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ORIGINAL RESEARCH

Demographic, Regional, and State-Level Trends of Mortality in Patients With Aortic Stenosis in United States, 2008 to 2018

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BACKGROUND: Aortic stenosis–related mortality might vary across demographic subsets, regions, and states in the United States.

METHODS AND RESULTS: We reviewed the death certificate data from the Centers for Disease Control and Prevention Wide-Ranging OnLine Data for Epidemiologic Research database to examine aortic stenosis–related mortality trends from 2008 to 2018. Crude and age-adjusted mortality rates (AAMRs) per 100 000 people and annual percentage change with 95% CIs were calculated. Between 2008 and 2018, AAMR reduced from 12.7 to 11.5 (average annual percentage change, −1.0 [95% CI, −1.5 to −0.5]), because of an accelerated decline between 2015 and 2018 (annual percentage change, −4.4 [95% CI, −6.0 to −2.7]). Older (aged >85 years), male, and White patients had higher death rates than younger, female, and non-White patients, respectively. Although mortality reduction was similar across sexes, significant mortality reduction was limited to White patients only. The AAMRs were higher in rural than urban areas. States with AAMRs >90th percentile were distributed in the West and the Northeast, and <10th percentile in the South. The AAMRs for sex and race were highest in the West and lowest in the South. None of the states located in the Midwest showed a significant reduction in mortality. Mortality remained stable for hospital setting and nursing home/long-term care facility, except that the number of deaths increased at home and hospice facility since 2014.

CONCLUSIONS: The reduction in mortality in patients with aortic stenosis was not consistent among demographic subsets and states. The substantial public health and economic implications call for determination of underlying clinical and socioeconomic factors to narrow the gap.

Key Words: aortic stenosis ■ epidemiology ■ mortality

Aortic stenosis (AS) is one of the most common valvular problems associated with significant morbidity and mortality in the United States.[1,2] Before transcatheter aortic valve replacement (TAVR) therapy, surgical aortic valve replacement (AVR) was considered the gold standard to improve the prognosis.[3] Consequently, a significant proportion of elderly patients with significant multimorbidity burden were left untreated. There has been a significant improvement in life expectancy in older patients after TAVR.[1] However, the survival benefit does not appear to be similar in non-White compared with White patients.[1,4] Moreover, geographical variations in the use of TAVR have demonstrated contrasting patterns of in-hospital mortality in the US regions.[5]

Prior data through 2017 suggested that AS-related mortality did not improve in nonmetropolitan populations.[1] In view of striking regional socioeconomic

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CLINICAL PERSPECTIVE

What Is New?

- Between 2008 and 2018, aortic stenosis–related mortality reduced in the United States, because of an accelerated decline between 2015 and 2018.
- Demographic differences existed, whereas geographical patterns demonstrated higher burden of mortality in the rural areas or states located in the West and the Northeast.

What Are the Clinical Implications?

- The demographic and regional variations in aortic stenosis mortality might have stemmed from clinical and behavioral heterogeneities as well as socioeconomic disparities, and limited health care access among patients.
- The substantial public health implications call for identification of underlying clinical and social determinants of health to narrow the differences in aortic stenosis mortality.

Nonstandard Abbreviations and Acronyms

AS	aortic stenosis
APC	annual percentage change
AAPC	average annual percentage change
AAMR	age-adjusted mortality rate
AVR	aortic valve replacement
TAVR	transcatheter aortic valve replacement

disparities and variations in TAVR volumes,[5,6] it is imperative to identify the patterns of AS-related mortality at the state level in the United States. Moreover, because prior data primarily focused on mortality trends in the inpatient setting,[4,5] assessment of contemporary trends for individuals with AS is warranted. Death certificates remain the key data source for measuring longitudinal global and local death trends in public health.[6] Accordingly, we used a national-level database examining death certificates to measure AS-related mortality trends in the United States, stratified by demographic and regional characteristics.

METHODS

The Centers for Disease Control and Prevention Wide-Ranging OnLine Data for Epidemiologic Research data sets used in this project are publicly available and are easily replicable from the methods described in the article.

Data Source

We analyzed the Mortality Multiple Cause-of-Death Public Use Record from the National Center for Health Statistics database, which provides mortality data for all US deaths, merged with death certificate data from the Centers for Disease Control and Prevention Wide-Ranging OnLine Data for Epidemiologic Research database.[7] This database includes the assigned cause of mortality from all death certificates filed in the 50 states and District of Columbia.[8] We selected natural deaths (defined by the World Health Organization as *the disease or injury that initiated the events leading directly to death as entered by the physician on the death certificate*) attributed to AS.[7,9] In multiple comorbidities (common in AS), the underlying cause is determined by the condition sequence on the certificate, provision of the *International Classification of the Diseases, Tenth Revision* (*ICD-10*) codes, and associated selection rules and modifications.[7,9] We identified AS-related cases using *ICD-10* revision codes: I06.0, I06.2, I35.0, and I35.20.[1] To counter the potential ascertainment bias, AS-related mortality rates were corroborated with all-cause, cardiovascular (I00-I78), and cancer-related (C00-C97) mortality (Figure S1); sex- and race-stratified analyses were performed for cancer mortality (Figures S2 and S3) to validate estimates of AS-related mortality. This study did not require institutional review board approval because we analyzed government-issued public-use data without individual identifiable information.

Data Extraction

The number of AS-related deaths and population size were abstracted from 2008 to 2018. This period was selected (1) to document contemporary 10-year trends in AS-related mortality and (2) to approximate the changing AS mortality patterns most closely in relation to use of TAVR in the United States. The data were abstracted on age, sex, race, region, states, and place of death. For age, we selected patients aged ≥45 years[1], and stratified them into 10-year age groups. Race was identified as White, Black, Hispanic, American Indian/Alaskan Native (North, Central, and South American Indians, Eskimos, and Aleuts), and Asian/Pacific Islander (Chinese, Filipino, Hawaiian, Japanese, and other Asian or Pacific Islanders). Regions were classified according to Census Bureau–defined regions into Northeast, Midwest, South, and West.[7] Using the National Center for Health Statistics Urban-Rural Classification Scheme, we divided our population into urban (large metropolitan area [≥1 million], medium/small metropolitan area [50 000–999 999]) and rural (<50 000) counties per the 2013 US census classification.[10] Place of death was categorized as medical facility (inpatient, outpatient, or emergency room), home, hospice facility, nursing home/long-term care, and other.

Statistical Analysis

The crude death rates for individual years were calculated by dividing the number of AS-related deaths by the total corresponding population. The annual mortality rates were calculated per 100 000 population with the corresponding 95% CIs.[11] The mortality rates were age-adjusted based on the US standard population from the year 2000. Temporal trends in mortality were examined to identify changes in slope using Joinpoint Regression Program version 4.7.0.0, which models consecutive linear segments on a log scale, connected by joinpoints, where the segments converge.[12] Annual percentage change (APC) with 95% CIs were calculated for the line segments linking a joinpoint using Monte Carlo permutation test. We estimated the weighted average of the APCs to calculate the average APC (AAPC) for entire study period (2008–2018). The AAPC is a summary estimate of the trend over a prespecified fixed time interval, which allows provision of a single numerical measure to describe the AAPCs over a duration of multiple years.[13] This measure is valid even if the joinpoint model suggests changes in trends during those years. Slopes were considered increasing or decreasing if the estimated slope differed significantly from zero.[12] The statistical significance was determined by 2-sided *t* testing (*P*=0.05).

RESULTS

Between 2008 and 2018, 176 743 AS-related deaths occurred, corresponding to age-adjusted mortality rate (AAMR) of 12.7 (95% CI, 12.6–12.8). The APC in AAMR was stable between 2008 and 2015 (0.4 [95% CI, −0.02 to 0.91]), but there was an accelerated decline between 2015 and 2018 (−4.4 [95% CI, −6.0 to −2.7]; Figure 1). Overall, AAMR reduced from 12.7 (95% CI, 12.5–12.9) to 11.5 (95% CI, 11.3–11.6) with AAPC of −1.0 (95% CI, −1.5 to −0.5).

Demographic Patterns

The crude mortality rates increased with age, with exponential distribution (Figure 2). AS-related mortality reduction was most pronounced in patients who were aged 75 to 84 years (AAPC, −2.2 [95% CI, −2.9 to −1.6]). The mortality trend remained flat in patients aged >85 years, because of significant increase in APC in crude death rate between 2008 and 2015 (0.8 [95% CI, 0.2–1.5]), followed by a significant downtrend between 2015 and 2018 (−4.1 [95% CI, −6.5 to −1.7]; Figure S4). Tables S1 and S2 report crude and AAMRs for AS-related mortality; and Table S3 reports the absolute number of AS-related deaths grouped by sex and race in the United States. Overall, men had higher AAMRs than women, and White patients had higher AAMRs than other races.

A consistent reduction in mortality was noted in women (AAPC, −1.0 [95% CI, −1.5 to −0.4]) and men (AAPC, −1.0 [95% CI, −1.4 to −0.46]), because of accelerated mortality decline since 2015 in women and 2014 in men into subsequent years (Figure 1). However, this downtrend was not consistent across race. In White patients, APC in AAMR initially increased between 2008 and 2015 (0.6 [95% CI, 0.2–1.0]), followed by reduction through 2018 (−4.0 [95% CI, −5.4 to −2.6]), translating into AAPC of −0.8 (95% CI, −1.2 to

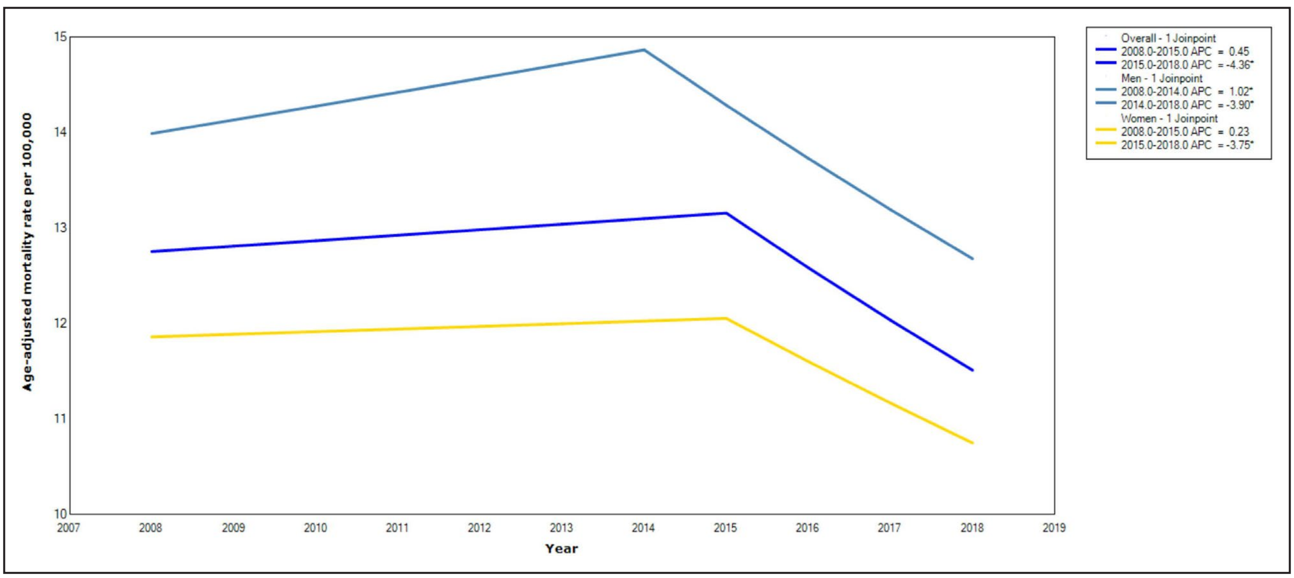

Figure 1. Overall and sex-stratified aortic stenosis–related mortality rates in the United States, 2008 to 2018.
*Indicates that the annual percentage change (APC) is significantly different from zero at α=0.05.

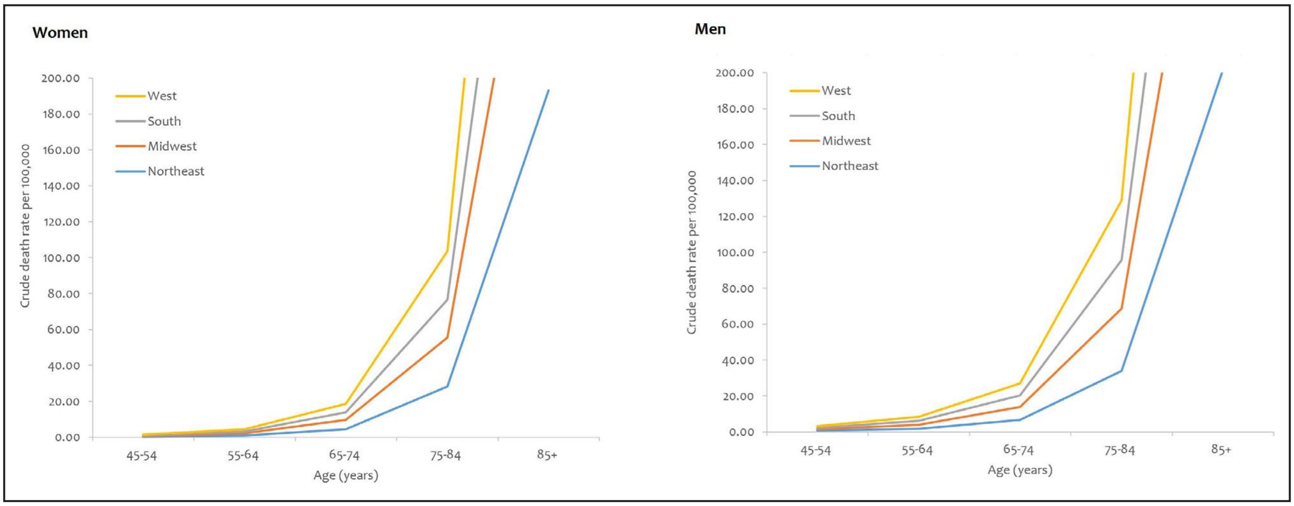

Figure 2. Aortic stenosis–related mortality rates in the US regions by age and sex, 2008 to 2018.

