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ORIGINAL RESEARCH

Demographic and Regional Trends of Mortality in Patients With Aortic Dissection in the United States, 1999 to 2019

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BACKGROUND: Aortic dissection (AoD) is associated with high morbidity and mortality. However, the burden of AoD mortality is not well characterized, and contemporary data and mortality trends in different demographic and geographic subgroups have not been described.

METHODS AND RESULTS: Trends in AoD mortality were assessed using a cross-sectional analysis of the Centers for Disease Control and Prevention Wide-Ranging Online Data for Epidemiologic Research database. Crude and age-adjusted mortality rates (AAMR) per 1 million people with associated annual percent changes were determined. Joinpoint regression was used to assess trends in the overall sample and different demographic (sex, race and ethnicity, age) and geographic subgroups. Between 1999 and 2019, a total of 86 855 AoD deaths occurred within the United States. In the overall population, AAMR was 21.1 per 1 million in 1999 and 21.3 in 2019. After an initial decline in mortality, AAMR increased from 2012 to 2019, with an associated annual change of 2.5% (95% CI, 1.8–3.3). Men, older adults (aged ≥85 years), and non-Hispanic Black or African American individuals had higher mortality rates than women, younger individuals, and other racial and ethnic individuals, respectively. Despite lower AAMRs throughout the study period, women experienced greater increases in AAMR from 2012 to 2019 compared with men. Similarly, non-Hispanic Black or African American individuals had a pronounced increase in AAMR from 2012 to 2019.

CONCLUSIONS: Despite an initial decline in AoD mortality, the mortality rate has been increasing from 2012 to 2019, with pronounced increases among women and non-Hispanic Black or African American individuals.

Key Words: aortic dissection ■ epidemiology ■ mortality

Aortic dissection (AoD) is associated with significant mortality and morbidity in the United States.[1,2] Challenges associated with the diagnosis and management of AoD result in high rates of mortality. Data from the IRAD (International Registry of Acute Aortic Dissection) indicate that acute Stanford type A AoD carries a 22% in-hospital mortality, whereas patients with type B dissection have a reported 13% in-hospital mortality, with increased mortality among patients who were medically managed compared with surgically managed patients.[3]

Despite the known morbidity of AoD, few studies have reported epidemiological population-based estimates of AoD mortality using contemporary data. In a study using inpatient Medicare data, AoD-related hospitalization rates remained stable from 2000 to 2011,

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CLINICAL PERSPECTIVE

What Is New?

- Overall, aortic dissection mortality increased from 2012 to 2019 in the United States.
- Women experienced greater increases in mortality compared with men from 2012 to 2019.
- Non-Hispanic Black or African American individuals had the highest mortality compared with other racial and ethnic groups.

What Are the Clinical Implications?

- Further studies are needed to understand the underlying mechanism of the recent increase in aortic dissection mortality.
- More strenuous efforts are needed to reduce the sex and racial disparities in aortic dissection mortality.

Nonstandard Abbreviations and Acronyms

AAMR	age-adjusted mortality rates
AoD	aortic dissection
APC	annual percentage change
CMR	crude mortality rates
IRAD	International Registry of Acute Aortic Dissection
WONDER	Wide-Ranging Online Data for Epidemiologic Research

with improvements in short-term mortality.[1] However, there remains a paucity of data on population-based estimates of AoD mortality over the past decade. In addition, prior studies using administrative databases are limited by inpatient and regional data that may not be representative of nationwide trends.[2,4–6] For example, data from specialty centers or registry analyses may not include deaths occurring outside of the hospital setting. There are also limited data on comparative mortality trends among demographic and regional populations within the United States. Therefore, we used a nationwide database of death certificates to describe contemporary trends in AoD mortality stratified by demographic and regional characteristics.

METHODS

Data Source

The CDC WONDER (Centers for Disease Control and Prevention Wide-Ranging Online Data for Epidemiologic Research) was used to analyze deaths occurring within the United States related to AoD.[7] The Multiple Cause-of-Death Public Use Record database death certificates were studied to determine AoD as an underlying or contributing cause of death on nationwide death certificates. This database has been previously used in several other studies to analyze nationwide trends in mortality of cardiovascular diseases.[8–10] AoD deaths were identified using the *International Classification of Diseases, Tenth Revision, Clinical Modification* (*ICD-10-CM*) I71.0 code in individuals aged ≥25 years. This study was exempt from local institutional review board approval because the CDC WONDER database includes deidentified publicly available data.

Data Extraction

AoD deaths and population sizes were extracted from 1999 to 2019. Demographic (sex, race and ethnicity, and age) and geographic (urban–rural and state) data were also extracted as identified on the death certificates. Racial and ethnic demographic characteristics were defined as non-Hispanic White, non-Hispanic Black or African American, Hispanic or Latino, non-Hispanic American Indian or Alaskan Native, and non-Hispanic Asian or Pacific Islander individuals. These racial and ethnic categories were previously used within analyses from the CDC WONDER database and rely on reported data on death certificates.[7,11] Non-Hispanic American Indian/Alaskan Native and non-Hispanic Asian/Pacific Islander individuals were analyzed together in an Other group because of the limited numbers of cases occurring in each individual group. Age categories were defined as 25 to 39, 40 to 54, 55 to 69, 70 to 84, and ≥85 years. The National Center for Health Statistics Urban-Rural Classification Scheme was used to classify the study population into urban (large metropolitan area [population ≥1 million], medium/small metropolitan area [population 50 000–999 999]), and rural (population <50 000) counties per the 2013 US Census classification.[12] Location of death was also extracted and included medical facilities (outpatient, emergency room, inpatient, death on arrival, or status unknown), home, hospice, and nursing home/long-term care facility.

