Has the first year of the COVID-19 pandemic reversed the trends in CV mortality between 1999-2019 in the United States?

Ofer Kobo[1,2*], Dmitry Abramov[3*], Marat Fudim[5], Garima Sharma[6], Vijay Bang[7], Ashish Deshpande [8], Rishi K. Wadhera[9], Mamas A. Mamas[2]

*Joint first authors

[1]Department of Cardiology, Hillel Yaffe Medical Center, Hadera, Israel
[2]Keele Cardiovascular Research Group, Centre for Prognosis Research, Keele University, Stoke-on-Trent, UK.
[3]Division of Cardiology, Department of Medicine, Loma Linda University Health, Loma Linda, California, US
5. Department of Medicine, Duke University Medical Center, Durham, NC and Duke Clinical Research Institute, Durham, NC
6. Johns Hopkins Ciccarone Center for the Prevention of Cardiovascular Diseases, Johns Hopkins School of Medicine,
7. Lilavati Hospital and Research Center, Mumbai, India
8. Oriion Citicare Hospital, Aurangabad.Aurangabad India
9. Richard A. and Susan F. Smith Center for Outcomes Research, Beth Israel Deaconess Medical Center, Boston, MA

***Correspondence to:**
Mamas A. Mamas
Keele Cardiovascular Research Group,
Centre for Prognosis Research, Keele University, Stoke-on-Trent, UK
E-mail: mamasmamas1@yahoo.co.uk; Tel: +44 1782 671654; Fax: +44 1782 734719

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Abstract:

Aims: Although cardiovascular (CV) mortality increased during the COVID-19 pandemic, little is known about how these patterns varied across key subgroups, include age, sex, and race and ethnicity, as well as by specific cause of CV death.

Methods and Results: The Centers for Disease Control WONDER database was used to evaluate trends in age-adjusted CV mortality between 1999 and 2020 among US adults aged 18 and older. Overall, there was a 4.6% excess CV mortality in 2020 compared to 2019, which represents an absolute excess of 62,802 deaths. The relative CV mortality increase between 2019 and 2020 was higher for adults under 55 years of age (11.9% relative increase), versus adults aged 55-74 (7.9% increase) and adults 75 and older (2.2% increase). Hispanic adults experienced a 9.4% increase in CV mortality (7,400 excess deaths) versus 4.3% for non-Hispanic adults (56,760 excess deaths). Black adults experienced the largest percent increase in CV mortality at 10.6% (15,477 excess deaths) versus 3.5% increase (42,907 excess deaths) for White adults. Among individual causes of CV mortality, there was an increase between 2019 and 2020 of 4.3% for ischemic heart disease (32,293 excess deaths), 15.9% for hypertensive disease (13,800 excess deaths), 4.9% for cerebrovascular disease (11,218 excess deaths), but a decline of 1.4% for heart failure mortality.

Conclusion: The first year of the COVID pandemic in the United States was associated with a reversal in prior trends of improved CV mortality. Increases in CV mortality were most pronounced among Black and Hispanic adults.

Introduction

Cardiovascular (CV) disease is a leading cause of mortality in the United States (US). Cardiovascular mortality has declined over time,[1] although may have reached a plateau from 2010 onward.[2] In early 2020, as part of the global pandemic, COVID-19 led to significant changes to healthcare delivery and patient outcomes in the US. Consequently, early phases of the pandemic in 2020 were associated with an increase in morbidity and mortality for both COVID-associated and non-COVID-associated etiologies; including from increase in CV disease attributed to COVID infection.[3,4] In addition to an increase in all-cause mortality,[5] reports based on data from 2020 demonstrated an increase in CV mortality, including from individual contributors such as from ischemic heart disease (IHD) and cerebrovascular disease.[6,7,8,9] However, there is limited data on excess mortality from CV disease overall as well as from its specific components throughout 2020 compared to historical trends, including mortality characterized by age, sex, and racial and ethnic populations. The impact of the pandemic on CV outcomes characterized by race may be of particular importance given prior literature on COVID-related exacerbation of health disparities among adults of lower socioeconomic status and among racial minorities, particularly Black adults, in the US.[7,10] Therefore, we queried the Centers for Disease Control and Prevention (CDC) dataset to gain a better understanding of the impact of the COVID pandemic on historical trends in both overall and individual components of CV mortality, and whether total and cause specific CV mortality during the COVID pandemic was disproportionally impacted in different age, sex, and racial subgroups.

Methods

Setting and study population

Cardiovascular mortality was determined using the Multiple Cause of Death database through the Centers for Disease Control and Prevention Wide-Ranging, Online Data for Epidemiologic Research (CDC WONDER). This database contains population counts and mortality data for all US counties between 1999 to 2020 based on death certificates for US residents aged 18 and older. Each death certificate contains demographic data as well as a single underlying cause of mortality with up to 20 additional contributing causes. The underlying cause of mortality is selected from conditions entered by the physician on the cause of death section of the death certificate. Causes of mortality are recorded in accordance with the International Classification of Disease Tenth Revision (ICD-10). Deaths of non-residents (e.g., nationals living abroad, non-resident aliens) are excluded. The absolute number of deaths, crude mortality rates, age-adjusted mortality rates, as well as 95% confidence intervals for mortality rates can be obtained by cause of mortality, age, gender, race, place of residence, Hispanic origin, and year.

Primary Outcome

We included all decedents with an underlying cause of mortality due to CV disease(I*). We sub-categorized CVDs into ischaemic heart disease (IHD, I20–I25), heart failure (I50), hypertensive diseases (I10–I15), and cerebrovascular disease (I60– I69) for additional analyses. We included decedents regardless of their known COVID status because COVID testing was not widespread, particularly in the early part of the pandemic, and COVID may impact CV mortality through its indirect impact on healthcare services and workforce.