−0.4). Conversely, in Black, American Indian/Alaskan Native, and Hispanic patients, the mortality trends remained static, except in Asian/Pacific Islanders, where mortality declined between 2013 and 2018 (–4.2 [95% CI, –7.5 to –0.8]; Figure 3).

Geographical Patterns

Between 2008 and 2018, the AAMRs were higher in rural (13.3–14.3) than urban (12.9–11.5) areas (Figure S5). In the urban areas, the APC in AAMR was stable between 2008 and 2014 (0.6 [95% CI, −0.1 to 1.4]), but there was an accelerated decline between 2014 and 2018 (–3.3 [95% CI, –4.6 to –2.0]). Conversely, in the rural area, APC in AAMR increased between 2008 and 2015 (2.4 [95% CI, 1.7–3.1]), followed by a decline between 2015 and 2018 (–3.4 [95% CI, –5.8 to –0.9]).

Across the states, AAMRs varied from 8.0 (95% CI, 7.6–8.4) to 26.6 (95% CI, 25.9–27.3; Figure 4). States with AAMRs >90th percentile were distributed in the West and the Northeast regions (Oregon, Vermont, Washington, Maine, New Hampshire, and Idaho). States with AAMRs <10th percentile were clustered in the South (Texas, Mississippi, District of Columbia, Georgia, and Alabama) (Table S4). The AAMRs for sex and race were highest in the West and lowest in the South. Sex- and age-specific differences were most prominent in the West and least prominent in the Northeast (Figure 5). Race- and age-specific differences were most prominent in the Northeast and least prominent in the South. Death rates classified by sex and race for each individual state are shown in Tables S1 and S2.

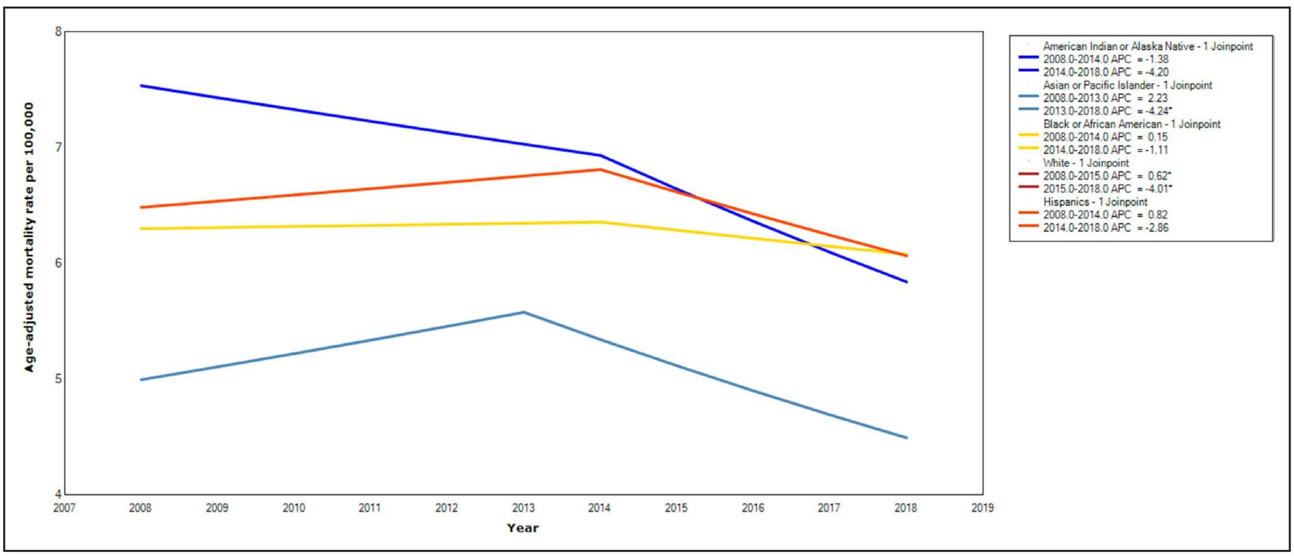

Figure 3. Aortic stenosis–related mortality rates stratified by race in the United States, 2008 to 2018.
*Indicates that the annual percentage change (APC) is significantly different from zero at α=0.05.

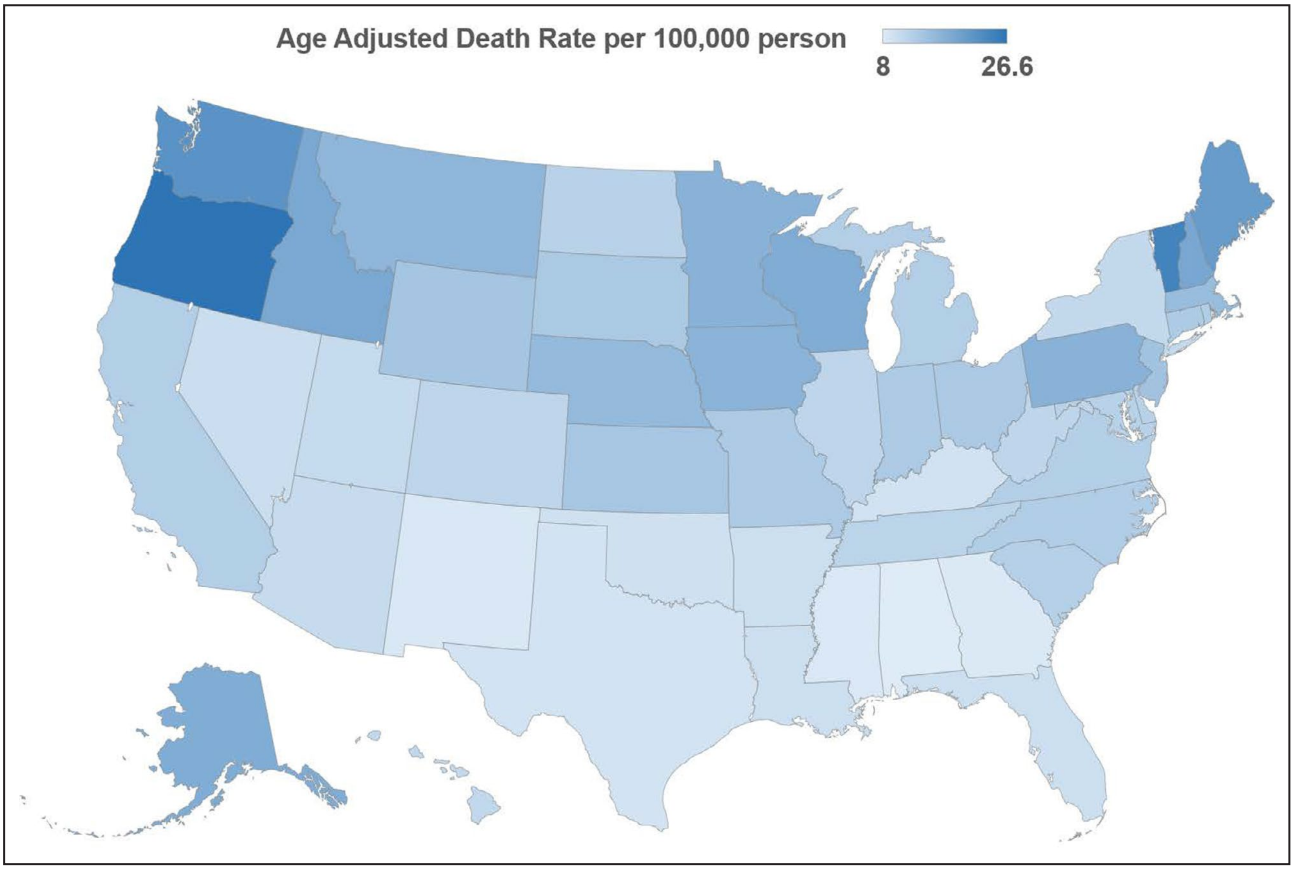

Figure 4. State-level aortic stenosis–related age-adjusted mortality rates per 100 000 people among adults aged ≥45 years in the United States, 2008 to 2018.

During the study period, the AAPC remained flat for most states except California (–2.29 [95% CI, −3.86 to −0.69]), New York (–1.64 [95% CI, −2.17 to –1.12]), North Carolina (–1.74 [95% CI, −2.94 to −0.53]), and Oregon (1.22 [95% CI, 0.11–2.33]) (Table S2). However, inflection points were identified in the year 2010 for Washington (–2.59 [95% CI, −3.89 to –1.28]) and Georgia (–3.06 [95% CI, −4.52 to −1.59]); 2012 and 2013 for North Carolina (–4.07 [95% CI, −5.59 to −2.53]) and Virginia (–4.70 [95% CI, −8.34 to −0.91]), respectively; 2014 for New York (–5.56 [95% CI, −6.79 to −4.33]), Arizona (–6.34 [95% CI, −12.15 to −0.15]), and Oregon (–3.60 [95% CI, −6.14 to –1.00]); and 2015 for New Jersey (–6.63 [95% CI, –12.62 to −0.23]). None of the states located in the Midwest showed reduction in AS mortality (Table S5). Tables S6 to S9 report state-level mortality rates stratified by sex and race.

Location of Death

Annually, the average absolute number of deaths was highest in the inpatient setting (n=6368), followed by home (n=4188) and nursing home/long-term care facility (n=3190); and lowest in outpatient/emergency department (n=671) and hospice facility (n=850). The APC in number of deaths increased for outpatient/emergency department between 2008 and 2012 (3.6 [95% CI, 0.3–7.1]), followed by decline between 2012 and 2018 (–2.9 [95% CI, −4.6 to −1.2]; Figure S6). A similar trend was noticed for nursing home/long-term care facility. The APC for inpatient deaths initially increased and then stabilized since 2015 onwards. The AAPC increased for deaths at home (3.3 [95% CI, 2.0–4.5]) and hospice facility (13.1 [95% CI, 9.7–16.6]), secondary to significant growth between 2008 and 2014 for home (5.6 [95% CI, 4.2–7.1]) and hospice facilities (19.8 [95% CI, 16.4–23.3]).

DISCUSSION

Using contemporary US data, we found some distinct patterns of AS-related mortality during the past 10 years. First, urban-rural differences existed, with higher burden of mortality in rural than urban areas. Second, the mortality varied across states, with higher death rates observed in states located in West and Northeast, and lower in South. Third, demographic disparities were observed at the national and state levels. And fourth, there was an upsurge in the number of patients dying at home and hospice facilities.

