Title: Unfavorable Trends in Cardiometabolic Mortality in the United States, 1999-2017

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BACKGROUND

The dramatic and persistent decline in age-adjusted cardiovascular disease (CVD) death rates in all segments of the U.S. population represented a considerable public health success in the 20th century. However, this progress may now be threatened by rising obesity prevalence and the recent, associated increases in diabetes and hypertension. CVD remains the leading cause of U.S. morbidity and mortality and accounted for >800,000 deaths in 2017 (2). By 2030, over 40% of American adults are expected to have some form of CVD (3) with associated costs estimated to exceed $800 billion annually.

OBJECTIVE

We sought to evaluate the most recent national trends in cardiometabolic disease mortality by age, sex, and race from 1999 to 2017.

METHODS

We determined mortality rates attributed to cardiometabolic diseases using underlying cause of death (UCD) on death certificate data from Centers for Disease Control and Prevention's Wide-Ranging Online Data for Epidemiologic Research (WONDER) multiple cause of death files from January 1, 1999 to December 31, 2017 (2). Mortality rates for decedents whose UCD was listed as heart disease (I00-I09,I11,I13,I20-I51), stroke (I60-I69), diabetes (E10-E14), or essential hypertension and hypertensive renal disease (I10,I12,I15) were age-adjusted using the 2000 U.S. standard population. Age-adjusted mortality rates (AAMR) were examined overall, by sex-race groups, and among adults who died prematurely aged <65 years. AAMR ratios quantifying racial disparities were calculated as number of deaths per 100,000 person-years in black individuals for every 1 death per 100,000 person-years in white individuals. Statistical trends and AAMR annual rate of change were identified using JoinPoint and Linear regression (SPSS v21).

FINDINGS

Trends in AAMR attributable to cardiometabolic UCD from 1999-2017 identify a consistent inflection point in 2010 for deaths due to heart disease, stroke, and diabetes (detailed in the Table, Figure, and Supplemental Figure). Specifically, the rate of AAMR decline for heart disease slowed considerably after 2010 (β = -8.3 [95%

CI -8.8, -7.8; P<0.01] indicating 8.3 fewer deaths per 100,000 person-years per year before 2010, versus β = -1.3 [-1.9, -0.8; P<0.01] thereafter). AAMR declines for stroke (β = -2.3 [-2.5, -2.1]; P<0.01) and diabetes (β = -0.4 [-0.6, -0.3]; P<0.01) were significant only through 2010, with plateauing therafter. Black individuals consistently had higher AAMR compared to whites with the widest observed disparities in hypertension-related deaths. Overall, hypertension AAMR increased through 2017, although declines were seen after 2003 in black men and women. AAMR for decedents <65 years showed similar patterns.

DISCUSSION

The previous declines in heart disease, stroke, and diabetes mortality have slowed or stopped since 2010, and overall AAMR from hypertension is actually increasing. Racial disparities in AAMR from cardiometabolic diseases have persisted over the past 2 decades. Increased competing risks for non-CVD death (e.g. homicide) among blacks compared with whites may contribute in part to the racial disparities in observed trends. While results derived from cross-sectional death certificate data may be subject to potential miscoding due to ill-defined UCD, especially for hypertension and diabetes. However, the underlying trends are consistent across all cardiometabolic causes of death and are clearly real and substantial.

Advances in and implementation of evidence-based medical therapy for CVD are estimated to have contributed to approximately 50% of the decline in AAMR due to coronary heart disease from 1980 to 2000.(4) However, the increasing prevalence of obesity over the last three decades has likely substantially contributed to the increased prevalence of poor cardiovascular health and slowing of CVD mortality declines. The increase in lifetime maximum body mass index (BMI) from 1988-2011 is estimated to have accounted for approximately 186,000 excess deaths in 2011 and reduced life expectancy at age 40 by 0.9 years. (5)

Premature deaths <65 years old showed similar patterns to overall AAMR. If current trends continue, 1.6 million premature and eminently avoiadable heart disease deaths are projected to occur in the United States between 2017 and 2030, underscoring the urgent need for effective public health interventions throughout the life course (6). Evidence-based tobacco control and healthy diet policies to promote healthful food and regulate processed food and sugar-sweetened beverages could substantially improve cardiometabolic health and increase life expectancy. Without targeted efforts focused on minority groups, sex and racial disparities in cardiometabolic mortality rates are likely to persist.