Statistical analysis

We presented the % change in crude and age adjusted CV mortality rates between four time points (1999, 2011, 2019 and 2020). Age adjusted mortality rates (AAMRs) are provided by the CDC WONDER website and were calculated yearly using the direct standardization method based on the age group weights from the 2000 U.S. population. Mortality rates were calculated for each year. The population estimates used as the denominators of rates were race-, Hispanic origin-, sex-, age-, and state- specific, and were obtained each year for the Rural and Urban population from the CDC Wonder website.

We estimated the annual percent change (APC) in AAMR assuming that rate changes are similar on a log scale for each consecutive period. The average annual percent change (AAPC) in AAMR was computed as a summary measure of the trend over the measured period. This was based on all years of data (1999-2019). By using the calculated AAPC in AAMR, we were able to assess the projected AAMR in 2020 for the different subgroups (AAMR in 2019 + AAPC). Comparing the projected and actual AAMR in 2020 allowed us to estimate the excess AAMR in 2020.. Using the % of excess AAMR allowed us to estimate the number of excess deaths in the different subgroups. We also presented the % change in AAMR between 2011-2019 as historical CV mortality trends are not linear. the Analysis was performed using the JointPoint Regression program (developed by the USA National Cancer Institute).

Results

Sociodemographic characteristic

Between 1999 and 2020 in the overall US population, we identified a total of 18,783,701 death certificates with CV as the underlying cause of mortality, resulting in an AAMR of 254.4 per 100,000 population. Absolute mortality and crude mortality rates are shown in Table 1, and

AAMR is shown in Table 2. Of the overall CV mortality, 51% (9,580,318) were female, 94.6% (17,765,308) were Not Hispanic or Latino, 85.4% (16,036,107) were White adults, 12.1% were Black or African American adults, 2.1% were Asian or Pacific Islander adults, and 0.5% were American Indian or Alaska native adults.

Overall, the AAMR was higher in males (303.7 vs 214.3 in females per 100,000 population), in adults of non-Hispanic origin (259.4 vs 184.0 per 100,000 population), and in Black or African American adults (329.1 vs 250.0, 173.6. and 146.4 per 100,000 population in White, American Indians or Alaska Natives, and Asian or Pacific Islander adults).

CV AAMRs were higher in rural counties compared to urban counties (284.1 vs 248.3 per 100,000 population). Among adults with CV mortality, 48.5% of mortality cases (9,108,644) were attributed primarily to IHD (AAMR of 123.0 per 100,000 population), which was the most common cause of mortality during the study period, 17.0% of the CV mortality was attributed to cerebrovascular diseases (AAMR of 43.3 per 100,000 population), 8.0% (1,497,884) to hypertensive diseases (AAMR of 20.2 per 100,000 population), and 7.6% (1,427,576) to heart failure (HF, AAMR 19.3 per 100,000 population).

Overall CV mortality

Between 1999 and 2019, the overall CV age adjusted mortality rate decreased by 38.8% (350.8 to 214.6 per 100,000 population), Table 2. This decrease was mainly driven by a decrease in IHD and cerebrovascular disease mortality (54.8% decrease in AAMR from 194.6 to 88.0 per 100,000 population and a 39.9% decrease in AAMR from 61.6 to 37.0 per 100,000, respectively). AAMR of HF increased by 3.4% (20.3 to 21.0 per 100,000 population) and of hypertensive disease increased by 58.9% (15.8 to 25.1 per 100,000 population), Figure 1. The decrease in overall CV AAMR between 1999 and 2019 was observed across all sex, race, Hispanic origin, US region and urbanization status groups (Table 2, Supplementary Figures 1-5). Table 2 also highlights changes in CV AAMR solely for the second half of the study period,

from 2011-2019. The decline in AAMR between 2011-2019 was less prominent than the AAMR decline for the whole study period, suggesting that CV mortality started to plateau over the last decade prior to 2020.

Sociodemographic Characteristics of Excess Deaths:

Using the average annual percent change between 1999-2019, we estimate that the projected AAMR for CV mortality in 2020 should have been lower than the AAMR for CV mortality in 2019 in all subgroups studied (Table 2). However, when actual the AAMR for CV mortality between 2019 and 2020 were calculated, we observed a 4.6% increase in CV AAMR (214.6 to 224.4 per 100,000 population). The magnitude of this increase in CV AAMR between 2019 and 2020 differed amongst different populations. While the increase in CV AAMR between 2019 and 2020 was greater among males (5%) than females (3.8%) it increased by a similar extent in rural and urban counties (4.4% and 4.6% respectively), and in all US regions (4.2%-4.8%). We observed a larger percentage increase in CV AAMR in younger age groups (11.9% in adults under 55 years old, vs 7.9% and 2.2% in adults aged 55-74 and over 75 years old, respectively). The increase in CV AAMR was greater among Black or African American (10.6%) and Asian or Pacific Islander (8.8%) adults compared to American Indian or Alaska Native (6.1%) and White adults (3.5%); the increase among Hispanic or Latino population was more than twice compared to non-Hispanic or Latino adults (9.4% vs 4.3%). The increase in CV AAMR was observed in most, but not all US states (Figure 4).

Given the major differences between observed CV AAMR for 2020 compared to projected CV AAMR that we predicted for 2020, we calculated the estimated excess CV AAMR (Actual CV AAMR - Projected CV AAMR) for 2020. The estimated excess 2020 AAMR for CV mortality was +6.7% (Table 2). The estimated excess 2020 CV mortality rates were higher in the younger age groups (11.3% in adults aged under 55, compared to 9.5% and 4.7% in adults aged 55-74, and

over 75, respectively), in males (7.1% vs. 6.1% among females), among adults of Hispanic or Latino origin (11.0% vs 6.6%) and in ethnic minorities (11.9%, 10.8%, and 8.5% excess mortality in Black or African American, Asian or Pacific Islander, and American Indian or Alaska Native adults compared to 5.6% in white adults). The estimated excess CV AAMR was greater in the Northeast US (7.1% compared to 6.4%-6.6% in other US areas) and was similar in urban and rural counties. The estimated number of excess deceased among different subgroups is presented in Table 3.

