Trends in population mortality rates in the United States from 1969 to 2017

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Background: Fundamental transformations in overall population health have occurred in the past five decades and are continuing. Our aim in this study was to characterize the trends in population mortality rates in the United States (U.S.) from 1969 to 2017.

Methods: Data on the 109,836,044 deaths registered in the Surveillance, Epidemiology, and End Results (SEER) database were analyzed by sex, race and ethnicity, and age. Temporal trends in population mortality rates were examined from 1969 to 2017. All data analyses were performed using the SEER*Stat software.

Results: The overall mortality rate for males and females in the U.S. per 100,000 population fell by 46.1% and 39.3%, from 1,610.0 and 1,019.3 in 1969 to 867.2 and 619.2 in 2017, respectively. This decline in overall mortality was mainly attributable to a decrease in mortality caused by heart and cerebrovascular diseases. From 1969 to 2017, the overall mortality rate was higher in males than females, and in blacks than whites for both sexes. From 1979 to 2017, the mortality rates of heart diseases, cerebrovascular diseases, and diabetes were all higher in blacks than in whites for both sexes.

Conclusions: The results indicate that the U.S. has dramatically reduced its overall annual mortality rate between 1969 and 2017; however, the disparities among different races are still apparent.

Keywords: Population mortality; heart diseases; cerebrovascular diseases

Introduction

The causes of human death have always been a concern among clinicians and the public. Understanding the changes in the causes of death over the past five decades is worthwhile for reducing the overall mortality. Fundamental transformations in overall population health have occurred in the past five decades and are continuing. However, few studies have systematically documented these transitions at the national levels (1). In this article, we provide the numbers of deaths and analyze the national age-adjusted mortality rates between 1969 and 2017 in the United States (U.S.). This data can be an important source of public health information when data on disease incidence are unavailable, helping public health professionals and policymakers understand the national health priorities in every country.

We present the following article in accordance with the STROBE reporting checklist (available at https://dx.doi.org/10.21037/apm-21-2835).

Methods

Mortality data

The Surveillance, Epidemiology, and End Results (SEER) database is an open-access resource for cancer-based epidemiology and survival analyses, which also has mortality data for all diseases. The U.S. mortality data, collected and maintained by the National Center for Health Statistics (NCHS), can be analyzed using the SEER*Stat software. The NCHS granted the SEER program limited permission to provide the mortality data to the public. The data on mortality for all diseases were collected from the SEER Database of Mortality-All cause of death (COD), Aggregated Total U.S. [1969–2017] <Katrina/Rita Population Adjustment>. The underlying mortality data are provided by the NCHS (www.cdc.gov/nchs). The data includes all causes of death, not just cancer deaths. A total of 109,836,044 deaths from 1969 to 2017 are registered in this database.

Causes of death were classified according to the International Classification of Diseases (ICD) (2). All cancer cases were classified according to the Site Recode ICD-O-3/ World Health Organization (WHO) 2008 (2).

Statistical analysis

Mortality rates and 95% confidence intervals (CI) were age-adjusted using the 2000 U.S. Standard Population and were expressed per 100,000 person-years (2,3). Annual rates are represented graphically as trends. Temporal trends in disease mortality rates were examined, and separate analyses were conducted for males and females. We also calculated the age-adjusted mortality rates according to race/ethnicity (white, black, and other) and age group (birth to 39, 40–49, 50–59, 60–69, and ≥70 years) (4,5). All data analyses were performed using the SEER*Stat software version 8.3.6 (2,3).