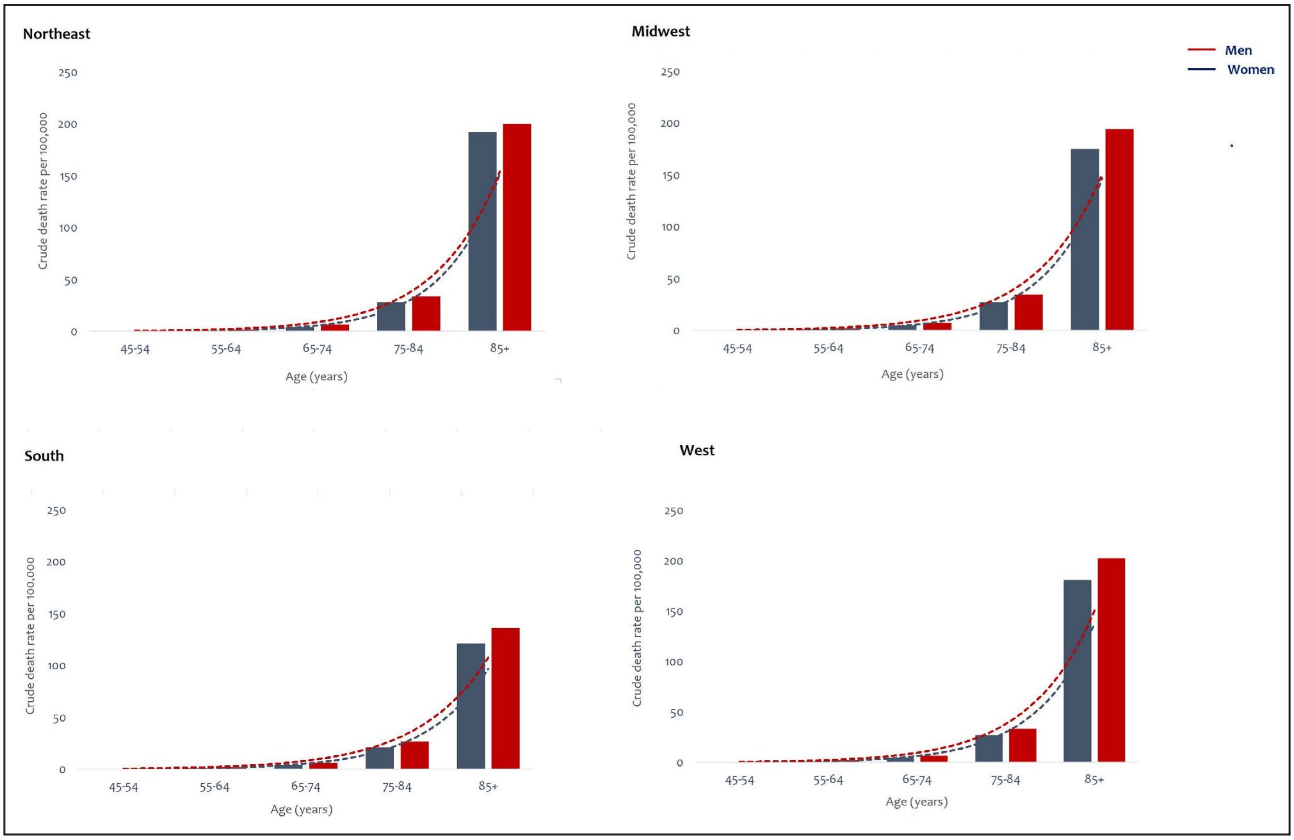

Figure 5. **Sex and age-specific aortic stenosis–related crude mortality rates per 100 000 people in the US regions, 2008 to 2018.**

Geographical variations in total and cardiovascular mortality in the United States have persisted over the years.[6,12] In a recent report, rural areas showed greater all-cause mortality rates with absolute rural-urban differences in AAMR doubling between 1999 and 2017.[10] Our study also illustrated higher AAMRs in rural than urban areas. We also identified new hotspots of AS-related death in states located in West and Northeast regions. During the past 5 to 8 years, advancement in AS-related life expectancy was observed in states substantially clustered outside the Midwest. These patterns are partially consistent with overall mortality trends in the United States,[12] and stem from different demographic makeup of the states and their inherent disease risk, heterogeneities in metabolic, behavioral, and clinical risk factors faced by the state's residents,[6,12] and access to health care that can modify prognosis over time.[14]

The known risk factors for AS include advancing age, men, White race, smoking, obesity, hypertension, atherosclerosis, and congenital bicuspid valve.[2,15] Different degrees of exposure to cardiometabolic risk factors and higher proportions of men and White population in certain regions can explain some of these trends. For instance, as per the Centers for Disease Control and Prevention Behavioral Risk Factor Surveillance System surveys, the recent prevalence of hypertension and obesity, respectively, in Oregon (30.1% and 29.9%), Vermont (30.4% and 27.5%), Washington (29.5% and 28.7%), Maine (34.8% and 30.4%), New Hampshire (30.0% and 29.6%), and Idaho (29.8% and 28.4%) were relatively higher than some states located in lower percentile for AS-related mortality.[16,17] Similarly, some of these states (Vermont, Maine, New Hampshire, and Idaho) had a higher prevalence of White people than other states.[18]

Similarly, both men and White people had higher AAMRs in West and Northeast states compared with those in South. Another set of potential explanations include socioeconomic pressures and financial hardships that can influence mortality. There was lack of AS-related mortality reduction in areas with history of economic challenges, such as rural areas[19] or the industrial Midwest.[12] However, mortality decline was prominent in states with more robust economies, such as California and New York.[12] Interplay of socioeconomic predictors, such as income, education level, quality of life, exposure to discrimination, and employment status between states and residential minorities can shape the mortality trends.[6,12,15,20] Finally, geographical variation in volume and use of AVR procedures, lower density of TAVR programs in rural areas, and challenges in accessing therapy can largely influence mortality.[5] Recently, residents of rural counties in Florida were shown to travel an extra 44 miles for TAVR and experience ≈7-fold lower rates of TAVR procedures compared with heavily populated regions.[15,21]

Prior evidence showed that AS-related morality decline was exclusively limited to patients aged ≥80 years.[1] We document an overall improvement in life expectancy in those aged 75 to 84 years during the past decade, and reversal of escalating mortality in those aged >85 years since 2015. These statistics signal the penetration of therapeutic benefits of TAVR in this target population, who may not have been candidates for surgical AVR procedures in the past. Although reductions in mortality were uniformly distributed across sexes, these patterns were not observed across race. The national data of inpatient hospitalization and Medicare beneficiaries showed that Black patients had lower proportion of AS-related hospitalizations and received fewer AVR procedures than White patients.[4,22] The transcatheter valve therapy registry from 2011 to 2016 showed that among 70 221 patients undergoing TAVR, 91% were White, 3.8% were Black, 3.4% were Hispanic, and 1.5% were Asian/Pacific Islander and American Indian/Alaskan Native patients.[14] The potential reasons for this imbalance include lower prevalence of AS in non-White patients compared with White patients,[2,15] referral bias for AVR favoring White people over other races,[23,24] and detection bias, where patients belonging to higher-income class were diagnosed more than poor.[20] Some of these factors might explain reduction in AS mortality in White compared with non-White patients.

Location of death is an important component of end-of-life care experience.[9] Overall proportion of AS-related deaths was higher in the inpatient setting. However, there was an emerging trend favoring more patients dying at home and hospice facilities. The most remarkable (≈20%) increase was noticed in patients dying at hospice facility. This trend is consistent with general population and patients with cardiovascular disease,[9,25] and reflects the use of palliative care in patients with debilitating symptoms without cure.

This study has various limitations. Vital statistics and census population data rely on death certificates. These sources are subject to error because reporting of deaths might vary across the states or deaths within the population might be missed or allocated to wrong state.[6] Inaccurate ascertainment of demographic information and cause of death based on *ICD-10* codes, which are subject to misclassification, can bias the results.[12] Analysis of the FHS (Framingham Heart Study) showed mismatch between true versus reported causes of death in decedents aged >85 years.[26] In-hospital mortality rates might be higher because AS is more readily diagnosed in the hospital than in those at the time of death. This might influence the estimates on location of death. The data set lacks the information on prevalence of AS or AVR rates. However, although the frequency of TAVR has increased, prevalence of AS does not seem to have changed over the years.[4,14,22,27] Because data were missing on pertinent clinical and social determinants of health, and regional growth rates of transcatheter or surgical AVR in the United States, the predictors of mortality could not be analyzed. Finally, the vital statistic records deaths to state of residence at the time of death, and does not factor migration between the states.[6]

In *summary*, AS-related mortality has reduced in the United States during the past 10 years, with the decline being more prominent in the second half of the decade. However, the downward trend in mortality was not consistent among all demographic groups or across all the states. The demographic and regional variations might have emerged from different clinical and social determinants of health among patients. Future studies designed to explore underlying clinical mechanisms, social disparities, and access to healthcare issues might shed further light to explain community-level variations in AS-related mortality.

ARTICLE INFORMATION

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Disclosures

None.

Supplementary Material

Tables S1–S9
Figures S1–S6

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Supplemental Material

Table S1. Aortic Stenosis Related Mortality Stratified by Age in the United States, 2008-2018.

			Crude death rate [95% CI]						
	Number of deaths	**Population**	**Overall**	**45-54 years**	**55-64 years**	**65-74 years**	**75-84 years**	**>85 years**	**Age-adjusted death rate [95% CI]**
Entire population	176,743	1,403,676,550	12.6 [12.5, 12.7]	0.6	1.6	5.6	27.8	167.5	12.7 [12.6, 12.8]
Alabama	1,655	22,056,123	7.5 [7.1, 7.9]	0.5	1.6	4.6	19.8	90.0	8.0 [7.6, 8.4]
Alaska	286	2,845,879	10.0 [8.9, 11.2]		2.4	7.4	42.9	225.8	17.8 [15.7, 19.9]
Arizona	3,075	29,120,788	10.6 [10.2, 10.9]	0.6	1.7	4.9	22.5	134.4	10.5 [10.1, 10.8]
Arkansas	1,319	13,319,205	9.9 [9.4, 10.4]	0.7	1.7	6.1	23.6	113.4	9.9 [9.4, 10.5]
California	19,163	158,207,289	12.1 [11.9, 12.3]	0.5	1.6	5.0	26.3	169.5	12.5 [12.3, 12.6]
Colorado	2,151	22,244,085	9.7 [9.3, 10.1]	0.5	1.2	4.9	25.2	152.0	11.4 [10.9, 11.9]
Connecticut	2,540	17,245,909	14.7 [14.2, 15.3]		1.1	4.5	27.4	187.8	13.1 [12.6, 13.6]
Delaware	514	4,394,589	11.7 [10.7, 12.7]		1.5	6.0	24.3	164.3	12.0 [11.0, 13.1]
District of Columbia	205	2,395,956	8.6[7.4, 9.7]				16.2	113.0	8.3 [7.1, 9.4]
Florida	11,431	98,475,823	11.6 [11.4, 11.8]	0.6	1.6	4.9	21.4	126.6	9.9 [9.8, 10.1]
Georgia	2,739	41,239,447	6.6 [6.4, 6.9]	0.4	1.5	3.8	19.7	102.4	8.3[8.0, 8.7]
Hawaii	841	6,401,149	13.1 [12.3, 14.0]		1.9	5.4	22.7	147.0	11.0 [10.3, 11.8]
Idaho	1,203	6,850,838	17.6[16.6, 18.6]		1.6	5.9	38.8	268.0	18.6 [17.5, 19.6]
Illinois	6,453	56,123,287	11.5 [11.2, 11.8]	0.4	1.5	5.1	24.8	150.5	11.4 [11.1, 11.7]
Indiana	3,766	29,044,072	13.0 [12.6, 13.4]	0.6	1.9	6.8	30.3	163.7	13.2[12.8, 13.6]
Iowa	2,860	14,213,150	20.1 [19.4, 20.9]	0.6	1.6	6.9	34.6	233.9	16.8 [16.2, 17.4]
Kansas	1,892	12,504,432	15.1 [14.4, 15.8]	0.6	1.5	6.7	31.9	175.1	13.8 [13.1, 14.4]
Kentucky	1,709	20,006,843	8.5 [8.1, 8.9]	0.5	1.3	5.2	23.4	108.7	9.4 [8.9, 9.8]
Louisiana	1,762	19,873,936	8.9 [8.5, 9.3]	0.8	1.7	5.5	25.2	109.1	9.9 [9.4, 10.3]
Maine	1,480	7,049,284	21.0 [19.9, 22.1]		2.1	9.0	46.3	273.4	20.5 [19.5, 21.6]
Maryland	2,964	26,579,275	11.2 [10.8, 11.6]	0.5	1.3	5.4	27.4	155.2	12.0 [11.5, 12.4]
Massachusetts	5,215	31,208,510	16.7 [16.3, 17.2]	0.5	1.3	5.0	32.8	217.0	15.3 [14.9, 15.8]
Michigan	5,857	46,647,612	12.6[12.2, 12.9]	0.5	1.9	5.7	28.6	158.3	12.5 [12.2, 12.8]
Minnesota	4,348	24,317,043	17.9 [17.3, 18.4]	0.5	1.7	6.4	34.3	241.2	17.0 [16.5, 17.5]
Mississippi	1,010	12,953,373	7.8 [7.3, 8.3]	0.9	2.1	5.6	20.8	84.6	8.4 [7.9, 8.9]
Missouri	3,719	27,662,944	13.4 [13.0, 13.9]	0.7	1.5	5.8	29.9	170.1	13.2[12.7, 13.6]
Montana	813	4,932,827	16.5 [15.3, 17.6]		1.7	6.6	36.2	218.8	16.3 [15.1, 17.4]
Nebraska	1,456	8,113,061	17.9 [17.0, 18.9]	0.8	1.8	5.6	32.5	221.2	15.8 [15.0, 16.7]
Nevada	992	12,159,773	8.2 [7.7, 8.7]	0.5	1.6	5.5	22.0	126.7	10.1 [9.5, 10.7]