Statistical Analysis

AoD crude and age-adjusted mortality (AAMR) rates per 1 million people were determined. Crude mortality rates (CMR) were calculated by dividing the number of AoD-related deaths by the corresponding US population of that year. AAMRs were calculated by standardizing the AoD-related deaths to the corresponding year 2000 US population, as previously described.[13] The Joinpoint regression program (version 4.9.0.0; National Cancer Institute) was used to describe trends in CMR and AAMR of AoD-related mortality.[14] Temporal trends in CMR and AAMR were determined by fitting log-linear regression models. We applied Joinpoint regression to identify inflection points in the temporal trends of CMR and AAMR for AoD from 1999 to 2019 based on published methodological guidelines.[15] For data containing 17 to 21 time points, the guidelines recommend that the analysis identifies a maximum of 3 inflection points across the study period.[15] In this study, 21 years were included; therefore, the Joinpoint regression statistical software was set to determine a maximum of 3 joinpoints where significant temporal variation existed in the trend. 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. Therefore, 0 to a maximum of 3 joinpoints were allowed to be identified. The Grid Search method (2, 2, 0), permutation test, and parametric method were used to estimate annual percent change (APC) and 95% confidence intervals (CIs). APC was considered increasing or decreasing if the slope describing the change in mortality was significantly different than 0 using 2-tailed *t* testing. Statistical significance was set at $P \le 0.05$.

RESULTS

Overall Population

Between 1999 and 2019, a total of 86 855 deaths related to AoD occurred in the overall study population (Table S1). Of 83 803 deaths with available information on place of death, 81.7% occurred within medical facilities, 2.8% occurred in nursing or long-term care facilities, 1.5% at hospice, and 13.9% at home (Table S2).

Overall, the AAMR was 21.1 per 1 million in 1999 and 21.3 in 2019 (Table S3). From 1999 to 2012, the overall AAMR of AoD-related deaths was decreasing, with an associated APC of −1.5% (95% CI, −1.8% to −1.2%). This decreasing AAMR was then followed by increasing AAMR from 2012 to 2019, with an APC of 2.5% (95% CI, 1.8%–3.3%) (Table S3, Figure 1).

Demographic Patterns

Sex

In men, the AAMR was 28.5 in 1999 and 27.2 in 2019 (Table S3). The AAMR decreased from 1999 to 2013, which was then followed by increasing AAMR, with an associated APC of 2.6% (95% CI, 1.4%–3.8%) from 2013 to 2019 (Figure 1).

In women, the AAMR was 15.1 in 1999 and 15.7 in 2019 (Table S3). Similar to men, the initial decrease was then followed by increasing AAMR, with an associated APC of 3.1% (95% CI, 2.3%–4.0%) from 2012 to 2019 (Figure 1).

Race and Ethnicity

The AAMR for non-Hispanic White individuals was 20.7 in 1999 and 20.3 in 2019 (Table S4). From 1999 to 2012, White individuals had decreasing AoD-related mortality (Figure 2). However, from 2012 to 2019, White individuals had increasing AoD-related mortality, with an associated APC of 2.6% (95% CI, 2.0%–3.2%).
Non-Hispanic Black or African American individuals had the highest AAMR throughout the study period, which was 28.7 in 1999 and 35.7 in 2019. From 1999 to 2012 there were no significant changes in AoD-related AAMR for non-Hispanic Black or African American individuals. However, from 2012 to 2019, AoD-related AAMR markedly increased at an associated APC of 4.0% (95% CI, 2.5%–5.5%).

Hispanic or Latino individuals had the lowest AAMR throughout the study period, which was 13.4 in 1999 and 13.6 in 2019. From 1999 to 2014, the AoD-related AAMR decreased; however, from 2014 to 2019, the AoD-related mortality remained stable without significant changes.

The AAMR for non-Hispanic Other individuals was 17.1 in 1999 and 18.0 in 2019. There were no significant changes in AAMR for non-Hispanic Other individuals throughout the study period.

Age

Individuals who were aged ≥85 years had a CMR of 106.8 in 1999 and 135.5 in 2019 (Table S5, Figure 3). From 1999 to 2012, CMR remained stable, followed by increase from 2012 to 2019, with an associated APC of 3.8% (95% CI, 2.4%–5.2%).
Individuals aged 70 to 84 years had the second highest CMR of 70.8 to 55.2 from 1999 to 2019. From 2012 to 2019, the CMR increased at an associated APC of 1.3% (95% CI, 0.45%–2.25%).

Individuals aged 55 to 69 years experienced increasing CMR from 2012 to 2019 (APC, 3.4% [95% CI, 2.0%–4.85%]).

Individuals aged 40 to 54 years and 25 to 39 years experienced increasing CMR from 1999 to 2019 (aged 40–54 years: APC, 1.3% [95% CI, 0.9%–1.7%]; aged 25–39 years: APC, 1.3% [95% CI, 0.9%–1.8%]).

Geographical Patterns

Rural, small/medium metropolitan, and large metropolitan counties had similar trends in AAMR throughout the study period, with initial decreasing AAMR from 1999 to 2012/2013, followed by increasing AAMR from 2012 to 2019 (Figure 4, Table S6). The AAMR varied from 14.3 in Massachusetts to 30.9 in the District of Columbia (Figure 5, Table S7). States in the ≥90th percentile of AoD-related AAMR included Washington, Kansas, Delaware, Michigan, Hawaii, and the District of Columbia. States in the ≤10th percentile of AoD-related AAMR included Connecticut, New Jersey, Kentucky, Virginia, Mississippi, and Massachusetts (Table S7).