Table. Trends in Age-Adjusted Mortality Rates Attributable to Leading Cardiometabolic Underlying Causes of Death in the U.S., 1999-2017

AAMR represents age-adjusted mortality rate per 100,000 person-years, directly standardized to the 2000 U.S. Census Population

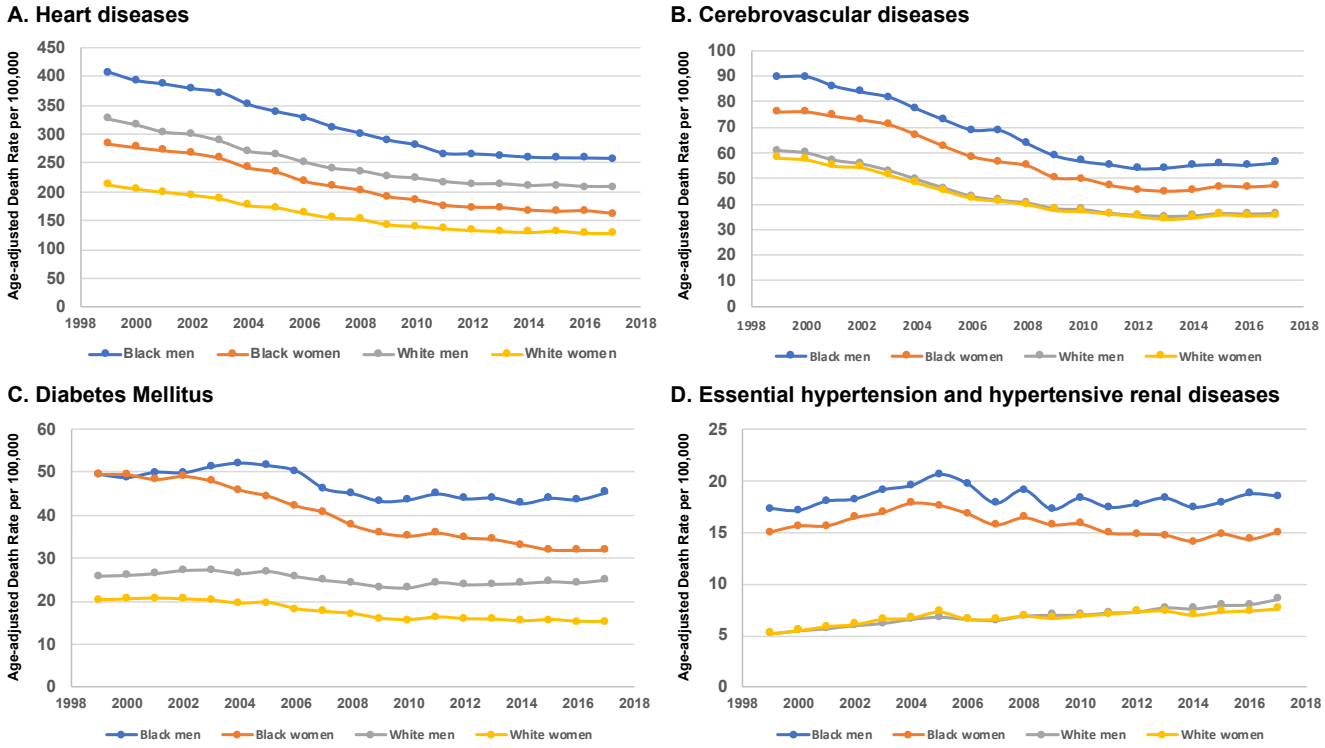
	1999	2003	2007	2011	2013	2015	2017	First Trend*		Second Trend*	
								β (95% CI)	P†	β (95% CI)	P†
Heart disease								1999-2010		2010-2017	
Overall	266.5	236.3	196.1	173.7	169.8	168.5	165.0	-8.3 (-8.8, -7.8)	<0.01	-1.8 (-2.5, -1.0)	<0.01
Black men	407.2	372.1	312.4	266.1	262.8	258.6	257.5	-11.9 (-12.7, -11.1)	<0.01	-2.7 (-4.3, -1.1)	<0.01
White men	327.1	288.2	240.3	216.9	213.1	211.2	208.3	-10.0 (-10.7, -9.2)	<0.01	-1.8 (-2.7, -1.0)	<0.01
AAMR ratio	1.24	1.29	1.30	1.23	1.23	1.22	1.24	β = -0.002 (-0.004, 0.000); P = 0.03‡			
Black women	283.7	258.5	209.8	176.2	172.1	165.7	161.9	-9.7 (-10.5, -8.9)	<0.01	-2.8 (-3.8, -1.9)	<0.01
White women	212.8	188.5	155.4	136.5	132	132.4	128.4	-6.9 (-7.3, -6.5)	<0.01	-1.5 (-2.2, -0.9)	<0.01
AAMR ratio	1.33	1.37	1.35	1.29	1.30	1.25	1.26	β = -0.006 (-0.007, -0.004); P < 0.01‡			
Stroke								1999-2010		2010-2017	
Overall	61.6	54.6	43.5	37.9	36.2	37.6	37.6	-2.3 (-2.5, -2.1)	<0.01	-0.1 (-0.5, 0.2)	0.38
Black men	89.6	81.6	68.7	55.3	54.1	55.5	56.1	-3.2 (-3.5, -2.9)	<0.01	0.03 (-0.4, 0.4)	0.88
White men	60.8	52.9	41.3	36.2	35.0	36.1	36.2	-2.4 (-2.6, -2.1)	<0.01	-0.1 (-0.4, 0.2)	0.44
AAMR ratio	1.47	1.54	1.66	1.53	1.55	1.54	1.55	β = 0.002 (-0.002, 0.006); P = 0.38‡			
Black women	76.2	71.1	56.4	47.0	44.7	46.7	47.0	-2.8 (-3.1, -2.4)	<0.01	-0.2 (-0.8, 0.4)	0.44
White women	58.0	51.3	41.2	36.2	34.2	35.9	35.7	-2.1 (-2.3, -1.9)	<0.01	-0.1 (-0.5, 0.2)	0.38
AAMR ratio	1.31	1.39	1.37	1.30	1.31	1.30	1.32	β = -0.003 (-0.006, -0.001); P = 0.01‡			
Diabetes								1999-2010		2010-2017	
Overall	25.0	25.5	22.8	21.6	21.2	21.3	21.5	-0.4 (-0.6, -0.3)	<0.01	0.02 (-0.1, 0.1)	0.64
Black men	49.4	51.2	46.1	44.9	44.0	43.9	45.2	-0.6 (-1.0, -0.2)	0.01	0.04 (-0.3, 0.4)	0.75
White men	25.8	27.2	24.8	24.3	23.9	24.5	24.9	-0.3 (-0.5, -0.1)	0.01	0.2 (0.1, 0.3)	0.02