Ethical considerations

Ethical approval was exempted by the Medical Ethics Committee of the First Affiliated Hospital, Zhejiang University School of Medicine (Hangzhou, China), as SEER is a publicly available database, and the data extracted from SEER were identified as a non-human study. All patient data were anonymized. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

Results

Trends in disease mortality rates by sex

The mortality and percentage changes from 1969 to 2017 of the 20 leading causes of death in the U.S. in 2017 are shown in *Table 1*. From 1969 to 2017, the mortality rates of all causes of death were higher for males than females (*Figure 1*), and had declined continuously in both sexes (*Figure 1*). The male and female mortality rates of all causes of death fell by 46.1% and 39.3%, from 1,610.0 and 1,019.3 (per 100,000 population) in 1969 to 867.2 and 619.2 (per 100,000 population) in 2017, respectively (*Table 1* and *Figure 1*). Heart diseases, accidents and adverse effects, chronic obstructive pulmonary disease and allied conditions, cerebrovascular diseases, as well as lung and bronchus cancers (in males) or Alzheimer's (in females) were the five leading causes of death in 2017 (*Table 1* and *Figure 2A,2B*). Although it remained the leading cause of death among both sexes in the U.S. from 1969 to 2017, the age-adjusted mortality for heart diseases in males and females dropped by 68.6% and 68.0%, from 668.2 and 404.4 (per 100,000 population) in 1969 to 209.6 and 129.4 (per 100,000 population) in 2017, respectively (*Table 1* and *Figure 2A,2B*). Similarly, from 1969 to 2017, the cerebrovascular disease mortality rate decreased by 77.3% and 75.3%, from 168.4 and 147.9 (per 100,000 population) to 38.2 and 36.6 (per 100,000 population), in males and females, respectively (*Table 1* and *Figure 2A,2B*).

By contrast, in 2017, accidents and adverse effects had become the second leading cause of death among males and the fifth leading cause of death among females (*Table 1*). The age-adjusted mortality rate for accidents and adverse effects in males had risen by 37.8%, from a minimum of 49.2 (per 100,000 population) in 2000 to 67.8 (per 100,000 population) in 2017 (*Table 1* and *Figure 2A*). Similarly, in females, the mortality rate for accidents and adverse effects had increased by 53.1%, from a minimum of 20.9 (per 100,000 population) in 1992 to 32.0 (per 100,000 population) in 2017 (*Table 1* and *Figure 2B*). The age-adjusted mortality rate for suicide and self-inflicted injury in males rose by 26.6%, from a minimum of 17.7 (per 100,000 population) in 2000 to 22.4 (per 100,000 population) in 2017, and increased by 52.5% in females, from a minimum of 4.0 (per 100,000 population) in 1999 to 6.1 (per 100,000 population) in 2017 (*Table 1* and *Figure 2*). Surprisingly, the Alzheimer's disease mortality rate increased in males (*Figure 2A*) and females (*Figure 2B*) by 4,900.0% and 8575.0%, from 0.5 and 0.4 (per 100,000 population) in

Table 1 Mortality rate changes [1969–2017] of the 20 leading causes of death by sex in the United States