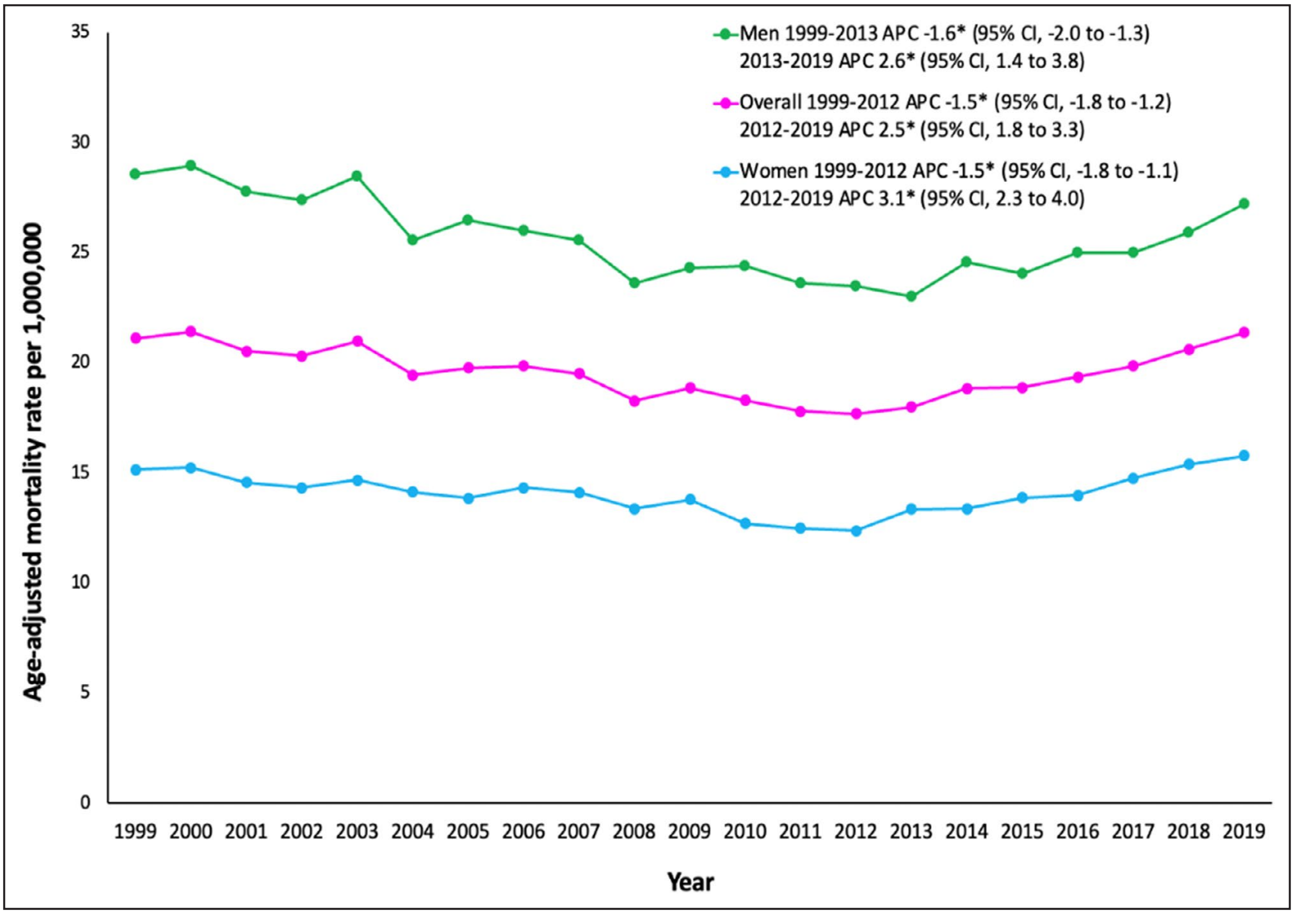

Figure 1. Overall and sex-stratified age-adjusted aortic dissection mortality rates in the United States, 1999 to 2019.
*The annual percent change (APC) is significantly different from 0 at α=0.05.

DISCUSSION

In this nationwide study, we report several important findings about AoD mortality using data from 1999 to 2019 within the United States. First, after an initial decline from 1999 to 2012, AoD mortality has been increasing from 2012 and 2019, including among most demographic groups within this study. Second, men had higher AAMR throughout the study; however, women experienced a larger relative increase in AAMR compared with men from 2012 onward. Third, non-Hispanic Black or African American individuals had the highest AAMRs compared with other racial and ethnic groups. In addition, non-Hispanic Black or African American individuals did not experience declines in AAMR from 1999 to 2012 and had markedly rising AAMR from 2012 to 2019. Fourth, individuals aged ≥85 years had the highest CMR, with markedly rising CMR from 2012 to 2019.

Despite the known morbidity of AoD, the current literature on population-based AoD mortality is limited. In a study using inpatient Medicare data from 2000 to 2011, the hospitalization rate for AoD remained stable, with significantly decreasing 30-day mortality, indicating an improvement in outcomes during this limited time period.[1] In addition, other existing studies on AoD mortality are limited by regional populations, inpatient databases, or registries from high-volume tertiary centers.[2,4,16] For example, county level data from Olmsted County, Minnesota indicated stable incidence of AoD, with unchanged short- and long-term mortality from 1995 to 2015.[16] Similarly, data from an all-payer nationwide database indicated rising incidence of AoD hospitalizations and emergency department visits from the early 2000s to 2017, with decreasing in-hospital mortality rates.[2,17] However, to our knowledge, there are no data on nationwide population-based AoD mortality rates beyond 2012 further stratified by important demographic and regional populations.

In this study using contemporary data, we report a concerning increase in AoD mortality rates from 2012 to 2019. Despite an initial decline in AoD mortality from 1999 to 2012, the AoD mortality rate has almost uniformly increased among all demographic and regional groups through 2019. There are several plausible explanations of this finding. First, the prevalence of AoD