New Hampshire	1,175	6,695,032	17.6 [16.5, 18.6]		1.8	7.4	42.9	251.2	18.7 [17.6, 19.8]
New Jersey	6,143	41,147,745	14.9 [14.6, 15.3]	0.5	1.4	5.5	29.7	199.6	14.3 [13.9, 14.7]
New Mexico	752	9,272,492	8.1 [7.5, 8.7]		1.8	4.2	20.2	99.9	8.5 [7.9, 9.1]
New York	10,213	88,664,277	11.5 [11.3, 11.7]	0.3	1.1	4.2	22.9	149.2	10.8 [10.6, 11.0]
North Carolina	5,160	43,970,232	11.7 [11.4, 12.1]	0.6	1.6	6.0	28.7	165.0	12.8 [12.5, 13.2]
North Dakota	447	3,111,774	14.4 [13.0, 15.7]			5.5	26.7	152.8	11.9 [10.8, 13.1]
Ohio	7,423	54,207,144	13.7 [13.4, 14.0]	0.6	1.7	6.6	30.4	167.2	13.3 [13.0, 13.6]
Oklahoma	1,549	16,631,544	9.3 [8.8, 9.8]	0.5	1.6	5.6	23.1	110.7	9.6 [9.1, 10.0]
Oregon	4,990	18,310,826	27.3 [26.5, 28.0]	0.8	2.6	9.0	58.1	370.2	26.6 [25.9, 27.4]
Pennsylvania	12,138	62,073,610	19.6 [19.2, 19.9]	0.7	1.6	6.6	37.8	229.9	17.0 [16.7, 17.3]
Rhode Island	742	5,014,440	14.8 [13.7, 15.9]			5.0	27.9	168.3	12.6 [11.7, 13.6]
South Carolina	2,431	22,071,803	11.0 [10.6, 11.5]	0.7	1.9	5.6	26.4	159.2	12.3 [11.8, 12.8]
South Dakota	590	3,782,478	15.6 [14.3, 16.9]			5.1	33.4	172.3	13.4 [12.3, 14.5]
Tennessee	3,167	29,542,896	10.7 [10.3, 11.1]	0.8	1.9	6.1	27.9	139.6	11.7 [11.3, 12.2]
Texas	7,998	102,454,518	7.8 [7.6, 8.0]	0.5	1.5	5.2	21.8	109.5	9.2 [9.0, 9.4]
Utah	887	9,482,591	9.4 [8.7, 10.0]	0.6	1.7	5.3	23.1	133.0	10.6 [9.9, 11.3]
Vermont	769	3,191,207	24.1 [22.4, 25.8]		2.0	9.4	50.8	344.1	24.3 [22.6, 26.0]
Virginia	4,026	36,367,503	11.1 [10.7, 11.4]	0.5	1.4	5.5	28.0	162.5	12.4 [12.0, 12.8]
Washington	6,333	30,878,750	20.5 [20.0, 21.0]	0.8	2.2	8.7	47.5	296.9	21.8 [21.3, 22.4]
West Virginia	1,042	9,292,823	11.2 [10.5, 11.9]	1.4	2.6	5.8	28.2	120.0	11.3 [10.6, 11.9]
Wisconsin	5,024	26,766,339	18.8 [18.3, 19.3]	0.6	1.7	6.8	38.2	246.9	17.9 [17.4, 18.3]
Wyoming	326	2,560,024	12.7 [11.4, 14.1]			7.4	33.2	172.2	14.0 [12.5, 15.6]
Sex									
Women	102,084	743,730,147	13.7 [13.6, 13.8]	0.3	1.1	4.6	25.1	162.1	11.7 [11.6, 11.8]
Men	74,659	659,946,403	11.3 [11.2, 11.4]	0.8	2.1	6.7	31.3	177.9	14.1 [13.9, 14.2]
Race									
Whites	165,999	1,162,397,579	14.3 [14.2, 14.4]	0.6	1.7	5.9	29.9	180.6	13.7 [13.6, 13.7]
Blacks	7,510	157,593,908	4.8 [4.7, 4.9]	0.7	1.7	4.4	15.3	63.0	6.3 [6.2, 6.4]
Asians or Pacific Islanders	2,646	69,817,576	3.8 [3.6, 3.9]	0.2	0.6	2.3	10.8	68.1	5.1 [4.9, 5.3[
American Indians or Alaska Natives	588	13,867,487	4.2 [3.9, 4.6]	0.7	1.6	5	18.0	64.0	6.8 [6.2, 7.4]
Hispanics	6,366	146,749,567	4.3 [4.2, 4.4]	0.4	1.3	3.9	16.6	71.3	6.5 [6.4, 6.7]

Displayed is the total population and number of aortic-stenosis related deaths in each state between 2008 and 2018. The colors represent the value of the observed age-adjusted mortality rates per 100,000 persons, ranging from green (lowest) to red (highest). Cells are empty if no data were available.

Table S2. Trends in Age-Adjusted Aortic Stenosis-Related Mortality Rates in the United States, 2008-2018.

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	AAPC [95% CI]
Entire population	12.7	12.8	13.0	12.8	12.9	13.3	13.2	13.0	12.5	12.1	11.5	
Alabama	8.6	8.8	9.2	8.1	8.4	8.6	9.1	7.6	6.4	7.7	6.5	-2.96 [-6.16, 0.35]
Alaska		17.5	22.3	21.5	16.0	19.6	18.9	20.2	19.8		15.7	44.71 [-70.05, 599.3]
Arizona	10.6	10.7	10.6	11.9	10.1	11.7	11.3	10.7	10.0	9.8	8.5	-1.84 [-4.39, 0.77]
Arkansas	9.4	8.1	10.4	9.3	11.0	10.9	10.8	9.5	9.6	10.7	9.4	0.82 [-3.17, 4.97]
California	13.4	13.5	13.5	12.5	12.8	13.2	12.3	12.4	12.3	11.3	10.8	-2.29* [-3.86, -0.69]
Colorado	10.0	12.1	11.1	12.6	12.1	11.7	12.2	10.8	11.7	11.4	10.1	0.23 [-2.92, 3.48]
Connecticut	14.7	12.3	15.9	13.4	12.8	11.2	13.7	13.4	12.9	12.3	11.8	-1.5 [-4.97, 2.11]
Delaware	12.8	11.5	9.9	11.6	10.5	12.6	15.5	9.8	12	11.4	14.2	0.22 [-8.91, 10.27]
District of Columbia					9.0		9.9			10	8.6	
Florida	10.8	10.4	10.3	9.5	10.4	9.8	11.0	10.0	9.8	9.2	8.8	-1.64 [-4.07, 0.86]
Georgia	9.1	8.5	10.0	8.7	8.6	8.3	8.3	8.5	7.9	7.7	6.9	-1.87 [-4.22, 0.53]
Hawaii	9.7	11.9	8.5	10.3	13.9	14.6	8.5	11.7	11.0	10.1	11.3	0.88 [-7.17, 9.64]
Idaho	18.8	17.3	20.3	16.5	17.8	19.9	19.5	18.1	21.4	18.3	16.5	-0.73 [-5.26, 4.02]
Illinois	11.1	11.1	11.3	11.5	11.2	11.9	12.3	11.6	11.5	11.8	9.8	-0.89 [-2.4, 0.66]
Indiana	13.1	11.9	12.6	14.0	13.7	14.1	12.9	13.9	13.3	13.3	12.3	0.2 [-2.11, 2.56]
Iowa	16.4	15.1	15.4	15.4	15.4	18.3	16.0	18.7	18.7	16.7	18.4	1.47 [-2.91, 6.05]
Kansas	11.3	14.7	15.8	12.0	11.5	15.0	14.8	13.8	14.1	15.2	13.1	1.5 [-4.34, 7.69]
Kentucky	7.4	8.1	9.0	10.4	10.0	9.7	9.0	9.7	11.0	9.9	8.5	2.47 [-1.45, 6.54]
Louisiana	10.8	11.9	10.9	9.3	9.0	10.1	9.2	9.8	8.6	10.3	9.0	-2.05 [-5.58, 1.62]
Maine	19.3	18	17.2	17.8	20.3	18.8	20.2	23.3	27.5	19.3	23.3	2.34 [-5.08, 10.33]
Maryland	12.3	12.2	12.3	11.7	12.2	12.3	12.4	11.3	11.3	12.4	11.5	-0.45 [-2.34, 1.48]
Massachusetts	15.4	15.7	15.8	15.7	14.8	17.1	15.0	16.0	15.7	14.0	13.6	-1.53 [-4.3, 1.32]
Michigan	12.5	11.3	12.2	11.6	12.5	12.2	13.3	13.7	13.5	12.4	12.2	0.35 [-2.61, 3.39]
Minnesota	16.4	16.6	17.3	16.1	16.9	17.5	17.0	18	17.9	16.3	16.5	-0.13 [-1.84, 1.61]
Mississippi	8.2	7.4	8.7	7.2	9.4	8.7	9.2	9.3	7.4	8.8	7.5	-0.03 [-4.81, 5]
Missouri	11.5	13.2	12.5	14.1	13.8	12.9	14.8	13.9	13.7	12.4	11.8	-0.11 [-2.57,2.4]
Montana	14.2	10.8	18.4	20.3	17.2	17.3	16.1	15.7	16.3	15.2	16.9	2.19 [-4.63, 9.5]
Nebraska	12.7	14.8	14.9	14.8	18.0	17.0	19.2	17.0	15.2	15.0	15.3	0.84 [-1.76, 3.51]
Nevada	13.5	7.8	11.2	9.7	9.9	8.0	8.8	11.5	11.2	11.2	8.7	-0.48 [-8.58, 8.34]
New Hampshire	15.2	18.8	22.0	17.8	20.0	18.8	19.1	18.4	18.3	17.8	19.2	1.42 [-1.18, 4.09]
New Jersey	15.0	13.6	14.1	14.6	15.0	14.4	15.5	15.4	13.9	13.1	12.5	-1.37 [-3.2, 0.5]

New Mexico	8.2	8.8	10.0	8.1	9.9	9.7	8.2	9.5	8.2	6.9	6.4	-3.27 [-7.7, 1.37]
New York	11.1	11.2	11.3	11.4	11.6	11.6	10.9	10.1	9.7	9.4	11.1	-1.64* [-2.17, -1.12]
North Carolina	13.3	13.9	12.8	13.6	14.5	13.7	13.2	12.6	11.8	11.7	10.9	-1.74* [-2.94, -0.53]
North Dakota	12.8	11.9	10.8	11.1	12.5	8.5	9.0	12.8	17.4	12.4	12.0	1.12 [-6.84, 9.77]
Ohio	13.8	13.2	12.8	13.9	13.0	13.3	14.3	13.8	12.8	12.9	12.4	-0.73 [-2.63, 1.2]
Oklahoma	10.0	11.5	10.1	10.5	9.6	9.5	9.9	7.9	9.5	9.9	7.3	-2.98 [-7.48, 1.74]
Oregon	23.4	23.6	24.8	25.6	26.5	29.2	30.8	28.5	27.1	26.1	26.5	1.22* [0.11, 2.33]
Pennsylvania	16.4	16.8	17.1	17.4	16.7	18.1	16.9	17.7	17.1	16.5	16.3	-0.28 [-1.63, 1.09]
Rhode Island	13.0	10.2	11.4	11.8	13.5	13.9	14.0	11.0	12.1	13.8	13.5	1.35 [-3.8, 6.77]
South Carolina	12.9	13.0	12.0	12.8	12.1	12.5	12.1	12.5	12.3	11.7	11.5	-1.06 [-2.82, 0.73]
South Dakota	13.1	12.8	15.0	11.5	12.2	15.6	10.9	15.5	13.8	13.6	13.4	0.36 [-5.79, 6.91]
Tennessee	10.2	10.6	11.4	12.1	12.9	13.2	12.9	11.7	10.8	11.8	11.4	1.02 [-1.02, 3.1]
Texas	9.5	9.8	9.7	9.3	9.5	9.9	9.5	9.0	8.3	9.1	8.5	-1.25 [-2.89, 0.41]
Utah	11.1	9.7	12.3	11.2	9.7	11.3	10.4	11.6	10.7	9.0	9.9	-1.37 [-5.97, 3.45]
Vermont	22.3	25.8	17.9	27.5	30.0	29.1	23.5	22.1	22.9	25.9	20.0	-0.03 [-7.02, 7.49]
Virginia	11.9	12.7	13.1	12.7	13.6	13.6	13.1	12.7	10.8	12.0	10.7	-1.24 [-3.4, 0.96]
Washington	21.1	23.0	24.9	23.0	21.6	23.2	21.6	22.2	20.9	20.0	19.3	-0.78 [-2.89, 1.37]
West Virginia	11.9	11.8	8.9	12.0	12.1	13.5	10.9	13.1	10.5	10.6	8.8	-2.01 [-8.12, 4.5]
Wisconsin	15.3	17.0	17.3	16.7	17.3	18.5	18.1	20.1	19.3	18.3	17.9	1.3 [-0.33, 2.96]
Wyoming	15.5	17.5	14.7	15.1	11.1	16.1	12.9	11.5	18.3	13.0	9.4	-4.24 [-11.67, 3.82]
Sex												
Women	11.8	11.9	12.1	11.8	11.9	12.1	12.1	12.0	11.5	11.3	10.7	-1.0 [-1.5, -0.4]
Men	14.1	14.0	14.3	14.4	14.5	14.9	14.7	14.3	13.9	13.2	12.6	-1.0 [-1.4, -0.6]
Race												
Whites	13.6	13.7	14.1	14.1	14.4	15.0	14.9	15.0	14.5	14.1	13.5	-0.8 [-1.2, -0.4]
Blacks	4.6	4.7	4.6	4.6	4.3	4.8	5.3	4.6	4.8	4.9	5.0	-0.4 [-1.4, 0.7]
Asians or Pacific Islanders	3.2	3.6	3.3	3.8	3.8	4.3	3.8	4	4.1	3.8	3.8	-1.1 [-3.0, 0.9]
American Indians or Alaska Natives	8.4	6.9	6.2	8.1	7.5	6.7	7.9	6.3	5.8	5.5	6.7	-2.5 [-7.6, 2.8]
Hispanics	6.3	7.0	7.0	5.8	6.6	7.0	6.9	6.7	6.3	6.4	6.0	-0.7 [-3.8, 2.5]

Observed age-adjusted mortality rates are reported for individual states and for the entire population between 2008 and 2018. The colors represent the value of the observed age-adjusted mortality rates per 100,000 persons, ranging from green (lowest) to red (highest). Cells are empty if no data were available. AAPC stands for Average Annual Percentage Change. Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05

Table S3. Absolute Number of Aortic Stenosis Related Deaths Stratified by Sex and Race in the United States, 2008-2018.