CV Mortality based on causes from 2019-2020

Estimated excess CV mortality in 2020 (Actual AAMR - Projected AAMR) in different subgroups and for the top 4 specific causes of CV mortality are shown in Table 3. Between 2019 and 2020, there was an estimated mortality excess of 32,923 for IHD, 11,218 for cerebrovascular disease, 13,800 for hypertensive disease, although an estimated decrease of 3,606 deaths from HF. Data on AAMR for less common causes of CV mortality including atrial fibrillation, cardiomyopathies, pulmonary heart disease, valvular disease, cardiac arrest, and arrhythmias is presented in Supplementary Table 1. Crude and AAMR for the top 4 specific components of CV mortality broken down by sex, age, race, and geography are listed in Supplementary Tables 2-5. Important findings from these analyses include a more prominent age adjusted increase in excess mortality among adults under 55 years of age compared to older adults (Supplementary Figure 2), particularly for IHD, cerebrovascular disease, and HF mortality. Among adults under the age of 55 we observed a 23.2% excess heart failure mortality, whilst in adults aged 55-74 and 75 and above we observed an estimated heart failure mortality decline of 0.4% and 4.9% respectively between 2019 and 2020. Excess mortality by specific components of CV mortality stratified by sex and race/ethnicity is shown in Figures 2 and 3 respectively.

There were prominent differences among individual components of CV mortality between 2019 and 2020 based on race and Hispanic ethnicity. Between 2019 and 2020, Black adults compared to White adults had an estimated increase in mortality of 16.0% vs 7.3% from IHD, an estimated increase of 9.5% vs 6.6% from cerebrovascular mortality, and an estimated increase of 16.9% vs 9.6% from hypertensive disease mortality. Among Black adults, this resulted in 7,607 estimated excess deaths from IHD, 2,151 estimated excess deaths from cerebrovascular disease, 3,994 estimated excess deaths from hypertension. Regarding HF mortality, Black adults had a relatively smaller estimated decrease in mortality of 0.5% vs 5.1% compared to White adults. Actual AAMR in 2020 also remained higher for Black adults compared to white adults for IHD (111.5 vs 91.5 per 100,000 population), cerebrovascular disease (55.0 vs 37.2 per 100,000 population), hypertensive disease (55.1 vs 26.2 per 100,000 population), and HF (26.0 vs 20.6 per 100,000 population). Over the same period, Hispanic adults, compared to non-Hispanic adults, saw an estimated 14.0% versus 7.2% increased mortality from IHD, 7.6% versus 7.2% estimated increased mortality from cerebrovascular disease, 14.9 versus 11.1% estimated increased mortality from hypertensive disease, and a smaller estimated decline of 3.0% versus 4.0% for HF related mortality.

Discussion

In this manuscript, we add to the growing body of literature around the impact of the COVID pandemic on CV mortality.[1,2,8,9,11] The current analysis of US CV mortality data from 1999 to 2019 as well as between 2019 and 2020 (the first full year of the COVID pandemic) demonstrates several important findings. We report that CV-associated mortality has decreased between 1999 and 2019, driven by significant declines in IHD and cerebrovascular mortality, with small increases in mortality from HF and hypertensive diseases. We show that the first year of the COVID pandemic in 2020 was associated with a significant reversal of these trends, with large

increases in CV mortality primarily due to increases in IHD, hypertensive, and cerebrovascular mortality. The first year of the COVID pandemic was associated with an excess of 66,869 CV deaths, which may be due to COVID infection directly or due to the indirect impact of COVID on healthcare delivery. Relative increases in CV mortality in 2020 were more notable for younger adults and racial/ethnic minorities, particularly Black and Hispanic adults. Given the significant population burden of CV disease and the ongoing COVID pandemic, these results have important implications for the understanding of disease-specific increases in CV mortality and consideration for targeted intervention, including targeting racial disparities, that may reduce CV mortality risk.

The current data also adds to prior literature on the differential impact of age and race/ethnicity on mortality in the first year of the COVID pandemic.[13] Prior literature on the impact of age and race/ethnicity on CV mortality in the COVID era has been limited. Wadhera et al evaluated 6 months of 2020 data[7] demonstrating greater increases in mortality rates for IHD and cerebrovascular disease among Hispanic, non-Hispanic Black, and Asian adults compared to White adults. These trends mirror reported increases in all-cause mortality in 2020, with higher rates among Hispanic adults, Indian Americans/Alaskan natives, and Black adults compared to White adults.[13] The current data extends the findings for race/ethinicy-based CV variation in mortality in 2020 compared to historical trends and for additional etiologies of CV mortality including HF and hypertensive disease. Relative increases in mortality in 2020 were higher for Black, Hispanic, Asian, and American Indian/Alaskan adults compared to White adults, despite decreases in mortality over the prior 20 years that were greater among Asian, American Indians/Alaskan native, and Hispanic compared to White adults. These trends of race/ethnicity-based increases in CV mortality in 2020 were generally noted for IHD, cerebrovascular disease, and hypertensive disease. However, among HF related mortality, only Asian adults experienced a 2020 rise in mortality, with remaining races demonstrating a decrease. The decrease in HF

related mortality was similar in Hispanic versus Non-Hispanic adults, although was more prominent in White than Black adults.