All causes	Mortality rank		Age-adjusted mortality rate (95% CI)		Death count		Relative change in mortality (2017 vs. 1969)
	1969	2017	1969	2017	1969	2017	
Males							
All causes of death			1,610.0 (1,606.6–1,613.3)	867.2 (865.7–868.6)	1,080,519	1,439,020	−46.1%
Heart diseases	1	1	668.2 (666.0–670.4)	209.6 (208.9–210.3)	421,729	347,854	−68.6%
Accidents and adverse effects	3	2	93.7 (93.0–94.4)	67.8 (67.4–68.2)	80,639	109,708	−27.6%
Chronic obstructive pulmonary disease and allied conditions	6	3	39.0 (38.5–39.5)	45.2 (44.9–45.6)	26,857	74,999	15.9%
Lung and bronchus cancers	4	4	65.0 (64.4–65.6)	44.5 (44.2–44.8)	50,393	78,694	−31.5%
Cerebrovascular diseases	2	5	168.4 (167.2–169.5)	38.2 (37.8–38.5)	94,203	61,644	−77.3%
Diabetes mellitus	11	6	23.7 (23.3–24.1)	26.9 (26.6–27.1)	15,682	46,301	13.5%
Alzheimer's	–	7	–	25.0 (24.8–25.3)	–	37,324	–
Suicide and self-inflicted injury	14	8	19.4 (19.1–19.7)	22.4 (22.2–22.7)	15,854	36,779	15.5%
Prostate cancer	9	9	29.6 (29.1–30.1)	18.9 (18.6–19.1)	16,834	30,486	−36.1%
Pneumonia and influenza	5	10	61.4 (60.7–62.1)	16.6 (16.4–16.8)	37,850	26,557	−73.0%
Colon and rectum cancers	7	11	33.2 (32.7–33.7)	16.0 (15.8–16.2)	22,044	27,797	−51.8%
Nephritis, nephrotic syndrome and nephrosis	20	12	10.3 (10.0–10.6)	15.8 (15.6–16.0)	6,894	25,744	53.4%
Chronic liver disease and cirrhosis	10	13	23.8 (23.4–24.1)	14.4 (14.3–14.6)	19,372	26,450	−39.5%
Pancreatic cancer	17	14	14.1 (13.8–14.4)	12.9 (12.7–13.1)	9,931	22,919	−8.5%
Septicemia	37	15	2.1 (2.0–2.2)	11.7 (11.6–11.9)	1,650	19,603	457.1%
Homicide and legal intervention	18	16	13.7 (13.4–13.9)	10.1 (10.0–10.3)	12,154	16,109	−26.3%
Symptoms, signs and ill-defined conditions	12	17	21.2 (20.9–21.6)	9.5 (9.4–9.7)	15,717	15,380	−55.2%
Hypertension without heart disease	26	17	7.5 (7.2–7.7)	9.5 (9.4–9.7)	4,337	15,742	26.7%
Leukemia	19	19	11.3 (11.1–11.6)	8.2 (8.1–8.4)	8,256	13,618	−27.4%
Liver cancer	32	20	4.2 (4.0–4.4)	7.7 (7.6–7.8)	3,028	14,721	83.3%