AAMR ratio	1.91	1.88	1.86	1.85	1.84	1.79	1.82	β = -0.006 (-0.010, -0.003); P < 0.01‡			
Black women	49.5	47.9	40.6	35.8	34.3	31.9	31.8	-1.5 (-1.7, -1.2)	<0.01	-0.6 (-0.8, -0.4)	<0.01
White women	20.2	20.1	17.5	16.2	15.7	15.6	15.2	-0.5 (-0.6, -0.4)	<0.01	-0.1 (-0.2, -0.01)	0.03
AAMR ratio	2.45	2.38	2.32	2.21	2.18	2.04	2.09	β = -0.020 (-0.023, -0.017); P < 0.01‡			
Hypertension								1999-2003		2003-2017	
Overall	6.2	7.6	7.6	8.1	8.5	8.5	9.0	0.3 (0.3, 0.4)	<0.01	0.1 (0.04, 0.1)	0.01
Black men	17.3	19.1	17.8	17.4	18.3	17.9	18.5	0.5 (0.1, 0.8)	0.02	-0.1 (-0.2, -0.01)	0.04
White men	5.2	6.2	6.5	7.2	7.7	7.9	8.5	0.3 (0.2, 0.3)	<0.01	0.1 (0.1, 0.2)	<0.01
AAMR ratio	3.33	3.08	2.74	2.42	2.38	2.27	2.18	β = -0.063 (-0.071, -0.055); P < 0.01‡			
Black women	15.0	16.9	15.7	14.9	14.7	14.8	15.0	0.5 (0.3, 0.7)	0.01	-0.2 (-0.3, -0.2)	<0.01
White women	5.2	6.6	6.6	7.1	7.4	7.3	7.6	0.3 (0.3, 0.4)	<0.01	0.1 (0.03, 0.1)	<0.01
AAMR ratio	2.88	2.56	2.38	2.10	1.99	2.03	1.97	β = -0.054 (-0.060, -0.047); P < 0.01‡			

*Linear regression of AAMR before and after inflection point identified by JoinPoint analysis of overall heart disease, stroke, diabetes, or hypertension trend. P<0.05 for comparison of linear trend after compared to before inflection point, for all diseases.

†P for statistical significance of first and second linear regression around JoinPoint regression-identified inflection point, respectively. Regression β coefficient represents change in AAMR or AAMR ratio per year.

‡Linear regression for AAMR ratio calculated across entire study period (1999-2017).

Figure. Age-adjusted mortality rates due to heart disease (A), stroke (B), diabetes mellitus (C), and hypertension (D) as underlying cause of death per 100,000 from 1999 to 2017 in the United States by sex and race.



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Supplemental Figures

Supplemental Figure 1. Trends in Age-adjusted premature mortality rates (<65 years) due to heart disease (A), stroke (B), diabetes mellitus (C), and hypertension (D) as underlying cause of death per 100,000 from 1999 to 2017 in the United States by sex and race.