Taken together, these findings demonstrate that racial disparities in CV care became more prominent in 2020 after previously showing evidence of improvement in the current as well as prior cohorts[1,14]. There may be several important reasons for more pronounced race/ethnicity-based disparities and exacerbation of previously identified racial/ethnic inequalities in the COVID era. Comorbidity burden of CV risk factors is higher in minority populations and general avoidance of medical care during the early phase of the COVID pandemic may have therefore had greater impact on minority populations.[7] Minority and lower socioeconomic status adults had lower utilization of telemedicine and video medicine during that time,[15] which may have also increased risks for adverse CV events. Additionally, multiple social determinants of health including psychosocial stress, food insecurity, and poverty which contributed to racial disparities prior to the pandemic[1] were worsened during the pandemic, with effects felt more prominently by members of racial/ethnic minority groups in the United States.[7] Whether these trends in social determinants of health and mortality will continue with the ongoing COVID pandemic deserves further evaluation, and efforts to improve social determinants of health[16] may play an important role in reversing the racial and ethnic disparities in CV mortality seen in 2020.

We also identified age related differences in CV mortality over the study period, including between 2019 and 2020. In relative terms, gains in improved CV mortality between 1999 and 2019 were most prominent among those aged 75 and older, and this group also saw the smallest relative excess mortality between 2019 and 2020. In contrast, adults aged 55 and younger experienced smaller relative gains in mortality improvement from 1999 to 2019 and larger relative increases in mortality during the COVID pandemic. Adults aged 55 and younger were also the only age group to experience an increase in HF mortality during the first year of

the COVID pandemic. There may be several explanations for these findings. Care for age-related CV comorbidities, including diabetes, hyperlipidemia, and HF, may have improved over time, although penetration of treatment in younger adults may be lower than among older adults.[17,18] Additionally, mortality from unintentional injuries, substance abuse, and suicide have been increasing among younger populations,[19] and these conditions played a prominent role in excess mortality in 2020.[20] Some of these conditions may contribute to CV morbidity and mortality. For example, substance abuse has been associated with an increase of coronary disease[21] and HF events,[22] and such comorbidities may explain the rise in HF mortality seen among younger adults in 2020. Additionally, differential access to health insurance in the United States for adults below Medicare age (generally under 65 years of age) during the pandemic may have affected access to care and therefore led to an increase in CV mortality. The relative changes in mortality over time between age groups also need to be interpreted in the context of absolute changes given significantly different baseline mortality rates. Although older patients experienced larger relative mortality improvements through 2019 and smallest relative excess mortality in 2020, the absolute mortality rates and excess mortality among those aged 55-74 and greater than 75 remain larger than among younger patients. This implies that ongoing efforts to address overall mortality should remain focused on older patients where the absolute burden of CV mortality remains most prominent.

Another important finding from the current analysis is the difference in mortality trends among individual components of CVD mortality between 2019 and 2020. The reasons for this may be multifactorial. Concern about receiving in-person medical care may have led more adults to defer screening for IHD/cerebrovascular disease. Additionally, there were significant reductions in cardiovascular hospitalizations, including for myocardial infarction and stroke at the start of the pandemic,[23,24,25] which may have led to less early intervention and contributed to increased CV mortality for these conditions. Unlike primarily acute conditions such as myocardial infarction or

stroke, chronic disease states such as HF may be more amenable to virtual care and disease surveillance.[26] At the start of the COVID pandemic, virtual visits among HF adults were associated with reduced readmissions.[27] Additionally, an increased reliance on home-based non-invasive monitoring and a rise in invasive monitoring could have contributed to stability in HF mortality between 2019 and 2020. This time frame also coincided with added focus on implementation of recently approved classes of HF therapies primarily for systolic HF, such as sodium-glucose cotransport 2 inhibitors and sacubitril/valsartan, which may have also contributed to reduced HF mortality. Whether the success of HF mortality reduction continues will require further evaluation, though telehealth and other remote monitoring of HF are likely to continue wide adoption given recent success in this population.

Strengths and Limitations:

This study has important limitations, including those inherent to analysis of large datasets and determination of cause of death. Cause of death may be multifactorial and coding accuracy is important to determine whether deaths were due to CV causes and specific etiologies. It is unclear to what extent COVID directly contributed to mortality or whether changes in mortality were due to the ways that adults sought care or clinicians provided care. We did not focus on non-CV causes of death. We didn't evaluate for the presence of the COVID diagnosis on death certificates due to potential inaccurate testing in the early part of the pandemic as well as difficulties in assigning causes of death. We instead focused on excess CV deaths which would be a function of direct infection with COVID and indirect effects of COVID on service provision. Furthermore, the estimation of excess mortality was based on predicted mortality using historical data, which are not linear and difficult to model. Important information about delivery of care, cardiac treatments or procedures, and other clinical characteristics are not available in this dataset. Nevertheless, the data from this large and frequently utilized federal dataset may be

the best source to evaluate mortality to determine the impact of the COVID pandemic on CV outcomes.

In conclusion, the current analysis of CV mortality between 1999 and 2019 demonstrates declines in overall CV mortality driven by declines in mortality for IHD and cerebrovascular disease with increase in HF mortality. However, the first year of the COVID pandemic in 2020 was associated with reversal of these trends, with prominent increases in IHD and cerebrovascular mortality but a decline in HF mortality. Relative increases in CV mortality in 2020 were more prominent for younger adults and racial/ethnic minorities. Additional evaluation of CV mortality, including among key demographic and racial/ethnic groups, is needed to gauge the impact of the ongoing COVID pandemic on CV disease and health disparities.