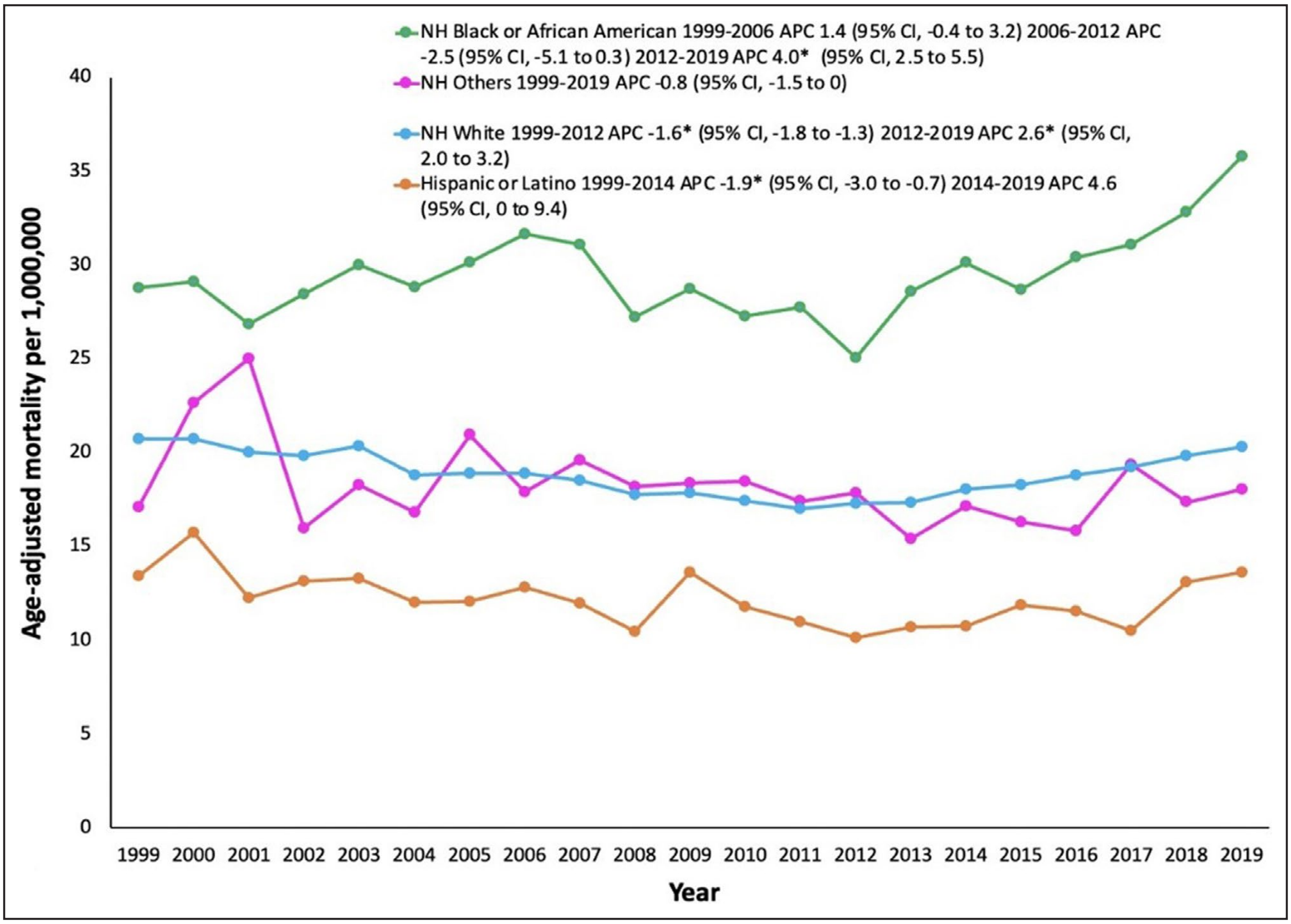

Figure 2. Aortic dissection age-adjusted mortality rates stratified by race and ethnicity in the United States, 1999 to 2019.
*The annual percent change (APC) is significantly different from 0 at α=0.05. NH indicates non-Hispanic.

risk factors such as uncontrolled hypertension, obesity, smoking, diabetes, and older age has been increasing within the United States.[18] In a study using prospective data from the Japan-Specific Health Checkups and UK Biobank, hypertension was associated with a high risk of AoD in a dose-dependent relationship.[19] The prevalence of hypertension has decreased from 47.0% in 1999 to 2000 to 41.7% in 2013 to 2014 and then increased to 45.4% in 2017 to 2018.[20] Notably, the prevalence of uncontrolled hypertension has also increased after 2014, plausibly contributing to the rising AoD deaths seen within this study.[21] This could be related to the impact of findings from trials such as The Action to Control Cardiovascular Risk in Diabetes trial (ACCORD) and The Secondary Prevention of Small Subcortical Strokes trial (SPS3-BP) that showed no apparent benefit from intensive blood pressure control.[22,23] Other less-significant risk factors including obesity, smoking, and diabetes have followed similar trends in the United States, possibly supporting the results of our study.[24–26] Therefore, there may be an increasing incidence of AoD resulting in increased AoD deaths after 2012. Second, although improvements in AoD management have occurred, AoD syndromes are associated with high rates of mortality. For example, despite an increase in surgical intervention and chest computed tomography use in the management and diagnosis of AoD, in-hospital mortality rates for Stanford type A and type B AoD have improved but have remained stagnant for type B AoDs.[3] Importantly, these studies only report in-hospital mortality of acute AoD requiring repair, which does not capture long-term mortality of AoD. For example, in patients with type A or type B acute aortic syndromes who survive the acute dissection, around two-thirds of patients experienced at least 1 aortic or nonaortic adverse event over long-term follow-up period, including death.[27] Finally, our analysis also includes deaths occurring in nonmedical facility settings, which comprised ~18% of total deaths throughout the study period, a considerable portion of the total study population.

Considering the increasing AoD deaths found within this study, efforts to control medical comorbidities associated with AoD and operative intervention shown to decrease in-hospital mortality may be required to improve these epidemiological trends. For example,