Females							
All causes of death			1,019.3 (1,017.0–1,021.5)	619.2 (618.2–620.3)	840,805	1,374,354	−39.3%
Heart diseases	1	1	404.4 (402.9–405.8)	129.4 (128.9–129.9)	317,341	299,563	−68.0%

Table 1 (*continued*)

Table 1 (*continued*)

All causes	Mortality rank		Age-adjusted mortality rate (95% CI)		Death count		Relative change in mortality (2017 vs. 1969)
	1969	2017	1969	2017	1969	2017	
Chronic obstructive pulmonary disease and allied conditions	15	2	7.9 (7.7–8.1)	38.2 (37.9–38.4)	6,985	85,194	383.5%
Cerebrovascular diseases	2	3	147.9 (147.0–148.8)	36.6 (36.4–36.9)	112,920	84,737	−75.3%
Alzheimer's	–	4	–	34.7 (34.5–34.9)	–	84,078	–
Accidents and adverse effects	3	5	39.2 (38.7–39.6)	32.0 (31.7–32.2)	35,658	60,212	−18.4%
Lung and bronchus cancers	10	6	12.2 (12.0–12.4)	30.6 (30.4–30.9)	11,323	67,155	150.8%
Breast cancer	5	7	31.8 (31.4–32.2)	19.9 (19.7–20.1)	28,828	42,000	−37.4%
Diabetes mellitus	8	8	26.4 (26.0–26.7)	17.1 (16.9–17.3)	22,848	37,262	−35.2%
Pneumonia and influenza	4	9	38.4 (38.0–38.9)	12.7 (12.5–12.8)	30,489	29,114	−66.9%
Colon and rectum cancers	7	10	26.7 (26.4–27.1)	11.4 (11.2–11.5)	23,145	24,750	−57.3%
Nephritis, nephrotic syndrome and nephrosis	22	11	6.6 (6.5–6.8)	11.1 (10.9–11.2)	5,718	24,889	68.2%
Septicemia	40	12	1.5 (1.4–1.5)	9.7 (9.6–9.8)	1,357	21,319	546.7%
Pancreatic cancer	14	13	8.7 (8.5–8.9)	9.6 (9.4–9.7)	7,716	21,092	10.3%
Hypertension without heart disease	25	14	5.2 (5.0–5.3)	8.4 (8.3–8.5)	4,088	19,556	61.5%
Symptoms, signs and ill-defined conditions	11	15	12.0 (11.7–12.2)	8.0 (7.9–8.1)	10,385	17,352	−33.3%
Chronic liver disease and cirrhosis	12	16	11.4 (11.2–11.7)	7.6 (7.5–7.8)	10,485	15,291	−33.3%
Ovarian cancer	13	17	10.4 (10.2–10.6)	6.6 (6.5–6.7)	9,670	14,193	−36.5%
Suicide and self-inflicted injury	19	18	7.1 (6.9–7.3)	6.1 (6.0–6.3)	6,503	10,389	−14.1%
Corpus and uterus cancers	23	19	6.0 (5.9–6.2)	5.0 (4.9–5.1)	5,477	10,994	−16.7%
Leukemia	20	20	6.8 (6.7–7.0)	4.6 (4.5–4.7)	6,193	9,909	−32.4%