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Table 1: Crude CV mortality in US 1999-2020

	Number Of deaths					Crude rate*				
	1999	2019	Percent change 1999-2019	2020	Percent Change 2019-2020	1999	2019	Percent change 1999-2019	2020	Percent Change 2019-2020
Overall	943,339	874,613	-7.3%	928,741	6.2%	342.0	266.5	-22.1%	281.9	5.8%
Main causes of death										
Ischemic heart diseases	529.659	360,900	-31.9%	382,820	6.1%	189.8	110.0	-42.0%	116.2	5.6%
Hypertensive diseases	42,997	102,072	137.4%	119,997	17.6%	15.4	31.1	101.9%	36.4	17.0%
Heart failure	54,913	86,177	56.9%	85,855	-0.4%	19.7	26.3	33.5%	26.1	-0.8%
Cerebrovascular diseases	167,366	150,005	-10.4%	160,264	6.8%	60.0	45.7	-23.8%	48.6	6.3%
Sex										
Male	443,541	453,801	2.3%	487,209	7.4%	324.2	280.7	-13.4%	300.3	7.0%
Female	510,798	420,812	-17.6%	441,532	4.9%	359.1	252.6	-29.7%	264.0	4.5%
Age										
Under 55	66,740	59,817	-10.4%	66,575	11.3%	30.3	25.8	-14.9%	28.8	11.6%
55-74	242,398	260,707	7.6%	286,808	10.0%	574.4	253.6	-55.8%	382.7	50.9%
75 and above	645,151	554,045	-14.1%	575,330	3.8%	3,938.9	2454.3	-37.7%	2,489.5	1.4%
Hispanic Origin										
Hispanic or Latino	33,851	58,684	73.4%	67,352	14.8%	99.7	96.9	-2.8%	109.8	13.3%
Not Hispanic or Latino	917,301	813,623	-11.3%	858,868	5.6%	374.3	304.0	-18.8%	320.3	5.4%
Race										
White	832,809	730,442	-12.3%	764,319	4.6%	364.2	286.4	-21.4%	299.7	4.6%
Black or Africans American	105,309	113,969	8.2%	130,008	14.1%	291.1	244.6	-16.0%	275.6	12.7%
Asian or Pacific Islander	13,087	22,253	70.0%	28,896	29.9%	115.3	115.8	0.4%	128.9	11.3%
American Indian or Alaska Native	3,134	4,949	57.9%	5,518	11.5%	110.6	103.4	-6.5%	112.6	8.9%
Region										
Northeast	200,208	157,087	-21.5%	165,295	5.2%	375.3	280.6	-25.2%	296.0	5.5%
Midwest	234,297	198,805	-15.1%	209,574	5.4%	365.5	291.0	-20.4%	306.8	5.4%
South	346,428	344,503	-0.6%	368,441	6.9%	349.3	274.3	-21.5%	290.9	6.1%
West	173,406	174,218	0.5%	185,431	6.4%	277.8	222.4	-19.9%	235.8	6.0%
Urbanization										
Urban	761,176	711,459	-6.5%	757,302	6.4%	324.7	252.1	-22.4%	267.2	6.0%
Rural	193,163	163,154	-15.5%	171,439	5.1%	432.9	354.2	-18.2%	372.5	5.2%

*Per 100,000 population.

Table 2: Overall CV mortality -Age Adjusted Mortality

	1999	2011	2019	Percent change 2011-2019	Percent change 1999-2019	AAPC (2019-1999) [95% CI)	2020				
							Actual AAMR	% Change (2020-2019)	Projected AAMR (95% CI)	Estimated Excess AAMR (95% CI)	% Excess mortality* (95% CI)
Overall	350.8	228.6	214.6	-6.1%	-38.8%	-2.4 [(-2.8) - (-2)]	224.4	+4.6%	209.4 (208.6-210.3)	15.0 (14.1-15.8)	6.7% (6.3%-7.0%)
Sex											
Female	297.9	191.4	176.4	-7.8%	-38.1%	-2.5 [(-3.1)- (-2)]	183.1	+3.8%	172.0 (170.9-172.9)	11.1 (10.2-12.2)	6.1% (5.6%-6.6%)
Male	420.5	274.6	260.4	-5.2%	-40.8%	-2.4 [(-2.7)- (-2.0)]	273.5	+5.0%	254.2 (253.4-255.2)	19.3 (18.3-20.1)	7.1% (6.7%-7.4%)
Age											
Under 55	30.9	26.9	26.0	-3.3%	-15.9%	-0.8 [(-1.0) –(-0.6)]	29.1	+11.9%	25.8 (25.7-25.9)	3.3 (3.2-3.4)	11.3% (11.1 %-11.5%)
55-74	571.2	362.0	353.9	-2.2%	-38.0%	-2.4 [(-2.6)- (-2.1)]	381.7	+7.8%	345.4 (344.7-346.5)	36.3 (35.2-37.0)	9.5% (9.2%-9.7%)
75 and above	3,958.2	2543.6	2319.2	-8.8%	-41.4%	-2.6 [(-3.1)- (-2.2)]	2,370.0	+2.2%	2258.9 (2247.3-2268.2)	111.1 (101.8-122.7)	4.7% (4.3%-5.2%)
Hispanic Origin											
Hispanic or Latino	269.0	167.4	157.2	-6.1%	-41.6%	-2.6 [(-3.0 – (-2.2)]	172.0	9.4%	153.1 (152.5-153.7)	18.9 (18.3-19.5)	11.0% (10.6%-11.3%)
Not Hispanic or Latino	353.7	233.3	220.5	-5.5%	-37.7%	-2.4 [(-2.6)- (-2.2)]	230.0	4.3%	214.8 (214.3-215.6)	15.2 (14.4-15.7)	6.6% (6.2%-6.8%)
Race											
American Indian or Alaska Native	263.7	163.4	142.0	-13.1%	-38.3%	-2.9 [(-4.0)- (-1.8)]	150.7	+6.1%	137.9 (136.3-139.4)	12.8 (11.3-14.4)	8.5% (7.5%-9.5%)
Asian or Pacific Islander	225.0	136.4	123.7	-9.3%	-38.4%	-2.9 [(-3.2)- (-2.6)]	134.6	+8.8%	120.1 (119.7-120.5)	14.5 (14.1-14.9)	10.8% (10.5%-11.0%)
Black or African American	450.0	291.8	277.3	-5.0%	-45.0%	-2.4 [(-2.6)- (-2.2)]	306.6	+10.5%	270.1 (269.3-271.2)	36.5 (35.4-37.3)	11.9% (11.5%-12.2%)
White	343.3	224.8	211.7	-5.8%	-46.2%	-2.3 [(-2.7)- (-1.9)]	219.1	+3.5%	206.8 (206.0-207.7)	12.3 (11.4-13.1)	5.6% (5.2%-6.0%)
Region											
Northeast	344.9	225.1	202.7	-10.0%	-41.2%	-2.6 [(-2.9) – (-2.2)]	212.4	+4.8%	197.4 (196.8-198.2)	15.0 (14.2-15.6)	7.1% (6.7%-7.3%)
Midwest	356.7	234.3	225.5	-3.8%	-36.8%	-2.3 [(-2.5)- (-2.1)]	235.9	+4.6%	220.3 (219.9-220.8)	15.6 (15.1-16.0)	6.6% (6.4%-6.8%)
South	364.8	238.8	227.5	-4.7%	-37.6%	-2.3 [(-2.7) – (-1.9)]	237.9	+4.6%	222.3 (221.4-223.2)	15.6 (14.7-16.5)	6.6% (6.2%-7.0%)
West	324.6	207.0	191.5	-7.5%	-41.0%	-2.4 [(-2.9) – (-	199.6	+4.2%	186.9 (185.9-	12.7 (11.9-	6.4% (6.0%-