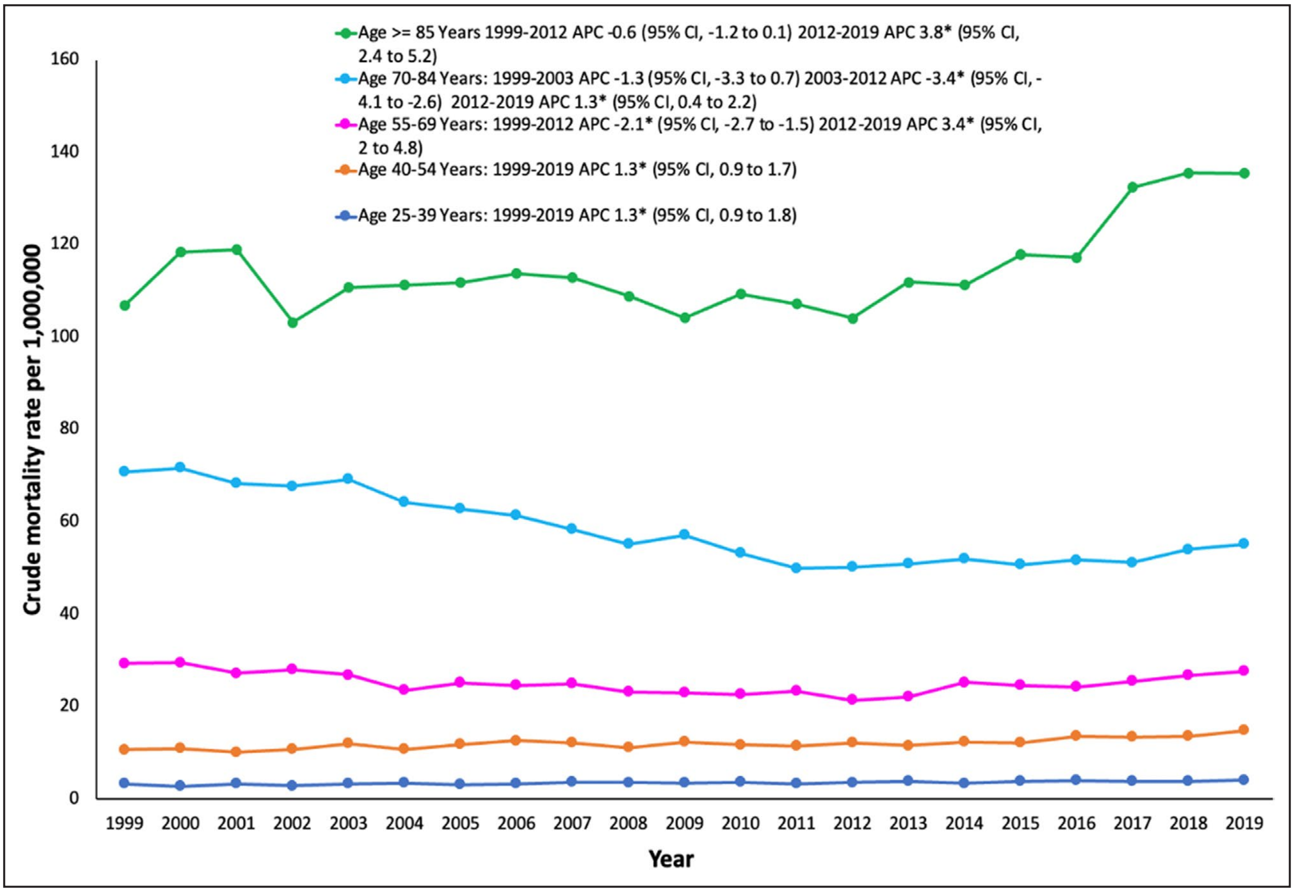

Figure 3. Aortic dissection crude mortality rates stratified by age groups in the United States, 1999 to 2019.
*The annual percent change (APC) is significantly different from 0 at α=0.05.

within the IRAD registry, type A AoD treated with surgical intervention had lower in-hospital mortality than those with medical treatment alone.[3] In addition, in-hospital mortality for patients undergoing surgery has decreased from 1996 to 2016 for type A AoD (17.5% versus 12.2%, respectively) within the IRAD registry, and the use of endovascular aortic repair has resulted in a significant decrease in operative mortality for type B AoD (18.6% versus 7.4%, respectively).[28,29] Therefore, expeditious referrals for surgical procedures are necessary to improve outcomes for patients with AoD. However, it is also important to note that some patients may not be candidates for aortic intervention because of AoD complications such as hemispheric stroke, cardiogenic shock/visceral malperfusion, or cardiopulmonary arrest >15 minutes, which are associated with worse operative outcomes.[30,31] In addition, close surveillance imaging for patients at high-risk of AoD or enlarged thoracic aortas, such as those with a family history of AoD, bicuspid aortic valve, women, and others, may be needed.[32,33]

Men had a higher AoD mortality throughout the study period. In the IRAD and population estimates from Olmstead County, Minnesota, AoD was more frequent in men compared with women.[16,34] This correlates with previous studies conducted on sex differences and hypertension prevalence within the United States. Men have higher prevalence of hypertension across the majority of age groups compared with women in the United States.[35] Men are more likely to smoke cigarettes than women, with about 15.3% of men versus 12.7% of women using cigarettes.[36] Therefore, the higher rates of hypertension, smoking, and other risk factors among men compared with women within the United States may contribute to the noted sex differences in AoD mortality rates in our study.

The more pronounced increase in AoD mortality from 2012 to 2019 among women found in this study correlates with recent reports of sex disparities in AoD outcomes. For example, the diagnosis of AoD is more often delayed in women than men, leading to a worse outcome of surgically treated women compared with men, plausibly supporting our reported trends.[34] In addition, thoracic aneurysms in women are more likely to grow at faster rates, and women experience dissections at smaller aortic diameters compared with men, potentially needing indexed aortic diameters for risk stratification.[37] Within the United States, there are