Rank is based on the age-adjusted mortality rate. Age-adjusted mortality rates are per 100,000 population and are age-adjusted to the United States standard population in 2000. Death count is the number of deaths. CI, confidence interval.
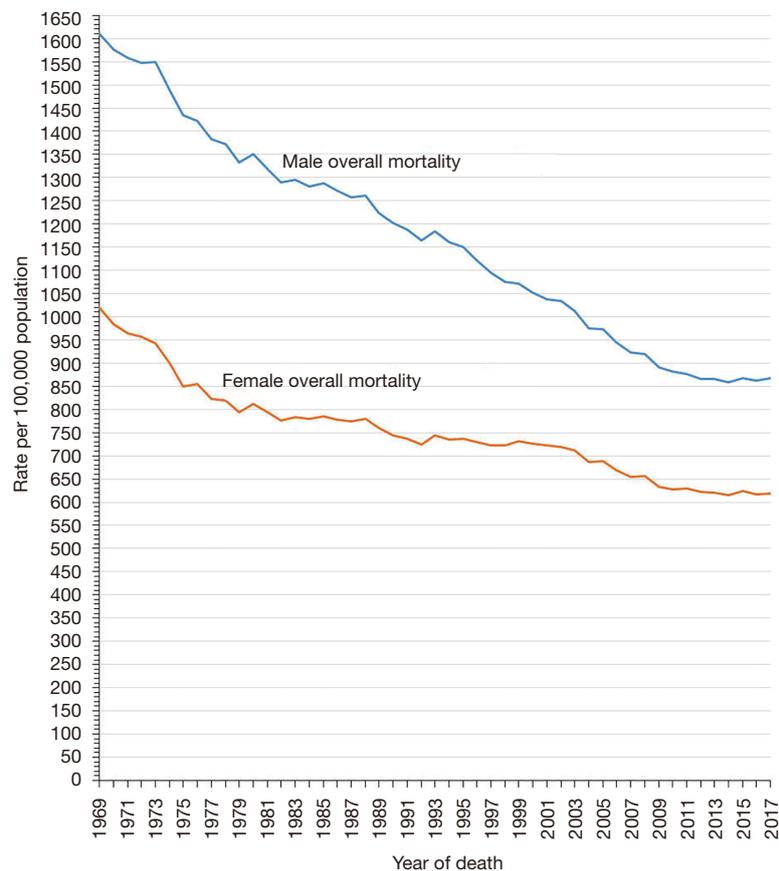
Figure 1 Trends in the overall mortality rates [1969–2017] by sex, United States. Rates are age-adjusted to the United States standard population in 2000.

1979 to 25.0 and 34.7 (per 100,000 population) in 2017, and was the seventh and fourth leading cause of death in 2017, respectively.