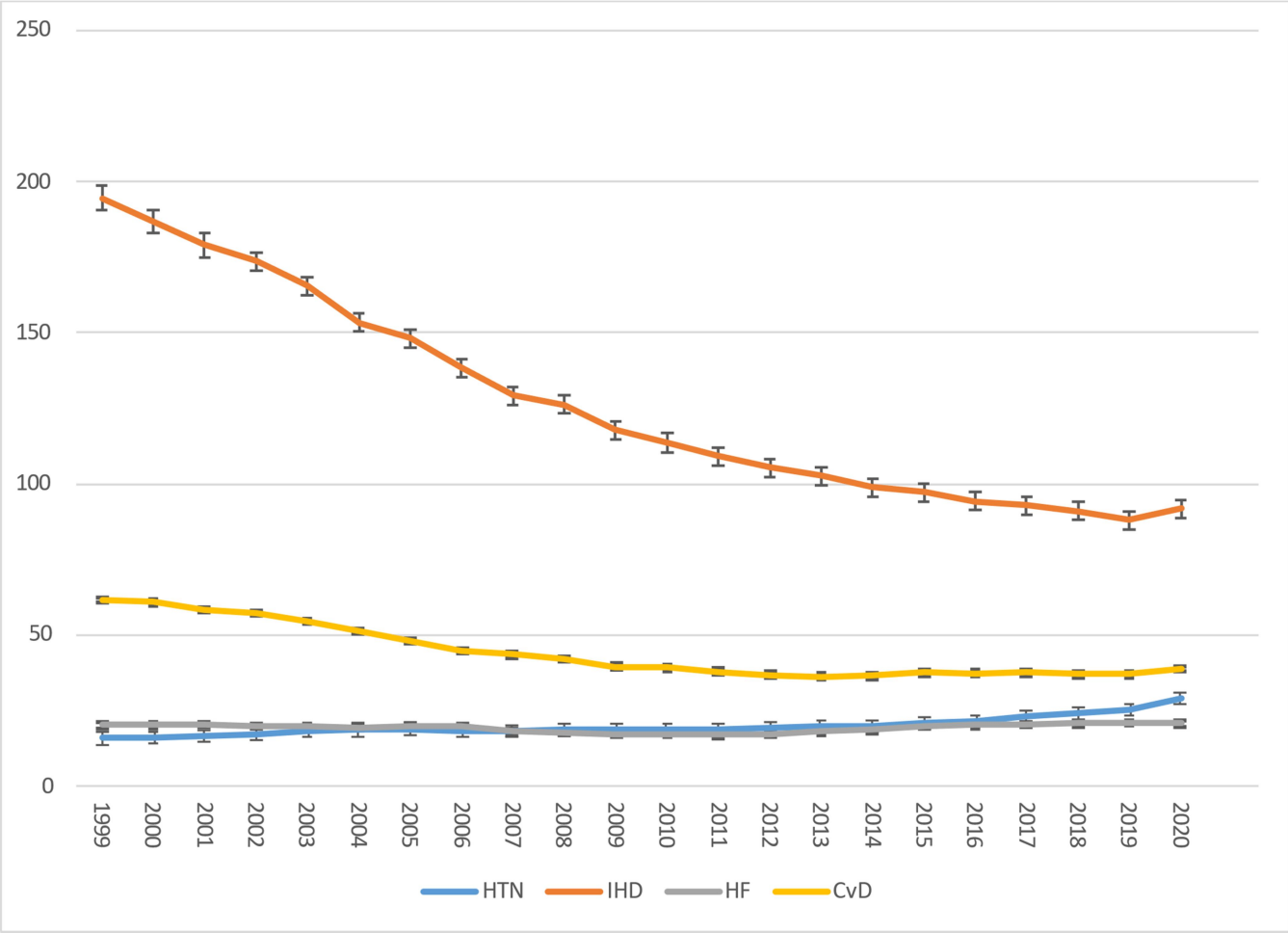
						2.0)]			187.7)	13.7)	6.8%)
Urbanization											
Rural	371.6	258.1	245.8	-4.8%	-39.7%	-2.5 [(-2.9) - (-2.0)]	256.5	+4.4%	239.7 (238.7-240.9)	16.8 (15.6-17.8)	6.5% (6.1%-7.0%)
Urban	346.0	222.6	208.8	-6.2%	-33.9%	-2.1 [(-2.3)- (-1.9)]	218.5	+4.6%	204.4 (204.0-204.8)	14.1 (13.7-14.5)	6.5% (6.3%-6.6%)

AAPC: Average Annual Percent Change; rates per 100,000 population. *% of excess mortality of actual 2020 mortality