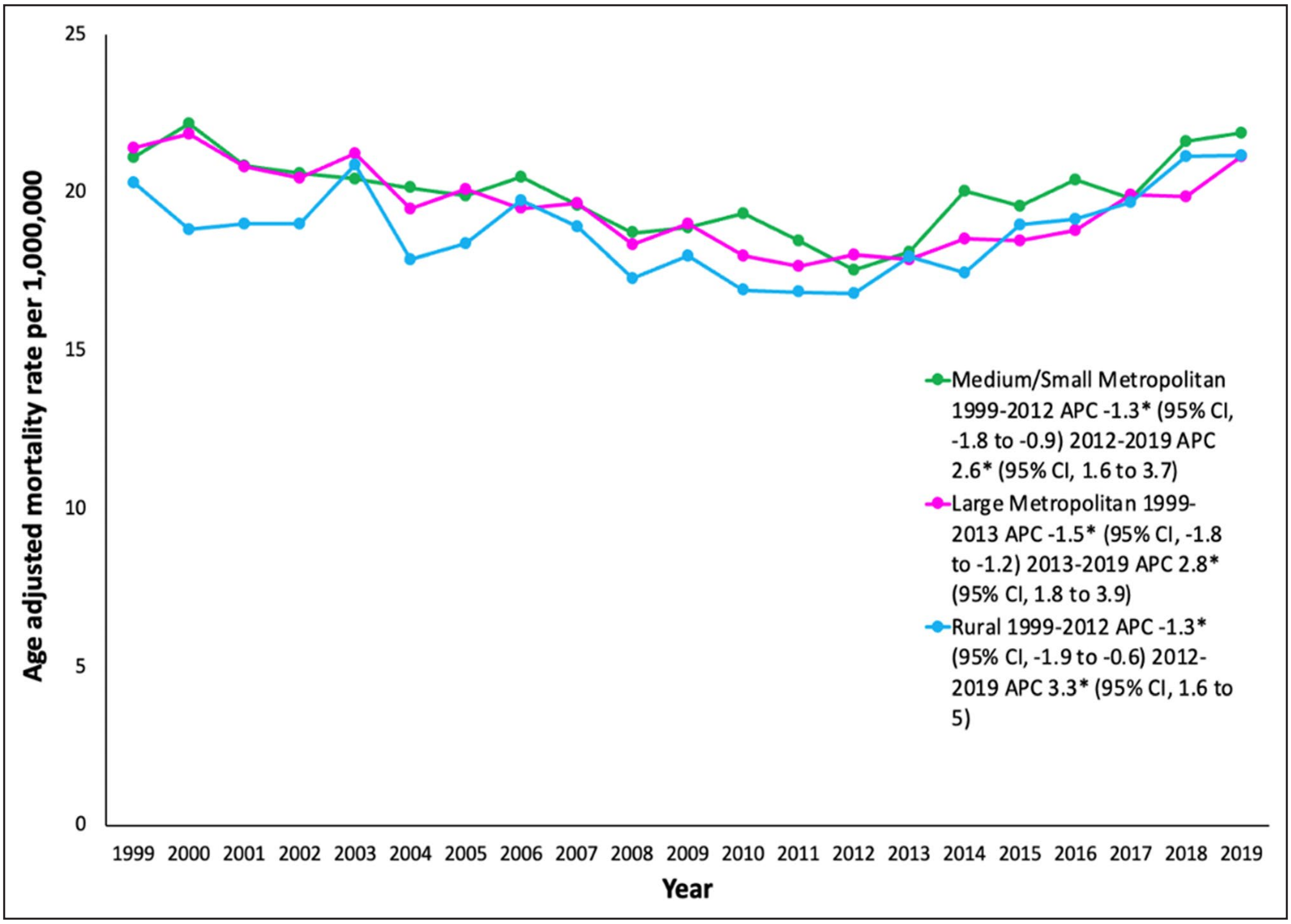

Figure 4. Aortic dissection age-adjusted mortality rates stratified by urban–rural classification in the United States, 1999 to 2019.
*The annual percent change (APC) is significantly different from 0 at α=0.05.

discrepancies among the professional society guidelines for abdominal aortic aneurysm (AAA) screening for women compared with men.[38] Moreover, female sex has previously been reported as an independent predictor of mortality among both ruptured and elective AAA repair groups.[38]

Non-Hispanic Black or African American individuals had persistently higher rates of AoD mortality throughout the study, with a marked increase in mortality from 2012 to 2019 compared with remainder of the races and ethnicities. This pronounced population-estimated AoD mortality in non-Hispanic Black or African American individuals has not been previously reported. In a study of Maryland hospitals, non-White race and ethnicity has been reported to be an independent risk factor for AoD admissions.[39] The proportion of non-Hispanic Black or African American individuals with controlled blood pressure is significantly lower than that of non-Hispanic White individuals, which may be associated with the pronounced mortality reported in our study.[21] Additionally, the impact of social determinants of health on cardiovascular disease outcomes has been previously described in the United States. Non-Hispanic Black or African American individuals are disproportionately affected by conditions such as hypertension and have a higher burden of social and economic factors impeding their care.[40,41] Individuals who are medically underserved have unequal access to health care resources to control their blood pressure, diabetes, or other potential risk factors for AoD.[42] Additionally, non-Hispanic Black individuals are more likely to have inadequately controlled hypertension with antihypertensive therapy, possibly increasing mortality rates from AoD.[43]

There are several limitations to this study. First, misclassification of AoD mortality may occur upon completion of death certificate data within the database. Second, the CDC WONDER database does not include procedural data on rate or outcomes of AoD repair or social determinants of health information, which may impact the outcomes of demographic subgroups. Therefore, we are unable to determine the exact reasons for reported disparities in AoD-related