The male age-adjusted mortality rate for chronic obstructive pulmonary disease and allied conditions dropped by 23.4%, from a peak of 59.0 (per 100,000 population) in 1999 to 45.2 (per 100,000 population) in 2017. However, this rate increased in females by 383.5%, from 7.9 (per 100,000 population) in 1969 to 38.2 (per 100,000 population) in 2017, with no downward trend (*Table 1* and *Figure 2A,2B*). Although mortality due to lung and bronchus cancers in males dropped by 50.9%, from a peak of 90.6 (per 100,000 population) in 1990 to 44.5 (per 100,000 population) in 2017, and decreased by 26.4% in females, from a peak of 41.6 (per 100,000 population) in 2002 to 30.6 (per 100,000 population) in 2017, it remained the leading cause of cancer death for both sexes in 2017 (*Table 1* and *Figure 2A,2B*). Malignant cancers of the lung

and bronchus, prostate, and colon and rectum were the three leading causes of cancer death in males in 2017 (*Table 1*). The same trend was found in females, except that breast cancer replaced prostate cancer (*Table 2*).

Trends in disease mortality rates by race and ethnicity

The age-adjusted mortality rate changes in different races and ethnicities from 1969 to 2017 were also analyzed (*Tables 2,3*). The mortality rates of all causes of death were higher for blacks than whites, irrespective of sex, from 1969 to 2017 (*Figure 3*). From 1979 to 2017, blacks had higher mortality rates than whites in three major chronic diseases (heart diseases, cerebrovascular diseases, and diabetes mellitus) for both sexes (*Figure 4A-4C*).

The top three causes of death in 2017 in white males were heart diseases, accidents and adverse effects, and chronic obstructive pulmonary disease and allied conditions
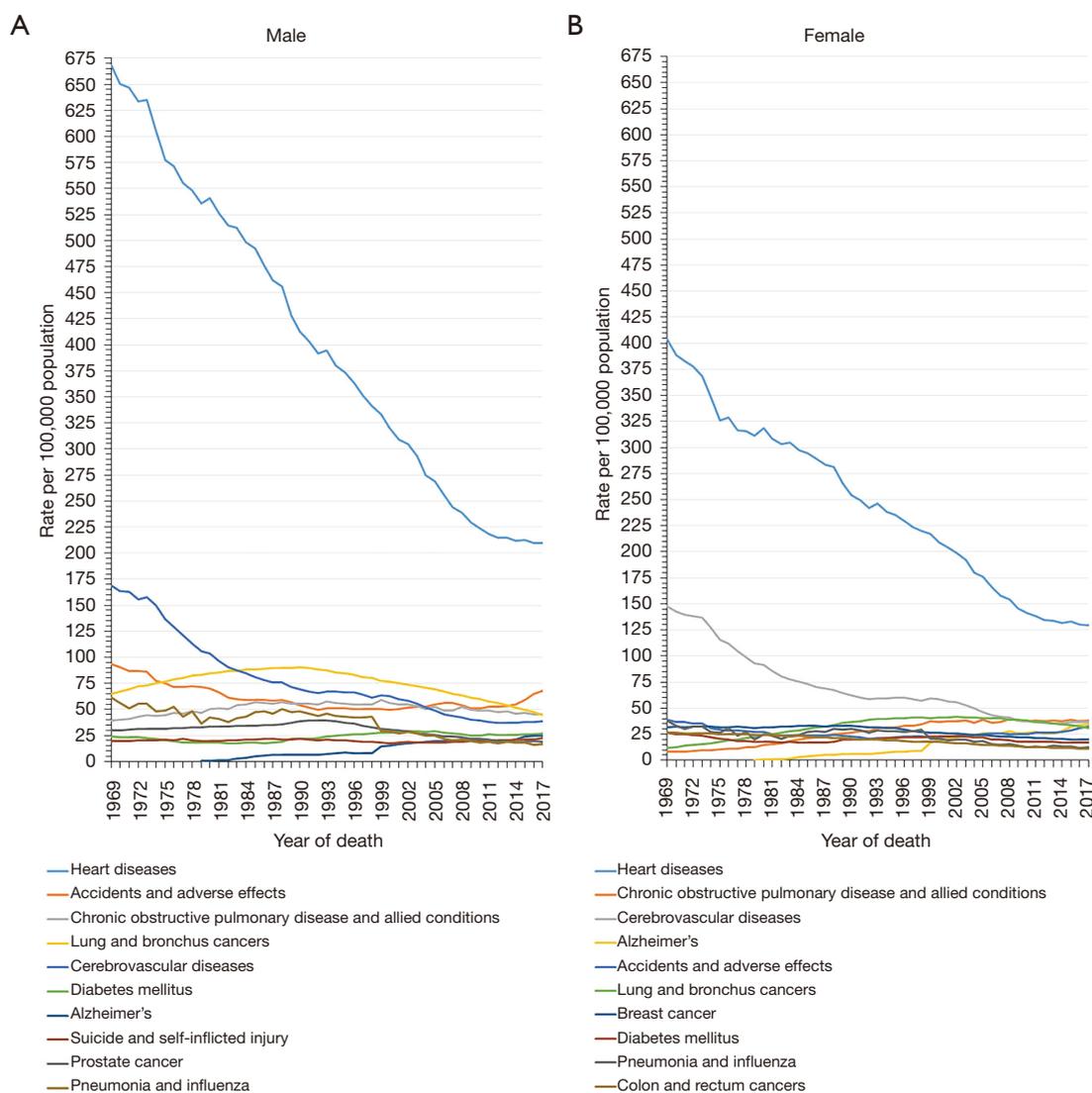
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Figure 2 Trends in the mortality rates [1969–2017] of the 10 leading causes of death by sex, United States. Rates are age-adjusted to the United States standard population in 2000. Males (A). Females (B).