Year	Women	Men	Whites	Blacks	Asians/PI	AI/AN	Hispanics	Total Population
2008	8440	5818	13468	582	160	48	411	117395131
2009	8680	5966	13804	610	189	43	472	119895863
2010	9014	6192	14371	618	179	38	492	121757429
2011	8994	6518	14613	632	216	51	449	124174484
2012	9260	6770	15132	611	231	56	535	126000296
2013	9640	7209	15839	688	271	51	613	127788037
2014	9747	7306	15972	772	250	59	638	129779643
2015	9891	7351	16226	686	275	55	675	131826832
2016	9627	7335	15874	741	291	56	670	133494018
2017	9585	7170	15634	772	289	60	710	135229289
2018	9206	7024	15066	798	295	71	701	136335528

AI/AN = American Indians or Alaska Natives; PI = Pacific Islanders

Table S4. Aortic Stenosis Related Mortality Stratified by States in the United States, 2008-2018.

States	Rank	Percentile	AAMR per 100,000
Oregon	1	100.00%	26.6
Vermont	2	98.00%	24.3
Washington	3	96.00%	21.8
Maine	4	94.00%	20.5
New Hampshire	5	92.00%	18.7
Idaho	6	90.00%	18.6
Wisconsin	7	88.00%	17.9
Alaska	8	86.00%	17.8
Minnesota	9	82.00%	17.0
Pennsylvania	9	82.00%	17.0
Iowa	11	80.00%	16.8
Montana	12	78.00%	16.3
Nebraska	13	76.00%	15.8
Massachusetts	14	74.00%	15.3
New Jersey	15	72.00%	14.3
Wyoming	16	70.00%	14.0
Kansas	17	68.00%	13.8
South Dakota	18	66.00%	13.4
Ohio	19	64.00%	13.3
Indiana	20	60.00%	13.2
Missouri	20	60.00%	13.2
Connecticut	22	58.00%	13.1
North Carolina	23	56.00%	12.8
Rhode Island	24	54.00%	12.6
California	25	50.00%	12.5
Michigan	25	50.00%	12.5
Virginia	27	48.00%	12.4
South Carolina	28	46.00%	12.3
Delaware	29	42.00%	12.0
Maryland	29	42.00%	12.0
North Dakota	31	40.00%	11.9
Tennessee	32	38.00%	11.7

Colorado	33	34.00%	11.4
Illinois	33	34.00%	11.4
West Virginia	35	32.00%	11.3
Hawaii	36	30.00%	11.0
New York	37	28.00%	10.8
Utah	38	26.00%	10.6
Arizona	39	24.00%	10.5
Nevada	40	22.00%	10.1
Arkansas	41	16.00%	9.9
Florida	41	16.00%	9.9
Louisiana	41	16.00%	9.9
Oklahoma	44	14.00%	9.6
Kentucky	45	12.00%	9.4
Texas	46	10.00%	9.2
New Mexico	47	8.00%	8.5
Mississippi	48	6.00%	8.4
District of Columbia	49	2.00%	8.3
Georgia	49	2.00%	8.3
Alabama	51	0.00%	8.0

States are arranged based on percentile ranked from highest to lowest age adjusted mortality rates (AAMR) per 100,000 persons.

Table S5. State-Wise Trends in Aortic Stenosis Related Mortality in the United States, 2008-2018.

States	Joinpoint year		APC	95% Confidence interval		P-value
Alabama	2008	2014	-0.67	-4.91	3.77	0.72
	2014	2018	-6.3	-13.65	1.68	0.10
Alaska	2008	2010	4255.46	-99.47	35739896	0.35
	2010	2018	-38.22	-76.89	65.17	0.28
Arizona	2008	2014	1.28	-2.13	4.8	0.40
	2014	2018	-6.34*	-12.15	-0.15	0.05
Arkansas	2008	2013	4.11	-3.04	11.8	0.22
	2013	2018	-2.37	-9.08	4.84	0.44
California	2008	2016	-1.25*	-2.25	-0.25	0.02
	2016	2018	-6.33	-14.64	2.79	0.14
Colorado	2008	2011	6.26	-5.06	18.92	0.24
	2011	2018	-2.25	-5.14	0.74	0.11
Connecticut	2008	2013	-2.43	-8.43	3.96	0.38
	2013	2018	-0.55	-6.66	5.97	0.84
Delaware	2008	2010	-8.11	-46.8	58.7	0.72
	2010	2018	2.42	-3.51	8.72	0.36
District of Columbia	2008	2016				
	2016	2018				
Florida	2008	2015	-0.32	-2.66	2.06	0.75
	2015	2018	-4.63	-12.71	4.2	0.24
Georgia	2008	2010	3.02	-10.31	18.34	0.62
	2010	2018	-3.06*	-4.52	-1.59	<0.01
Hawaii	2008	2012	5.91	-13.52	29.71	0.51
	2012	2018	-2.34	-12.36	8.84	0.61
Idaho	2008	2016	1.31	-1.6	4.31	0.32
	2016	2018	-8.49	-29.95	19.55	0.45
Illinois	2008	2016	1.02*	0.06	2	0.04
	2016	2018	-8.17	-15.92	0.3	0.06
Indiana	2008	2013	2.34	-1.78	6.63	0.22
	2013	2018	-1.9	-5.85	2.22	0.30
Iowa	2008	2010	-2.29	-24.1	25.79	0.83
	2010	2018	2.44	-0.35	5.3	0.08

Kansas	2008	2010	7.52	-23.38	50.88	0.62
	2010	2018	0.05	-3.58	3.82	0.97
Kentucky	2008	2011	11.35	-2.96	27.78	0.10
	2011	2018	-1.12	-4.69	2.59	0.48
Louisiana	2008	2012	-4.98	-13.11	3.92	0.21
	2012	2018	-0.05	-4.72	4.85	0.98
Maine	2008	2010	-3.84	-37.48	47.88	0.83
	2010	2018	3.94	-0.83	8.94	0.09
Maryland	2008	2016	-0.66	-1.84	0.54	0.22
	2016	2018	0.4	-10.02	12.03	0.93
Massachusetts	2008	2016	0.08	-1.69	1.88	0.92
	2016	2018	-7.71	-21.6	8.64	0.27
Michigan	2008	2016	1.78	-0.1	3.7	0.06
	2016	2018	-5.19	-20.08	12.47	0.47
Minnesota	2008	2016	0.95	-0.13	2.04	0.08
	2016	2018	-4.31	-13.32	5.63	0.32
Mississippi	2008	2014	2.81	-3.55	9.59	0.33
	2014	2018	-4.13	-14.93	8.03	0.42
Missouri	2008	2014	3.15	-0.14	6.55	0.06
	2014	2018	-4.82	-10.42	1.13	0.09
Montana	2008	2011	13.94	-10.73	45.41	0.24
	2011	2018	-2.47	-8.62	4.1	0.38
	2012	2018	-0.05	-4.72	4.85	0.98
Nebraska	2008	2014	5.64*	2.11	9.29	0.01
	2014	2018	-5.95	-11.74	0.23	0.06
Nevada	2008	2013	-4.02	-17.38	11.49	0.53
	2013	2018	3.2	-11.16	19.89	0.63
New Hampshire	2008	2010	13.62	-2.07	31.84	0.08
	2010	2018	-1.42	-3	0.19	0.07
New Jersey	2008	2015	0.98	-0.79	2.79	0.23
	2015	2018	-6.63*	-12.62	-0.23	0.04
New Mexico	2008	2015	0.88	-3.49	5.44	0.65
	2015	2018	-12.3	-25.67	3.48	0.10
New York	2008	2014	1.06*	0.36	1.77	0.01
	2014	2018	-5.56*	-6.79	-4.33	<0.01

North Carolina	2008	2012	1.86	-1.14	4.94	0.18
	2012	2018	-4.07*	-5.59	-2.53	<0.01
North Dakota	2008	2013	-4.55	-17.42	10.32	0.46
	2013	2018	7.13	-7.31	23.83	0.29
Ohio	2008	2015	0.39	-1.42	2.23	0.62
	2015	2018	-3.29	-9.66	3.52	0.27
Oklahoma	2008	2016	-1.92	-4.79	1.03	0.16
	2016	2018	-7.11	-29.22	21.91	0.53
Oregon	2008	2014	4.56*	3.08	6.07	<0.01
	2014	2018	-3.60*	-6.14	-1.00	0.02
Pennsylvania	2008	2015	0.8	-0.49	2.1	0.18
	2015	2018	-2.74	-7.32	2.07	0.21
Rhode Island	2008	2013	2.75	-6.28	12.64	0.50
	2013	2018	-0.03	-8.82	9.6	0.99
South Carolina	2008	2016	-0.55	-1.66	0.57	0.27
	2016	2018	-3.06	-12.53	7.43	0.49
South Dakota	2008	2011	-1.6	-21.3	23.02	0.87
	2011	2018	1.21	-4.65	7.44	0.64
Tennessee	2008	2012	6.70*	1.53	12.13	0.02
	2012	2018	-2.59	-5.14	0.03	0.05
Texas	2008	2013	0.01	-2.9	3	1.00
	2013	2018	-2.49	-5.33	0.43	0.08
Utah	2008	2015	0.21	-4.21	4.82	0.91
	2015	2018	-4.96	-19.71	12.48	0.49
Vermont	2008	2012	6.79	-10.49	27.41	0.40
	2012	2018	-4.33	-12.94	5.14	0.29
Virginia	2008	2013	2.34	-1.57	6.41	0.20
	2013	2018	-4.70*	-8.34	-0.91	0.02
Washington	2008	2010	6.79	-5.56	20.76	0.24
	2010	2018	-2.59*	-3.89	-1.28	<0.01
West Virginia	2008	2015	1.69	-4.3	8.05	0.53
	2015	2018	-10.13	-28.39	12.79	0.29
Wisconsin	2008	2015	3.06*	1.49	4.65	<0.01
	2015	2018	-2.69	-8.11	3.05	0.29
Wyoming	2008	2016	-0.99	-5.86	4.13	0.65

	2016	2018	-16.2	-47.21	33.04	0.39

APC (Annual Percent Change) in Age Adjusted Mortality Rates. Cells are empty if no data were available.

*Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05

Table S6. Aortic Stenosis Related Mortality Stratified by State and Sex in the United States, 2008-2018.

	Females				Males			
State	**Death**	**Population**	**Crude rate**	**AAMR**	**Death**	**Population**	**Crude rate**	**AAMR**
Alabama	933	11,844,702	7.9	7.3	722	10,211,421	7.1	9.1
Alaska	152	1,382,156	11	16.7	134	1,463,723	9.2	19.1
Arizona	1,681	15,288,108	11	9.9	1,394	13,832,680	10.1	11.2
Arkansas	741	7,062,057	10.5	9.1	578	6,257,148	9.2	11.1
California	10,614	83,199,489	12.8	11.3	8,549	75,007,800	11.4	14.2
Colorado	1,226	11,542,066	10.6	10.6	925	10,702,019	8.6	12.5
Connecticut	1,574	9,230,427	17.1	12.5	966	8,015,482	12.1	13.9
Delaware	299	2,359,700	12.7	11.3	215	2,034,889	10.6	12.8
District of Columbia	119	1,301,760	9.1	7.2	86	1,094,196	7.9	9.8
Florida	6,152	52,429,018	11.7	9	5,279	46,046,805	11.5	11.3
Georgia	1,582	22,066,010	7.2	7.7	1,157	19,173,437	6	9.3
Hawaii	471	3,345,418	14.1	10.1	370	3,055,731	12.1	12.4
Idaho	688	3,524,297	19.5	17.7	515	3,326,541	15.5	19.5
Illinois	3,833	29,869,677	12.8	10.5	2,620	26,253,610	10	12.6
Indiana	2,217	15,358,987	14.4	12.3	1,549	13,685,085	11.3	14.5
Iowa	1,715	7,458,861	23	15.6	1,145	6,754,289	17	18.6
Kansas	1,135	6,571,422	17.3	13.1	757	5,933,010	12.8	14.5
Kentucky	973	10,605,060	9.2	8.6	736	9,401,783	7.8	10.7
Louisiana	999	10,601,950	9.4	9.1	763	9,271,986	8.2	11
Maine	884	3,714,139	23.8	19.6	596	3,335,145	17.9	21.6
Maryland	1,754	14,330,151	12.2	11.2	1,210	12,249,124	9.9	13.2
Massachusetts	3,146	16,755,289	18.8	14.2	2,069	14,453,221	14.3	17.1
Michigan	3,344	24,645,035	13.6	11.3	2,513	22,002,577	11.4	14.1
Minnesota	2,504	12,649,473	19.8	15.3	1,844	11,667,570	15.8	19.2
Mississippi	572	6,973,847	8.2	7.7	438	5,979,526	7.3	9.4
Missouri	2,155	14,690,232	14.7	12	1,564	12,972,712	12.1	14.7
Montana	441	2,528,598	17.4	14.6	372	2,404,229	15.5	18.1
Nebraska	886	4,245,386	20.9	14.9	570	3,867,675	14.7	16.7
Nevada	532	6,191,923	8.6	9.5	460	5,967,850	7.7	10.8
New Hampshire	700	3,485,057	20.1	17.7	475	3,209,975	14.8	19.8
New Jersey	3,779	22,098,302	17.1	13.6	2,364	19,049,443	12.4	15.3