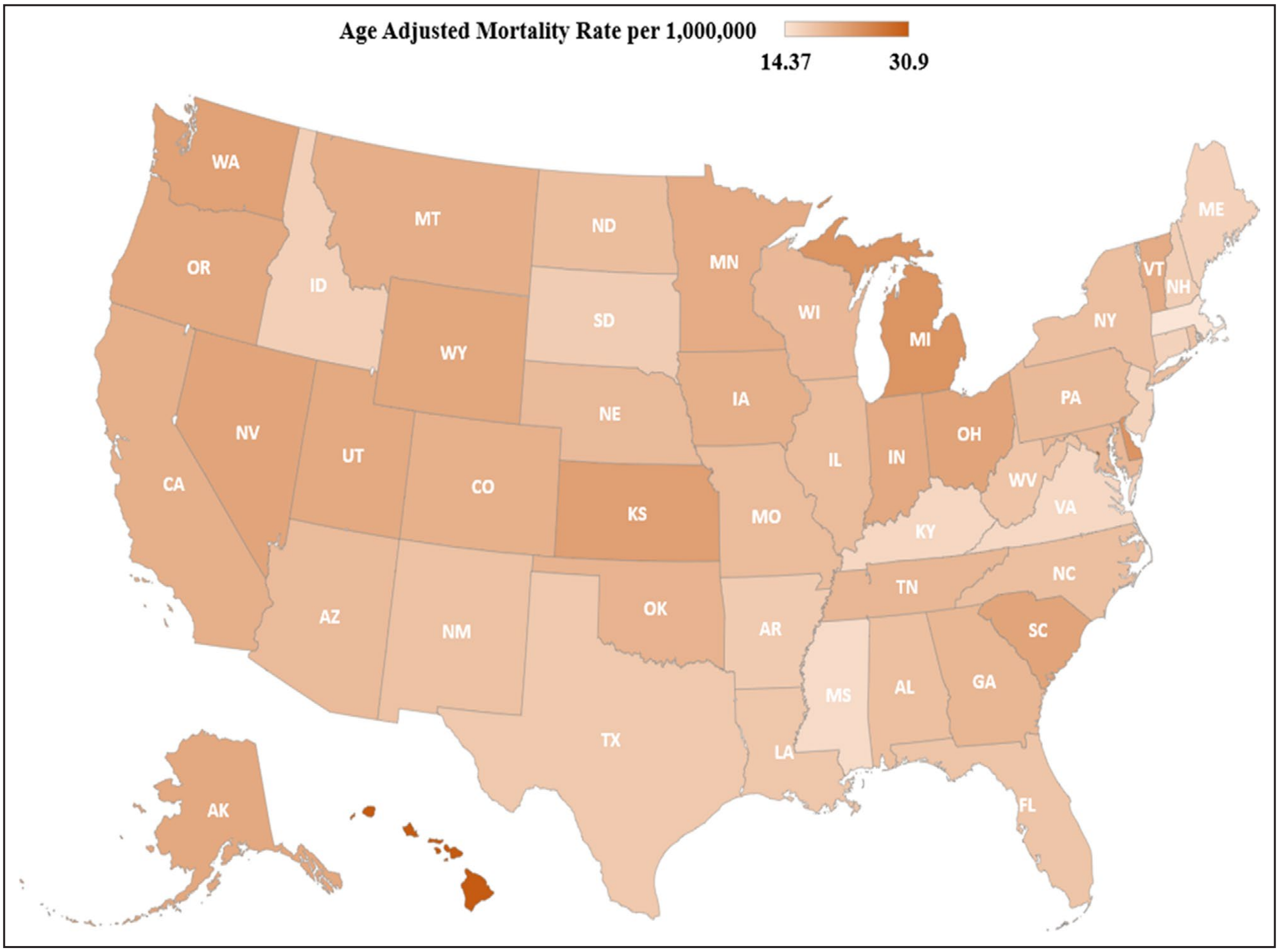

Figure 5. State-level aortic dissection age-adjusted mortality rates per 1 million people in the United States, 1999 to 2019.

mortality within this analysis. Third, our data include deaths for both type A and type B AoD given the lack of specific *ICD-10-CM* diagnostic codes for type A and type B dissection. Fourth, the database lacks important information on underlying comorbidities, risk factors (hypertension, smoking, connective tissue disorders), and imaging data (echocardiography, computed tomography angiography, magnetic resonance angiography). Fifth, given that the database is based on death certificate data only, we cannot ascertain how the diagnosis of AoD was made (autopsy versus imaging versus symptoms), particularly for individuals who died outside of the medical facilities. Finally, residents who may have relocated to another state at the time of death are recorded as deaths occurring in their final location.

In conclusion, despite an initial decline, we report a concerning increase in AoD mortality from 2012 to 2019 in this nationwide population-based analysis of death certificate data. This increasing mortality is especially pronounced within women, non-Hispanic Black individuals, and older individuals and requires further investigation into the causative mechanisms of these identified disparities for this highly lethal and morbid condition.

ARTICLE INFORMATION

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Disclosures

None.

Supplemental Material

Tables S1–S7.

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Supplemental Material

Table S1. Absolute Number of Aortic Dissection Deaths Stratified by Sex and Race/Ethnicity in the United States, 1999-2019.

Year	Overall	Women	Men	NH White	NH Black or African American	NH Others	Hispanics or Latino
1999	3745	1553	2192	3014	487	92	143
2000	3844	1590	2254	3035	495	126	171
2001	3749	1546	2203	2960	476	146	150
2002	3772	1532	2240	2970	521	102	164
2003	3964	1589	2375	3085	567	125	175
2004	3721	1556	2165	2864	547	122	182
2005	3868	1554	2314	2927	593	154	184
2006	3957	1631	2326	2963	633	138	211
2007	3960	1628	2332	2939	654	166	197
2008	3780	1580	2200	2853	581	156	180
2009	3940	1635	2305	2892	621	168	250
2010	3891	1541	2350	2861	606	173	235
2011	3895	1545	2350	2849	631	173	231
2012	3920	1552	2368	2906	580	196	221
2013	4067	1705	2362	2956	686	180	235
2014	4371	1768	2603	3159	735	212	249
2015	4442	1861	2581	3217	711	211	289
2016	4608	1889	2719	3319	770	207	295
2017	4854	2064	2790	3473	807	274	283
2018	5126	2178	2948	3618	860	257	369
2019	5381	2267	3114	3755	950	279	379
Total	86855	35764	51091	64615	13511	3657	4793

Table S2. Trends in Aortic Dissection Mortality Stratified by Location of Death in the United States, 1999-2019.

Year	Medical Facility	Nursing home/Long Term Care	Hospice	Home
1999	3193	104	Missing	372
2000	3276	125	Missing	368
2001	3137	124	Missing	396
2002	3169	89	Missing	425
2003	3266	89	2	465
2004	3028	113	0	465
2005	3157	124	15	448
2006	3184	112	21	515
2007	3172	120	34	484
2008	2992	133	34	444
2009	3063	114	48	514
2010	3041	95	57	554
2011	3016	98	67	553
2012	3005	107	92	585
2013	3127	116	83	559
2014	3342	116	117	628
2015	3317	136	129	710
2016	3481	103	135	725
2017	3646	112	139	786
2018	3874	99	152	801
2019	3983	144	160	879
Total	68469	2373	1285	11676

Table S3. Overall and Sex-Stratified Aortic Dissection Age-Adjusted Mortality Rates per 1,000,000 in the United States, 1999 to 2019.

