018

A. Total heart disease

B. Ischemic heart disease

C. Heart failure

D. Hypertensive heart disease

—Total population —Black women —White women —Black men —White men
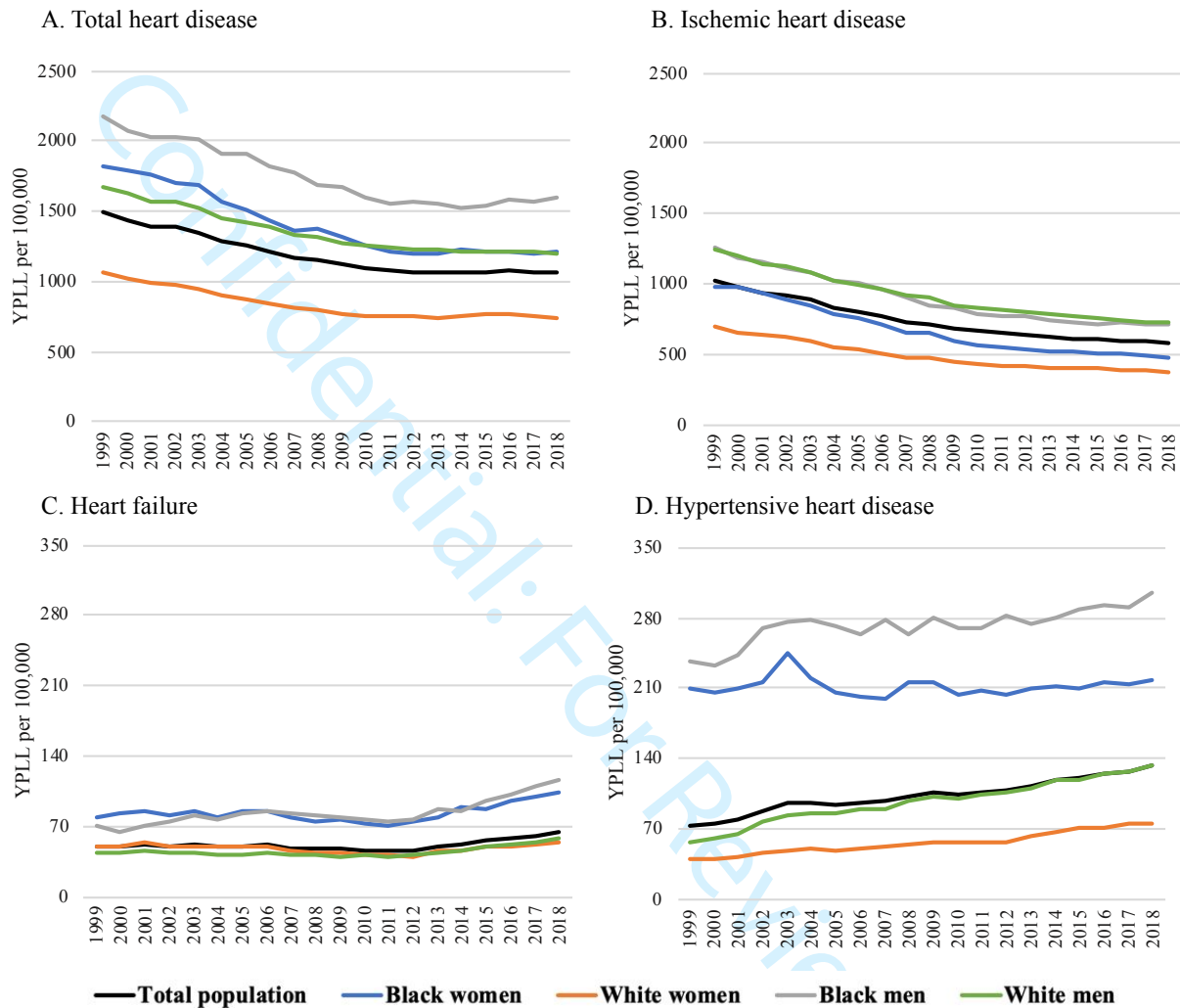
Years of potential life lost (YPLL) per 100,000 shown for (A) total heart disease, (B) ischemic heart disease, (C) heart failure, and (D) hypertensive heart disease, in black and white women and men. Average annual percentage change of YPLL before and after 2011 are listed in Table 3.