New Mexico	389	4,883,677	8	7.5	363	4,388,815	8.3	9.8
New York	6,190	47,855,034	12.9	10.1	4,023	40,809,243	9.9	11.8
North Carolina	3,008	23,598,160	12.7	11.8	2,152	20,372,072	10.6	14.3
North Dakota	260	1,599,349	16.3	11	187	1,512,425	12.4	13.2
Ohio	4,286	28,854,577	14.9	12.1	3,137	25,352,567	12.4	15
Oklahoma	893	8,775,760	10.2	9.1	656	7,855,784	8.4	10.2
Oregon	2,913	9,591,034	30.4	25.3	2,077	8,719,792	23.8	28.3
Pennsylvania	7,488	33,132,629	22.6	16.2	4,650	28,940,981	16.1	18.1
Rhode Island	436	2,707,595	16.1	11.1	306	2,306,845	13.3	14.9
South Carolina	1,389	11,852,022	11.7	11.2	1,042	10,219,781	10.2	13.8
South Dakota	355	1,954,751	18.2	12.9	235	1,827,727	12.9	14.2
Tennessee	1,798	15,771,813	11.4	10.6	1,369	13,771,083	9.9	13.3
Texas	4,358	53,782,694	8.1	8.3	3,640	48,671,824	7.5	10.5
Utah	469	4,889,122	9.6	9.7	418	4,593,469	9.1	11.8
Vermont	467	1,670,267	28	23.3	302	1,520,940	19.9	25.3
Virginia	2,272	19,301,699	11.8	11.2	1,754	17,065,804	10.3	14.3
Washington	3,583	16,057,105	22.3	20.1	2,750	14,821,645	18.6	24.2
West Virginia	584	4,879,261	12	10.3	458	4,413,562	10.4	12.4
Wisconsin	2,977	13,934,494	21.4	16.6	2,047	12,831,845	16	19.6
Wyoming	168	1,290,507	13	12.4	158	1,269,517	12.4	16.2

Crude death rates and AAMR (age adjusted mortality rates) are calculated per 100,000 persons

Table S7. Aortic Stenosis Related Mortality Stratified by State and Race (White and Blacks) in the United States, 2008-2018.

	Whites				Blacks			
State	**Death**	**Population**	**Crude rate**	**AAMR**	**Death**	**Population**	**Crude rate**	**AAMR**
Alabama	1,442	16,714,244	8.6	8.7	205	4,972,571	4.1	5.1
Alaska	221	2,186,767	10.1	17.8				
Arizona	2,973	26,158,455	11.4	10.8	25	1,021,291	2.4	3.8
Arkansas	1,229	11,389,687	10.8	10.4	81	1,673,582	4.8	6.4
California	17,403	120,664,334	14.4	14.2	620	10,325,897	6	7.8
Colorado	2,095	20,501,255	10.2	11.8	23	821,760	2.8	4.6
Connecticut	2,484	15,161,778	16.4	13.8	49	1,498,073	3.3	4.8
Delaware	469	3,448,923	13.6	12.8	43	801,930	5.4	8
District of Columbia	89	870,595	10.2	10.2	112	1,443,316	7.8	7.2
Florida	10,849	83,748,843	13	10.4	517	11,939,979	4.3	5.6
Georgia	2,363	28,526,306	8.3	9.4	361	11,230,821	3.2	4.9
Hawaii	266	1,944,422	13.7	15.3				
Idaho	1,187	6,628,966	17.9	18.7				
Illinois	6,061	46,016,729	13.2	12.3	330	7,346,812	4.5	5.5
Indiana	3,641	26,390,868	13.8	13.6	116	2,179,728	5.3	6.6
Iowa	2,844	13,731,462	20.7	16.9	13	265,997	Unreliable	Unreliable
Kansas	1,830	11,518,178	15.9	14	42	613,929	6.8	9.2
Kentucky	1,648	18,452,000	8.9	9.6	54	1,316,562	4.1	5.6
Louisiana	1,483	13,939,082	10.6	10.9	265	5,506,109	4.8	6.3
Maine	1,474	6,908,742	21.3	20.6				
Maryland	2,605	17,667,840	14.7	13.9	336	7,291,427	4.6	6.6
Massachusetts	5,093	27,797,292	18.3	16.1	89	1,943,959	4.6	6.7
Michigan	5,565	39,893,561	13.9	13.3	251	5,505,925	4.6	5.3
Minnesota	4,258	22,682,749	18.8	17.1	47	791,969	5.9	12.2
Mississippi	832	8,735,247	9.5	9.3	176	4,053,762	4.3	5.6
Missouri	3,542	24,493,388	14.5	13.6	161	2,634,538	6.1	7.9
Montana	797	4,672,939	17.1	16.4				
Nebraska	1,435	7,654,822	18.7	16.1	14	279,090	Unreliable	Unreliable
Nevada	917	9,892,298	9.3	10.9	33	940,061	3.5	4.9
New Hampshire	1,173	6,510,539	18	18.9				
New Jersey	5,829	32,618,916	17.9	15.6	244	5,199,384	4.7	6.3

New Mexico	715	8,200,201	8.7	8.8				
New York	9,731	67,345,461	14.4	12.4	382	14,013,368	2.7	3.3
North Carolina	4,596	33,998,283	13.5	13.9	520	8,619,300	6	7.9
North Dakota	442	2,959,151	14.9	12				
Ohio	7,081	47,662,263	14.9	14	321	5,614,956	5.7	6.8
Oklahoma	1,414	14,050,153	10.1	9.7	47	1,056,192	4.4	6.5
Oregon	4,882	17,066,988	28.6	27.1	30	287,554	10.4	17.2
Pennsylvania	11,733	54,988,198	21.3	17.8	367	5,544,650	6.6	7.9
Rhode Island	732	4,602,020	15.9	13.1				
South Carolina	2,080	16,356,767	12.7	13.3	344	5,344,755	6.4	8.3
South Dakota	575	3,524,134	16.3	13.5				
Tennessee	2,936	25,010,476	11.7	12.3	225	4,049,561	5.6	7.6
Texas	7,401	85,757,292	8.6	9.7	500	11,539,602	4.3	6.4
Utah	865	8,987,994	9.6	10.7				
Vermont	769	3,128,486	24.6	24.6				
Virginia	3,593	27,727,837	13	13.6	394	6,559,341	6	7.9
Washington	6,075	27,051,023	22.5	22.8	72	980,337	7.3	12.7
West Virginia	1,019	8,941,744	11.4	11.3	21	272,907	7.7	9.1
Wisconsin	4,940	25,051,942	19.7	18.2	52	1,138,990	4.6	7.2
Wyoming	323	2,465,939	13.1	14.3				

Crude death rates and AAMR (age adjusted mortality rates) are calculated per 100,000 persons. Cells are empty if no data were available.

Table S8. Aortic Stenosis Related Mortality Stratified by State and Race (Asian/Pacific Islander and American Indian/Alaska Native) in the United States, 2008-2018.

	Asian/Pacific Islander				American Indian/Alaska Native			
State	**Death**	**Population**	**Crude rate**	**AAMR**	**Death**	**Population**	**Crude rate**	**AAMR**
Alabama								
Alaska					50	378,215	13.2	22.6
Arizona	29	847,302	3.4	5.1	48	1,093,740	4.4	5.7
Arkansas								
California	1,068	24,881,969	4.3	4.9	72	2,335,089	3.1	5
Colorado	21	624,039	3.4	5.2	12	297,031	Unreliable	Unreliable
Connecticut								
Delaware								
District of Columbia								
Florida	59	2,379,610	2.5	3.8				
Georgia	15	1,320,159	Unreliable	Unreliable				
Hawaii	15	1,320,159	Unreliable	Unreliable				
Idaho								
Illinois	61	2,507,737	2.4	3.7				
Indiana								
Iowa								
Kansas					13	125,263	Unreliable	Unreliable
Kentucky								
Louisiana								
Maine								
Maryland	21	1,497,686	1.4	2.3				
Massachusetts	30	1,348,548	2.2	3.4				
Michigan	18	934,789	Unreliable	Unreliable	23	313,337	7.3	11.1
Minnesota	23	615,308	3.7	6	20	227,017	8.8	13.3
Mississippi								
Missouri	12	379,943	Unreliable	Unreliable				
Montana					14	214,124	Unreliable	Unreliable
Nebraska								
Nevada	37	1,152,757	3.2	5.2				
New Hampshire								

New Jersey	68	3,142,733	2.2	3.8				
New Mexico					30	732,695	4.1	5.6
New York	91	6,608,142	1.4	2				
North Carolina	13	817,694	Unreliable	Unreliable	31	534,955	5.8	10
North Dakota								
Ohio	18	770,114	Unreliable	Unreliable				
Oklahoma					83	1,251,253	6.6	9.8
Oregon	53	684,704	7.7	11.4	25	271,580	9.2	17.9
Pennsylvania	34	1,381,709	2.5	4.8				
Rhode Island								
South Carolina								
South Dakota								
Tennessee								
Texas	92	4,257,139	2.2	3.9				
Utah	16	285,025	Unreliable	Unreliable				
Vermont	35	1,919,638	1.8	3.5				
Virginia	136	2,366,488	5.7	8.1				
Washington	15	359,113	Unreliable	Unreliable	50	480,902	10.4	19.3
West Virginia								
Wisconsin	92	4,257,139	2.2	3.9	17	216,294	Unreliable	Unreliable
Wyoming								

Crude death rates and AAMR (age adjusted mortality rates) are calculated per 100,000 persons. Shaded areas suggest absence of deaths recorded. Cells are empty if no data were available. Crude and AAMR were reported unreliable when number of events were too low.

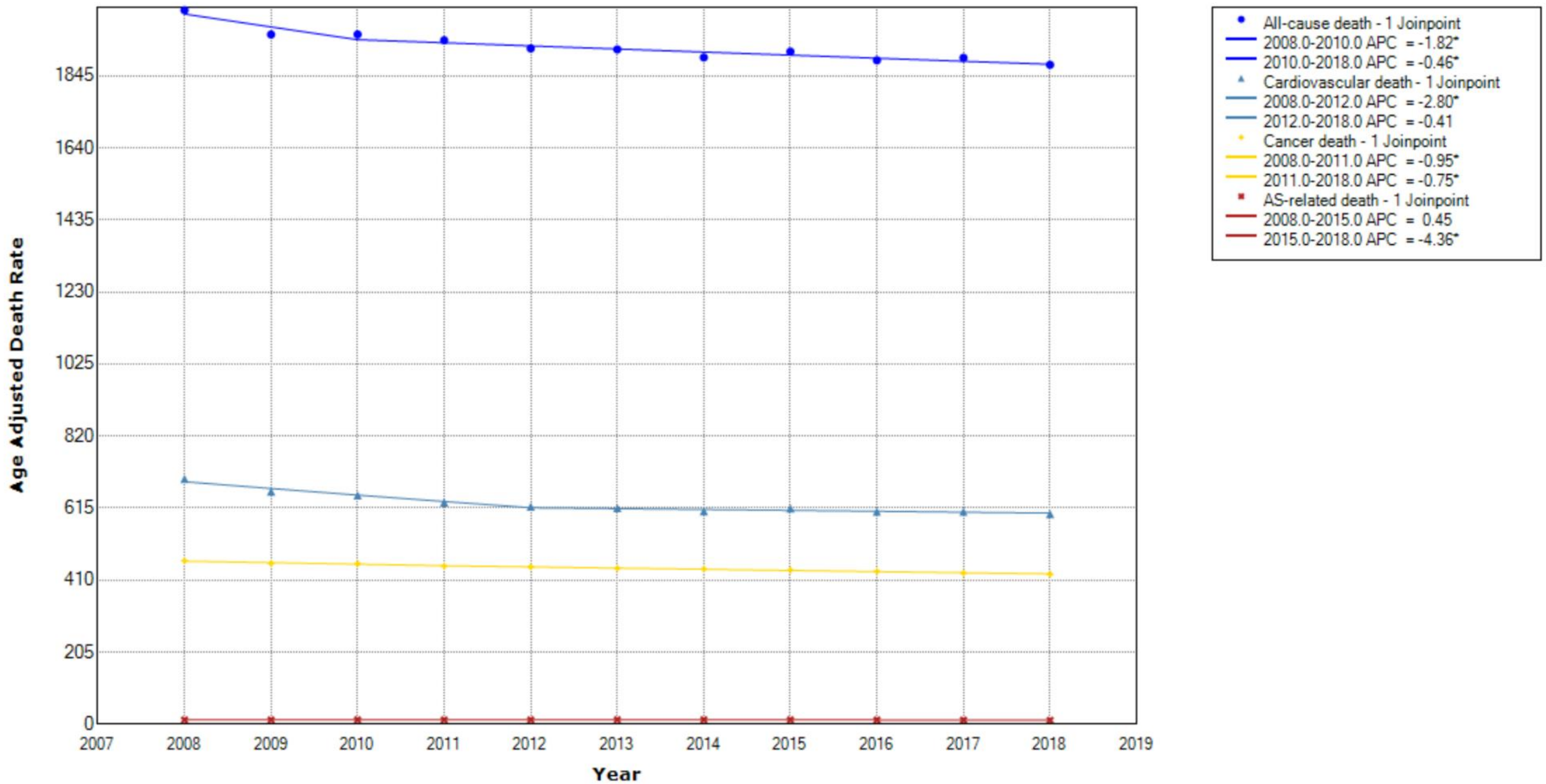
Table S9. Aortic Stenosis Related Mortality Stratified by State and Race (Hispanics) in the United States, 2008-2018.