Year	Overall	Male	Female
1999	21.11	28.56	15.14
2000	21.42	28.96	15.24
2001	20.53	27.79	14.57
2002	20.3	27.39	14.33
2003	20.98	28.48	14.67
2004	19.44	25.57	14.13
2005	19.77	26.47	13.85
2006	19.86	25.98	14.32
2007	19.51	25.55	14.11
2008	18.28	23.61	13.38
2009	18.85	24.33	13.78
2010	18.29	24.41	12.7
2011	17.8	23.62	12.49
2012	17.68	23.5	12.37
2013	18	23	13.35
2014	18.83	24.59	13.38
2015	18.88	24.04	13.88
2016	19.36	25.01	13.97
2017	19.86	25.02	14.76
2018	20.61	25.9	15.38
2019	21.37	27.21	15.78
Total	19.47	25.42	14.04

Table S4. Aortic dissection age-adjusted mortality rates per 1,000,000 stratified by race in the United States, 1999 to 2019.

Year	NH White	NH Black or African-American	NH Others	Hispanic or Latino
1999	20.75	28.77	17.11	13.44
2000	20.73	29.11	22.65	15.76
2001	20.01	26.86	25.01	12.27
2002	19.84	28.44	15.99	13.15
2003	20.37	30	18.31	13.31
2004	18.8	28.83	16.85	12.02
2005	18.88	30.14	20.95	12.08
2006	18.91	31.65	17.91	12.83
2007	18.54	31.08	19.61	11.98
2008	17.75	27.25	18.21	10.49
2009	17.88	28.76	18.38	13.62
2010	17.46	27.27	18.46	11.78
2011	17.01	27.75	17.42	11.01
2012	17.3	25.08	17.88	10.12
2013	17.33	28.59	15.4	10.69
2014	18.07	30.13	17.14	10.75
2015	18.29	28.69	16.32	11.89
2016	18.82	30.41	15.85	11.56
2017	19.23	31.11	19.39	10.53
2018	19.85	32.84	17.37	13.11
2019	20.33	35.79	18.07	13.61
Total	18.78	29.45	17.98	12.01

Table S5. Aortic dissection crude mortality rates per 1,000,000 stratified by age groups in the United States, 1999 to 2019.

Year	Age 25-39	Age 40-54	Age 55-69	Age 70-84	Age 85+
1999	3.23	10.65	29.29	70.85	106.88
2000	2.75	10.86	29.49	71.64	118.41
2001	3.32	10.08	27.17	68.27	118.96
2002	2.82	10.75	27.98	67.67	103.23
2003	3.32	11.96	26.8	69.18	110.83
2004	3.51	10.72	23.49	64.26	111.31
2005	3.15	11.76	25.1	62.74	111.86
2006	3.27	12.59	24.6	61.39	113.85
2007	3.61	12.19	24.9	58.31	112.91
2008	3.54	11.03	23.17	55.12	108.93
2009	3.51	12.3	22.97	57.08	104.15
2010	3.64	11.72	22.63	53.18	109.4
2011	3.24	11.45	23.4	49.86	107.2
2012	3.54	12.19	21.36	50.21	104.12
2013	3.75	11.51	22.07	50.84	111.91
2014	3.36	12.35	25.2	51.91	111.32
2015	3.8	12.14	24.57	50.66	117.86
2016	3.94	13.54	24.19	51.68	117.24
2017	3.85	13.38	25.51	51.17	132.48
2018	3.85	13.63	26.77	53.99	135.53
2019	4.06	14.82	27.61	55.2	135.5
Total	3.49	11.98	24.97	57.85	115.22

Table S6. Aortic dissection age-adjusted mortality rates per 1,000,000 stratified by Urban-Rural classification in the United States, 1999 to 2019.

Year	Large Metropolitan	Medium/Small Metropolitan	Rural
1999	21.41	21.12	20.32
2000	21.85	22.19	18.83
2001	20.84	20.86	19.03
2002	20.48	20.62	19.01
2003	21.24	20.45	20.9
2004	19.49	20.16	17.9
2005	20.12	19.91	18.4
2006	19.51	20.5	19.77
2007	19.67	19.61	18.94
2008	18.36	18.74	17.31
2009	19.01	18.91	18.01
2010	18.01	19.34	16.93
2011	17.67	18.48	16.87
2012	18.03	17.57	16.82
2013	17.9	18.12	17.98
2014	18.55	20.05	17.47
2015	18.49	19.59	19
2016	18.82	20.41	19.17
2017	19.93	19.83	19.69
2018	19.89	21.63	21.15
2019	21.15	21.9	21.17
Total	19.45	19.9	18.71

Table S7. State-level Aortic Dissection age-adjusted mortality rates per 1,000,000 people in the United States, 1999 to 2019.

State	Rank	Percentile	Age-adjusted mortality rate per 1,000,000
Massachusetts	1	0	14.37
Mississippi	2	2	15.58
Virginia	3	4	15.91
Kentucky	4	6	16.05
New Jersey	5	8	16.55
Connecticut	6	10	16.59
Maine	7	12	16.61
Idaho	8	14	16.97
New Hampshire	9	16	17.1
South Dakota	10	18	17.34
Arkansas	11	20	17.46
Texas	12	22	17.73
Louisiana	13	24	17.94
West Virginia	14	26	18.19
Florida	15	28	18.22
Rhode Island	16	30	18.38
New Mexico	17	32	18.56
Alabama	18	34	18.78
New York	19	36	18.84
North Carolina	20	38	18.88
North Dakota	21	40	19
Missouri	22	42	19.24
Illinois	23	44	19.27
Arizona	24	46	19.32
Nebraska	25	48	19.43
Pennsylvania	26	50	19.46
Maryland	27	52	19.67
Wisconsin	27	52	19.67
Tennessee	29	56	19.82
Georgia	30	58	19.89
Oklahoma	31	60	20.26
Colorado	32	62	20.55
Iowa	33	64	20.69
California	33	64	20.69
Montana	35	68	20.74
Minnesota	36	70	21.09

Vermont	37	72	21.11
Indiana	38	74	21.34
Utah	39	76	21.38
Oregon	40	78	21.48
Alaska	41	80	21.54
Wyoming	42	82	21.68
Nevada	43	84	21.93
Ohio	44	86	22
South Carolina	45	88	22.01
Washington	46	90	22.33
Kansas	47	92	22.71
Delaware	48	94	23.87
Michigan	49	96	23.94
Hawaii	50	98	30.8
District of Columbia	51	100	30.9