Table 3: Excess CV mortality 2020

	Overall CV mortality		IHD mortality		HF mortality		Cerebrovascular diseases mortality		HTN mortality	
	2020 mortality	Estimated Excess mortality	2020 mortality	Estimated Excess mortality	2020 mortality	Estimated Excess mortality	2020 mortality	Estimated Excess mortality	2020 mortality	Estimated Excess mortality
Overall	928,741	62,802	382,820	32,923	85,855	-3,606	160,264	11,218	119,997	13,800
Sex										
Female	441,532	26,767	154,933	12,550	44,958	-2,518	90,627	5,981	61,574	7,327
Male	487,209	34,381	227,887	19,598	40,897	-1,472	69,637	5,501	58,423	6,310
Age										
Under 55	66,575	7550	24,908	3,911	2,871	666	8,717	994	10,794	1,036
55-74	286,808	27,276	134,828	15,640	17,435	-70	40,516	3,525	38,012	5,132
75 and above	575,330	26,970	223,067	13,830	65,549	-3,212	111,029	6,884	71,190	7,617
Hispanic Origin										
Hispanic or Latino	67,352	7,400	29,623	4,146	4,490	-136	13,370	1,018	9,462	1,411
Not Hispanic or Latino	858,868	56,760	351,843	25,339	81,262	-3276	146,659	10,597	110,111	12,257
Race										
American Indian or Alaska Native	5,518	469	2,303	182	373	-20	905	76	938	158
Asian or Pacific Islander	28,896	3,113	12,128	1,831	1,752	23	6,754	608	3,968	194
Black or African American	130,008	15,477	47,542	7,607	10,696	-53	22,646	2,151	23,635	3,994
White	764,319	42,907	320,847	23,422	73,034	-3,725	129,959	8,577	91,456	8,780
Region										
Northeast	228,356	16,126	76,366	7,713	14,383	-921	22,806	1,209	19,224	2,730
Midwest	209,574	13,859	84,111	6,561	21,630	-1,146	35,830	3,189	24,041	2,741
South	368,441	24,160	146,177	12,425	34,765	-1,008	67,183	4,636	50,699	5,932
West	185,431	11,799	76,166	6,474	15,077	-528	34,445	2,411	26,033	2,135
Urbanization										
Rural	171,439	11,229	72,768	5,894	16,609	-615	27,559	2,039	19,530	1,914
Urban	757,302	48,870	310,052	26,975	69,246	-3,185	132,705	9,289	100,467	11,453

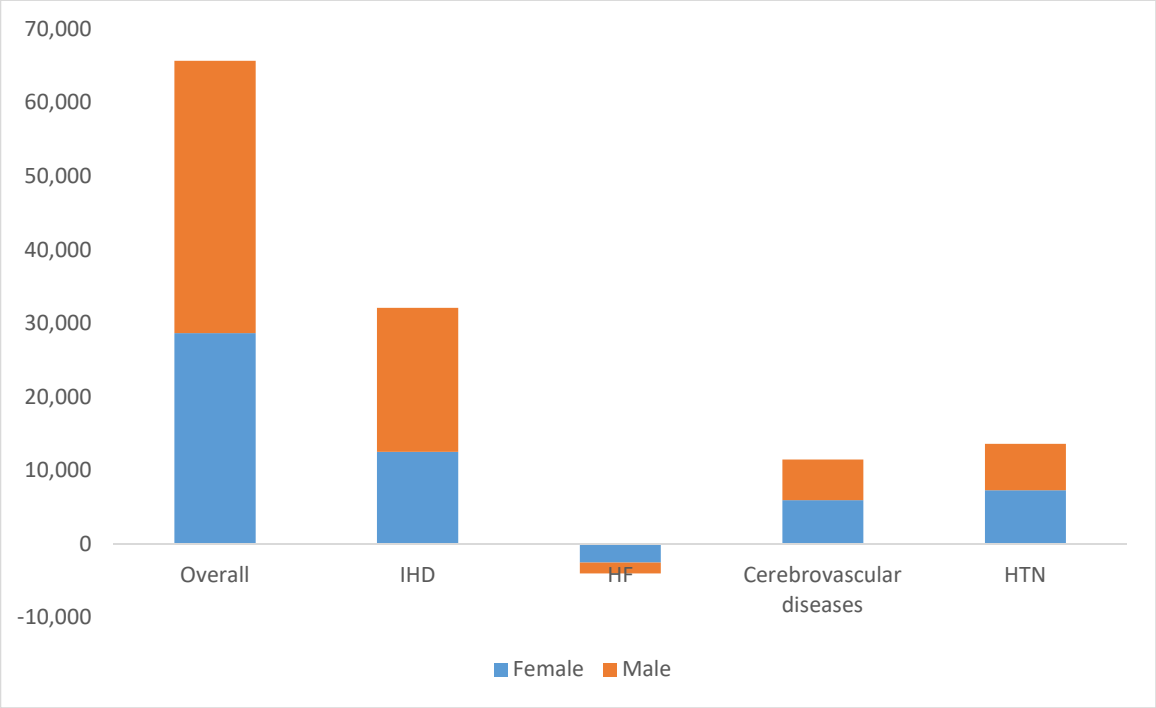
Figure 1: Overall CV mortality trend for Age Adjusted Mortality Rate*, by cause of death



IHD: Ischemic heart disease; HF: Heart failure; HTN: Hypertensive disease; CVD: Cerebrovascular diseases.