	Hispanics			
State	**Death**	**Population**	**Crude rate**	**AAMR**
Alabama				
Alaska				
Arizona	214	5,196,734	4.1	6.5
Arkansas				
California	2,036	40,219,800	5.1	7.7
Colorado	136	2,863,397	4.7	7.3
Connecticut	54	1,373,343	3.9	7.3
Delaware				
District of Columbia				
Florida	1,042	17,635,656	5.9	6.7
Georgia	24	1,763,290	1.4	2.8
Hawaii	36	307,198	11.7	19.9
Idaho	12	396,133	Unreliable	Unreliable
Illinois	132	5,162,361	2.6	4.6
Indiana	33	860,798	3.8	6.9
Iowa	12	313,341	Unreliable	Unreliable
Kansas	27	657,763	4.1	7.5
Kentucky				
Louisiana	21	588,202	3.6	4.4
Maine				
Maryland	31	1,235,627	2.5	4.9
Massachusetts	52	1,762,165	3	5.6
Michigan	41	1,089,280	3.8	6
Minnesota	16	489,258	Unreliable	Unreliable
Mississippi				
Missouri	11	505,369	Unreliable	Unreliable
Montana				
Nebraska	11	354,550	Unreliable	Unreliable
Nevada	66	1,900,774	3.5	6.7
New Hampshire				
New Jersey	199	5,096,487	3.9	6.4

New Mexico	179	3,421,162	5.2	6.2
New York	335	11,496,097	2.9	4
North Carolina	23	1,547,909	1.5	3.2
North Dakota				
Ohio	34	893,141	3.8	5.8
Oklahoma	11	705,143	Unreliable	Unreliable
Oregon	49	975,844	5	10.8
Pennsylvania	101	1,921,821	5.3	9.6
Rhode Island				
South Carolina	14	506,294	Unreliable	Unreliable
South Dakota				
Tennessee				
Texas	1,194	27,699,489	4.3	6.5
Utah	29	775,162	3.7	7.2
Vermont				
Virginia	37	1,600,951	2.3	5
Washington	74	1,628,776	4.5	10
West Virginia				
Wisconsin	14	702,819	Unreliable	Unreliable
Wyoming				

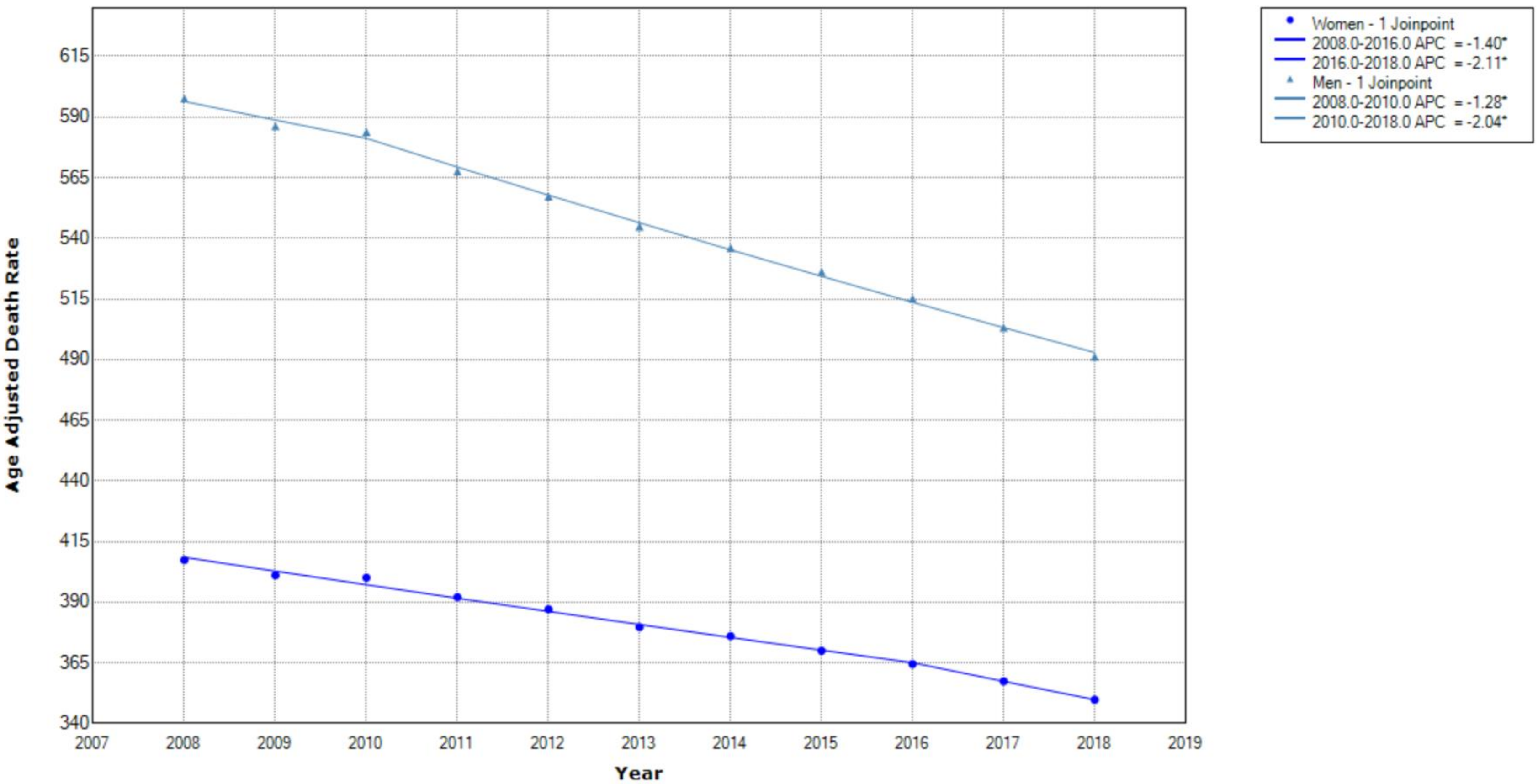
Crude death rates and AAMR (age adjusted mortality rates) are calculated per 100,000 persons. Shaded areas suggest absence of deaths recorded. Cells are empty if no data were available. Crude and AAMR were reported unreliable when number of events were too low.

Figure S1. Trends in All-Cause Mortality, Cardiovascular Mortality, Cancer Related Mortality and Aortic Stenosis Related Mortality in the United States, 2008-2018.



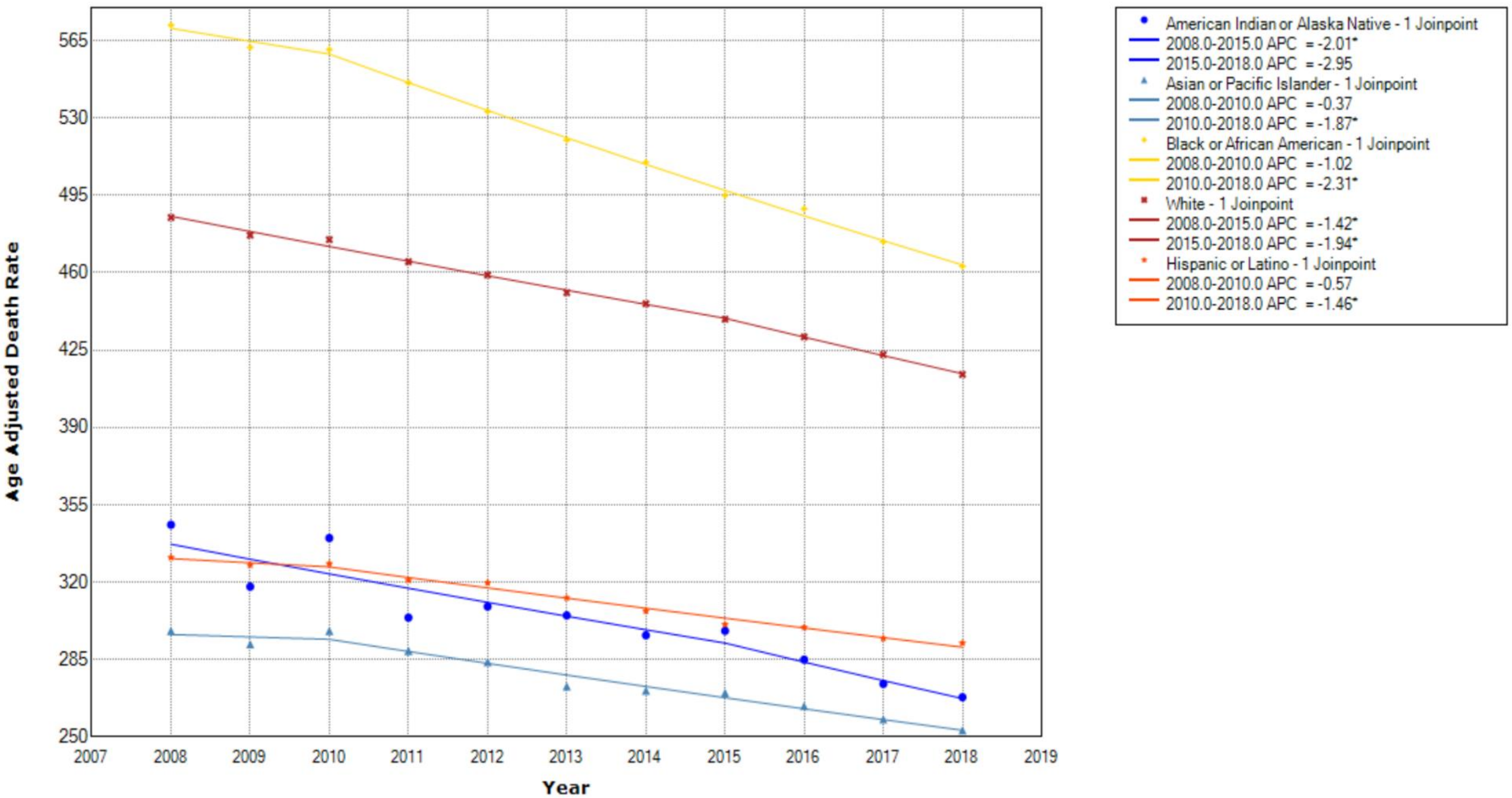
*Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05. Between 2008 and 2018, following were the age-adjusted death rates for all-cause (2031.6 to 1876.2; AAPC, -0.7 [-1.0, -0.4]), cardiovascular (698.0 to 598.8; AAPC, -1.4 [-1.7, -1.0]), cancer (465.3 to 427.1; AAPC, -0.8 [-1.0, -0.7]), and aortic stenosis (12.7 to 11.5; AAPC, -1.0 [-1.5, -4.1]) mortality.

Figure S2. Trends in Cancer Related Mortality Stratified by Sex in the United States, 2008-2018.



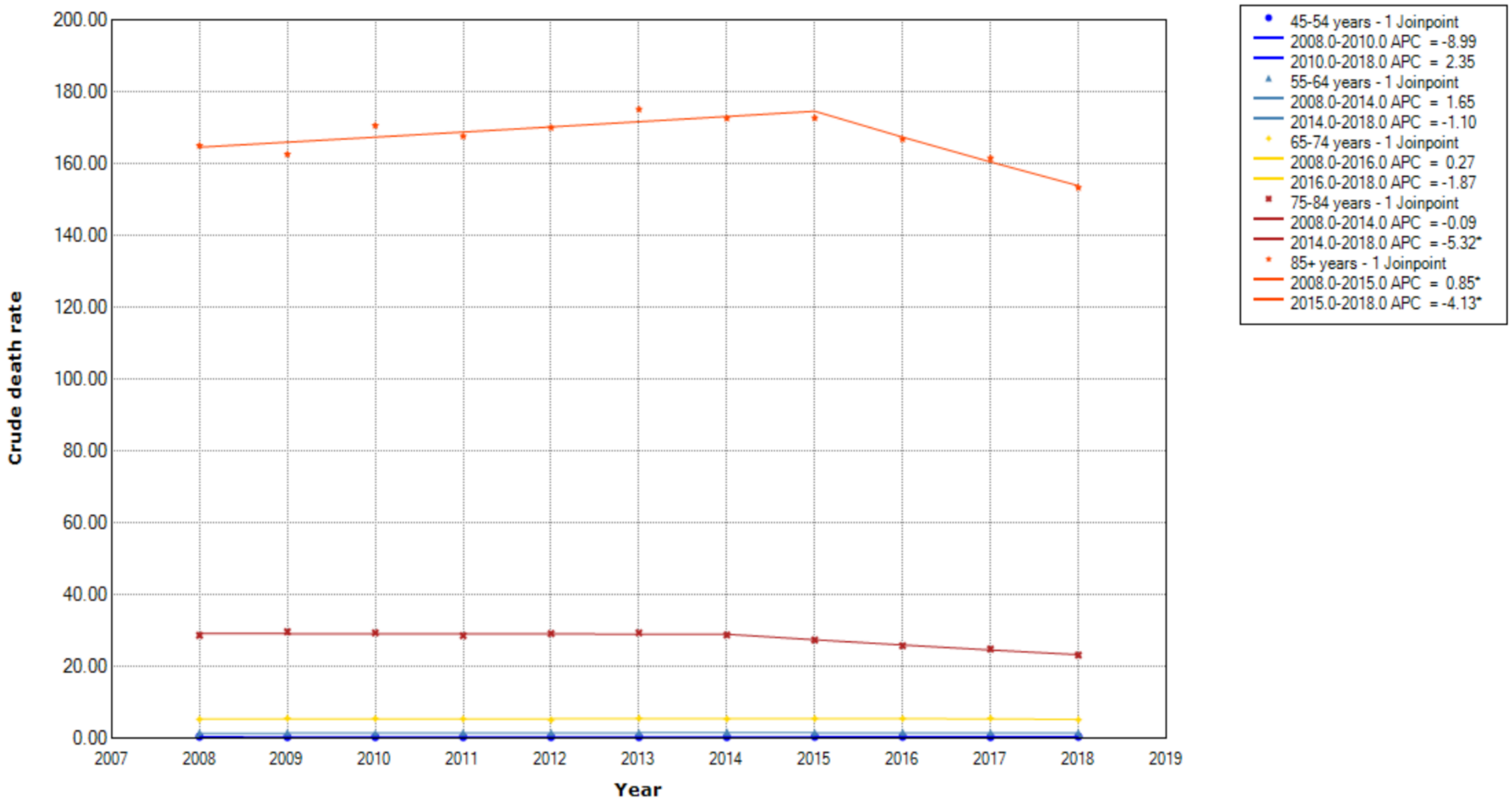
*Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05. Between 2008 and 2018,following were the age-adjusted death rates for women (407.4 to 349.8; AAPC, -1.5 [-1.8, -1.3]), and men (597.7 to 491.20; AAPC, -1.9 [-2.1, -1.7]).

Figure S3. Trends in Cancer Related Mortality Stratified by Race in the United States, 2008-2018.



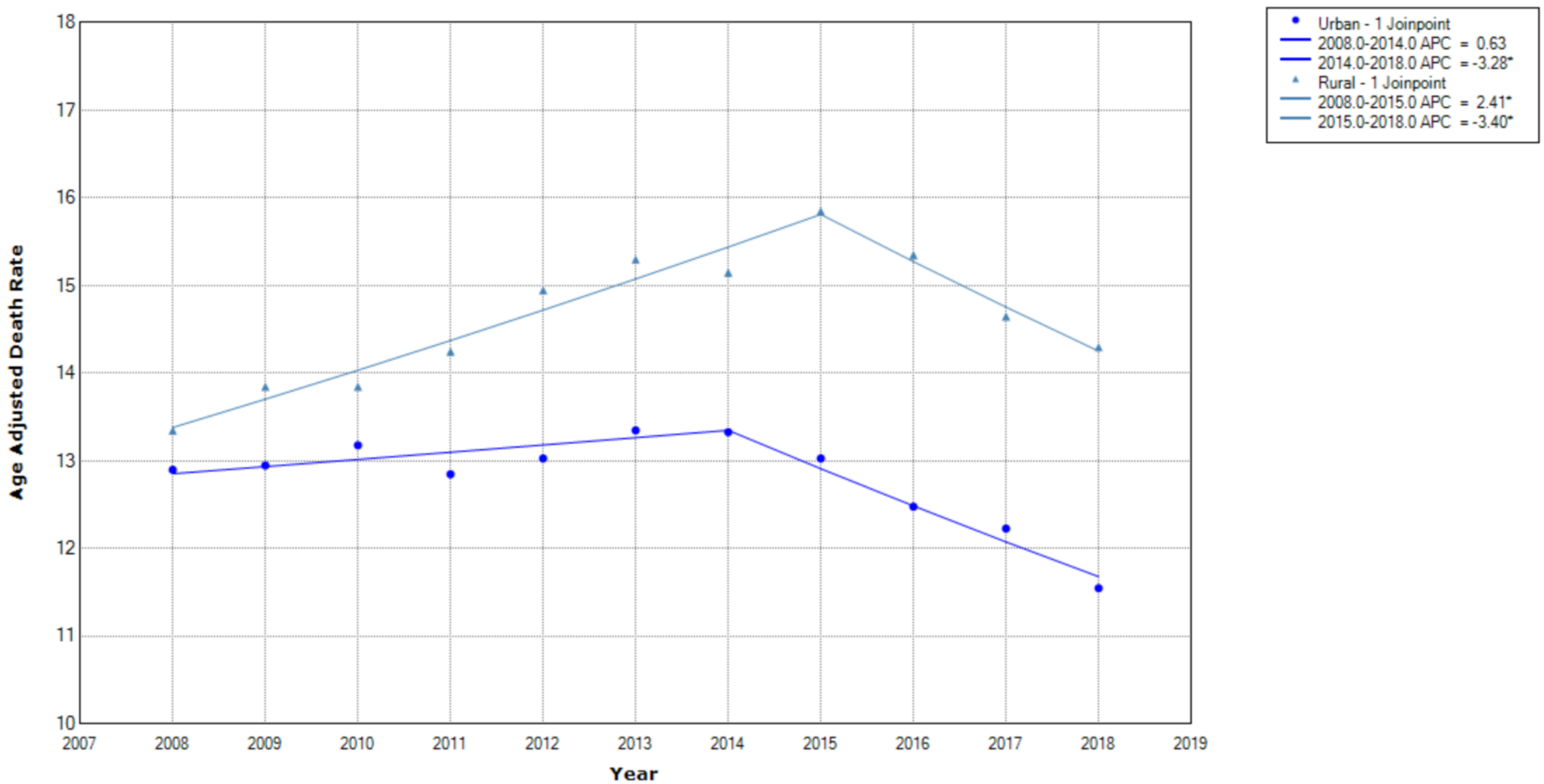
*Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05. Between 2008 and 2018, following were the age-adjusted death rates for Whites (485.0 to 414.0; AAPC, -1.6 [-2.1, -1.1]), Blacks (572.0 to 463.0; AAPC, -2.1 [-2.3, -1.8]), Hispanics (331.2 to 292.5; AAPC, -1.3 [-1.6, -1.4]), Asians or Pacific Islanders (298.0 to 253.0; AAPC, -1.6 [-2.1, -1.1]), and American Indian or Alaska Native (346.0 to 268.0; AAPC, -2.3 [-3.8, -0.7]).

Figure S4. Trends in Aortic Stenosis Related Mortality Stratified by Age in the United States, 2008-2018.



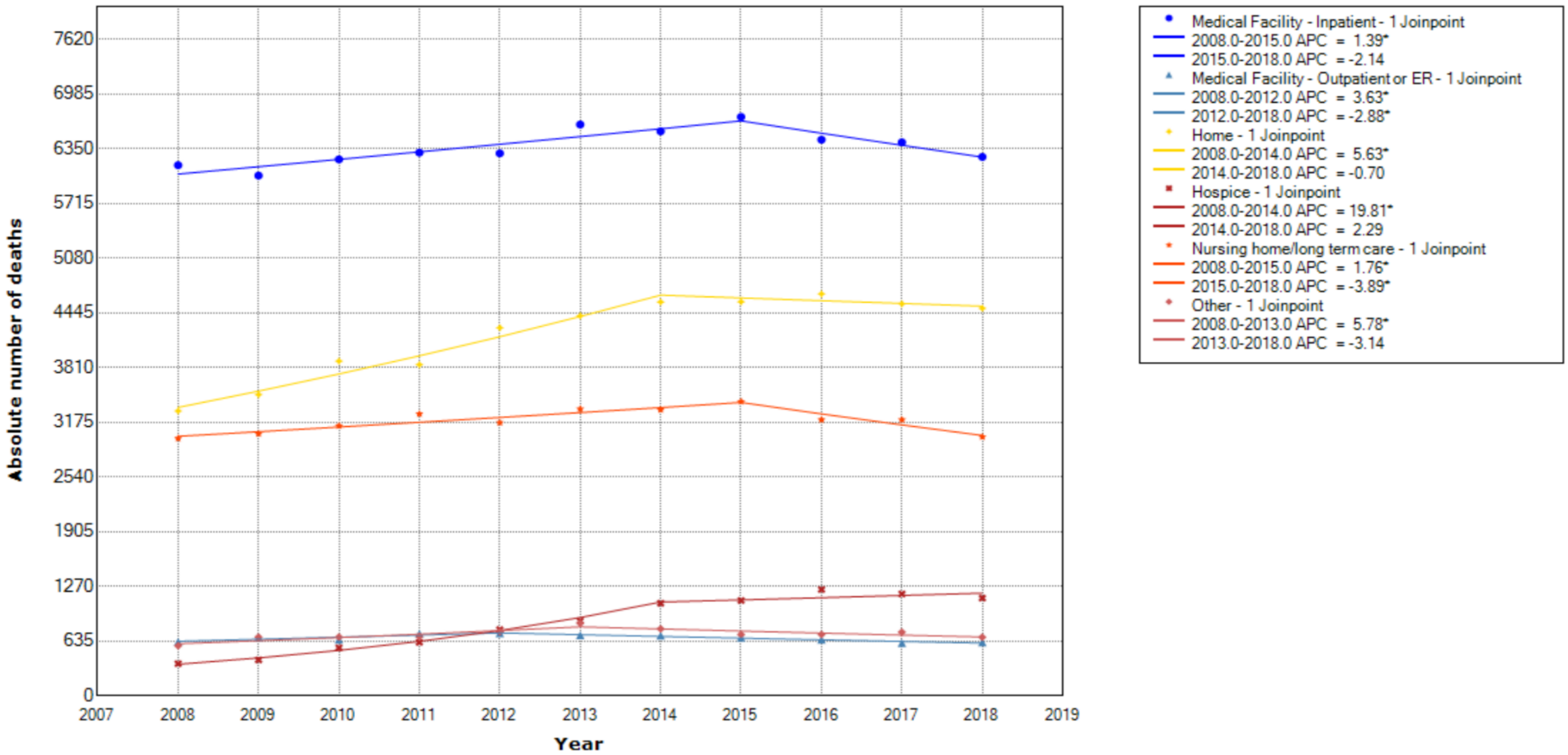
*Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05. Between 2008 and 2018, following were the crude death rates for 45-54 years (0.60 to 0.60; AAPC, -0.0 [-4.7, 4.9]), 55-64 years (1.60 to 1.60; AAPC, -1.9 [3.0, 0.4]), 65-74 years (5.40 to 5.30; AAPC, -2.1 [1.9, -0.2]), 75-84 years (28.8 to 23.3; AAPC, -2.2 [-2.9, -1.6]), and >85 years (165.2 to 153.5; AAPC, -0.7 [-1.4, 0.0]).

Figure S5. Trends in Aortic Stenosis Related Mortality Stratified by Urban-Rural Classification in the United States, 2008-2018.



**Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05. Between 2008 and 2018, following were the age-adjusted death rates in urban (12.9 to 11.5; AAPC, -1.0 [-1.5, 0.4]) and rural (13.3 to 14.3; AAPC, 0.6 [-0.1, 1.4]) areas.

Figure S6. Trends in Aortic Stenosis Related Mortality Stratified by Place of Death in the United States, 2008-2018.



**Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05. Between 2008 and 2018, following were the absolute number of deaths for medical facility-inpatient (6158 to 6254; AAPC, 0.3 [-0.4, 1.1]), medical facility-outpatient or ER (628 to 623; AAPC, -0.3 [-1.7, 1.0]), home (3348 to 3536; AAPC, -3.1 [2.0, 4.1]), hospice (375 to 1136; AAPC, 12.5 [10.0, 15.0]), nursing home/long-term care (2988 to 3007; AAPC, 0.0 [-0.9, 1.0]), and other (583 to 682; AAPC, -0.7 [3.2, 1.2]).