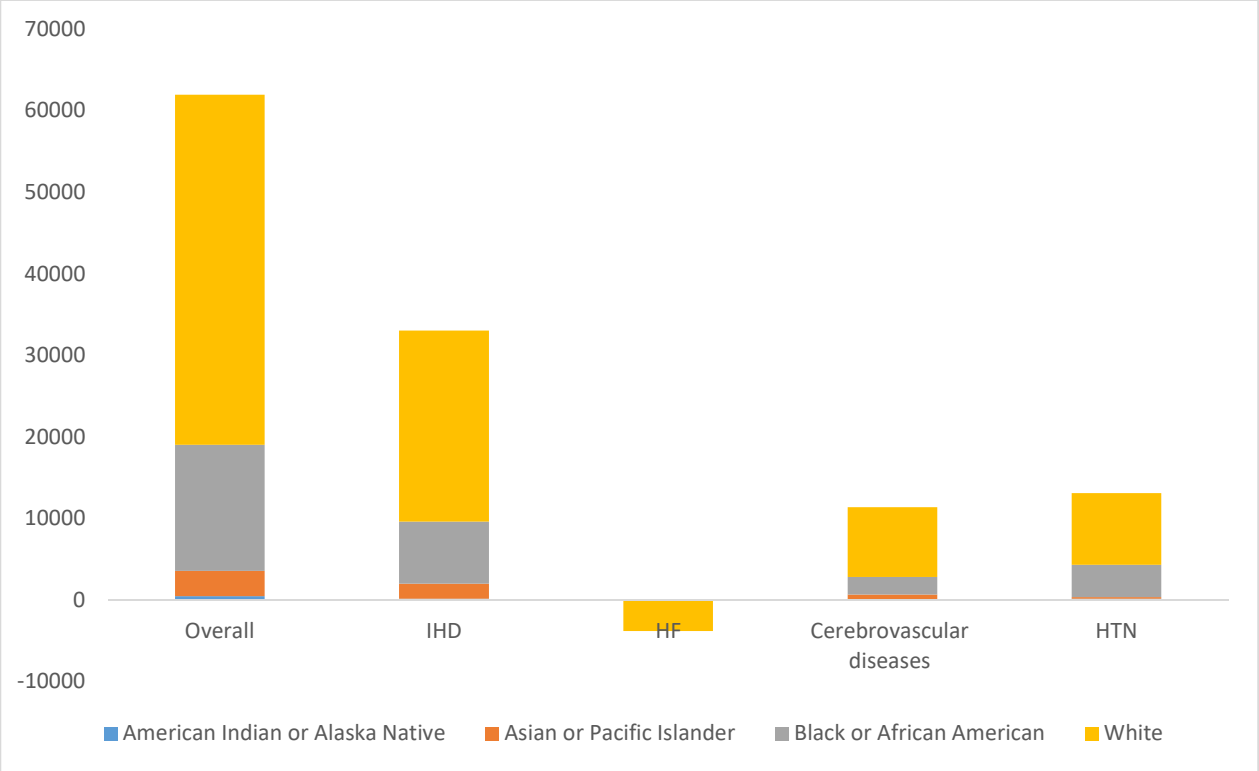
*per 100,000 population.

Figure 2: Estimated excess CV mortality in 2020 versus 2019, by sex and main cause of death



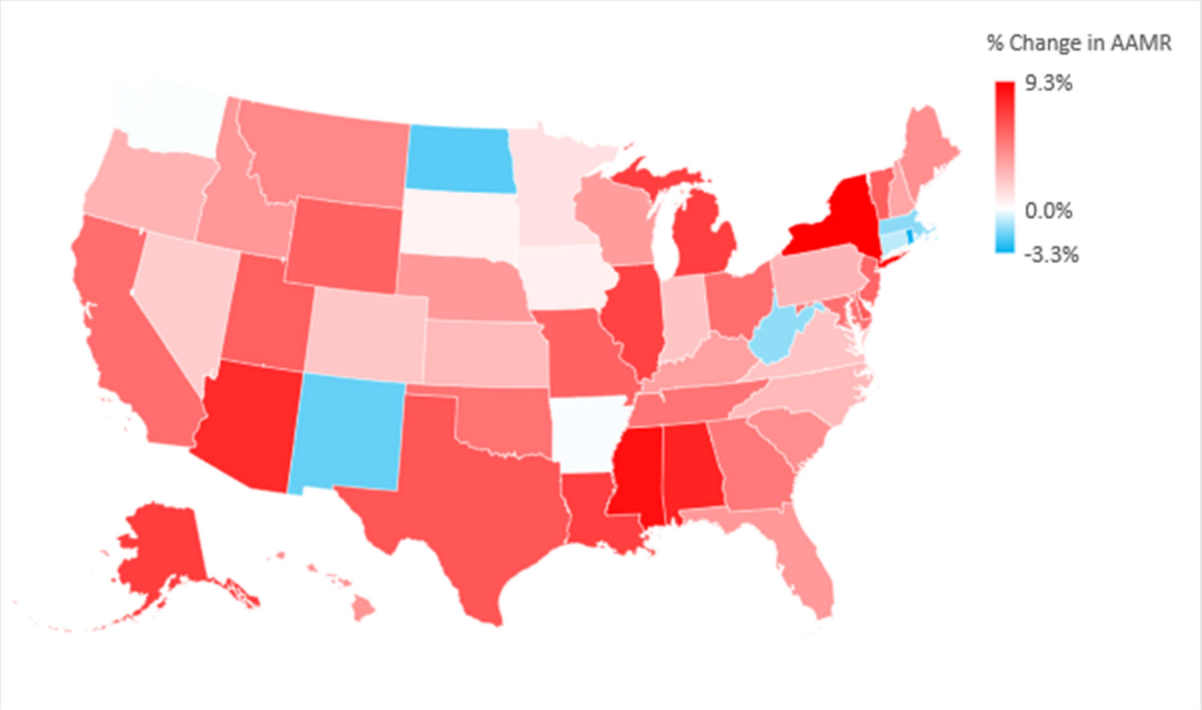
IHD: Ischemic heart disease; HF: Heart failure; HTN: Hypertensive disease.

Figure 3: Estimated excess CV mortality in 2020 compared to 2019, by Race and main cause of death



IHD: Ischemic heart disease; HF: Heart failure; HTN: Hypertensive disease.

Figure 4: % Change in overall age adjusted CV mortality rate*, by state 1999 vs 2020



AAMR: age-adjusted mortality rate, *

per 100,000 population.