(*Table 2* and Figure S1A). The top three causes of death in 2017 in black males and males of other races and ethnicities were heart diseases, accidents and adverse effects, and cerebrovascular diseases (*Table 2* and Figure S1B,S1C). The top three causes of death in 2017 in white females were heart diseases, chronic obstructive pulmonary disease and allied conditions, and Alzheimer's (*Table 3* and Figure S2A). The top three causes of death in 2017 in black females were heart diseases, cerebrovascular diseases, and diabetes mellitus (*Table 3* and Figure S2B). The top three causes of death in 2017 in females of other races and ethnicities were heart diseases, cerebrovascular diseases, and Alzheimer's

(*Table 3* and Figure S2C).

Trends in disease mortality rates by age intervals

In addition, the age-adjusted mortality rate changes in different age intervals from 1969 to 2017 were also analyzed (Tables S1,S2). Mortality rates among males were higher than those among females across all age intervals from 1969 to 2017 (*Figure 5*). The top three causes of death in males aged between birth and 39 years in 2017 were accidents and adverse effects, suicide and self-inflicted injury, and homicide and legal intervention (Table S1 and Figure S3A),

Table 2 Mortality rate changes [1969–2017] of the 10 leading causes of death in males by race and ethnicity, United States

All causes	Mortality rank		Age-adjusted mortality rate (95% CI)		Death count		Relative change in mortality (2017 vs. 1969)
	1969	2017	1969	2017	1969	2017	
White males							
All causes of death			1,577.5 (1,574.0–1,580.9)	865.0 (863.4–866.5)	945,081	1,212,411	–45.2%
Heart diseases	1	1	673.1 (670.8–675.4)	208.7 (207.9–209.4)	383,936	295,002	–69.0%
Accidents and adverse effects	3	2	89.6 (88.8–90.3)	71.0 (70.6–71.5)	68,005	91,794	–20.8%
Chronic obstructive pulmonary disease and allied conditions	6	3	40.2 (39.7–40.7)	47.4 (47.0–47.8)	25,091	67,623	17.9%
Lung and bronchus cancers	4	4	64.4 (63.8–65.1)	44.7 (44.3–45.0)	45,235	67,201	–30.6%
Cerebrovascular diseases	2	5	163.8 (162.6–165.1)	36.4 (36.0–36.7)	81,621	50,146	–77.8%
Alzheimer's	–	6	–	25.9 (25.7–26.2)	–	33,898	–
Suicide and self-inflicted injury	12	7	20.3 (20.0–20.7)	25.2 (24.9–25.4)	14,883	32,863	24.1%
Diabetes mellitus	10	8	23.0 (22.6–23.4)	25.0 (24.7–25.2)	13,614	36,393	8.7%
Prostate cancer	9	9	28.1 (27.6–28.6)	17.8 (17.5–18.0)	14,365	24,657	–36.7%
Pneumonia and influenza	5	10	58.7 (57.9–59.4)	16.3 (16.1–16.6)	31,484	22,454	–72.2%
Colon and rectum cancers	7	11	33.8 (33.3–34.3)	15.6 (15.4–15.8)	20,317	22,811	–53.8%
Chronic liver disease and cirrhosis	11	12	22.3 (22.0–22.7)	15.4 (15.2–15.6)	16,512	23,251	–30.9%
Nephritis, nephrotic syndrome and nephrosis	23	13	9.0 (8.7–9.2)	14.5 (14.3–14.7)	5,318	20,184	61.1%
Pancreatic cancer	17	14	13.9 (13.6–14.2)	13.0 (12.8–13.2)	8,837	19,525	–6.5%
Septicemia	37	15	1.8 (1.7–2.0)	11.2 (11.0–11.4)	1,232	15,900	522.2%
Symptoms, signs and ill-defined conditions	14	16	16.3 (16.0–16.7)	9.3 (9.2–9.5)	10,722	12,519	–42.9%
Hypertension without heart disease	25	17	6.6 (6.4–6.9)	8.6 (8.4–8.7)	3,288	12,050	30.3%
Leukemia	18	17	11.7 (11.4–12.0)	8.6 (8.4–8.8)	7,640	12,096	–26.5%
Urinary bladder cancer	21	19	9.6 (9.3–9.9)	7.7 (7.6–7.9)	5,515	10,891	–19.8%
Lymphoma	19	20	9.7 (9.4–9.9)	7.6 (7.4–7.7)	6,725	10,812	–21.6%

Table 2 (*continued*)

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Table 2 (*continued*)

All causes	Mortality rank		Age-adjusted mortality rate (95% CI)		Death count		Relative change in mortality (2017 *vs.* 1969)
	1969	2017	1969	2017	1969	2017	
Black males							
All causes of death			1,957.7 (1,945.5–1,969.9)	1,058.3 (1,053.0–1,063.6)	127,043	177,318	−45.9%
Heart diseases	1	1	643.7 (636.3–651.1)	259.8 (257.2–262.5)	35,582	42,084	−59.6%
Accidents and adverse effects	3	2	127.5 (124.9–130.2)	68.8 (67.6–70.0)	11,322	14,197	−46.0%
Cerebrovascular diseases	2	3	225.5 (221.0–230.0)	56.9 (55.6–58.1)	11,954	8,670	−74.8%
Lung and bronchus cancers	6	4	73.2 (71.0–75.4)	52.2 (51.1–53.4)	4,914	8,825	−28.7%
Diabetes mellitus	11	5	31.2 (29.7–32.7)	45.6 (44.5–46.7)	1,902	7,611	46.2%
Homicide and legal intervention	5	6	77.1 (75.2–79.0)	38.5 (37.7–39.3)	6,763	8,924	−50.1%
Chronic obstructive pulmonary disease and allied conditions	14	7	26.0 (24.6–27.4)	38.1 (37.0–39.1)	1,629	5,692	46.5%
Prostate cancer	8	8	50.0 (47.8–52.2)	36.4 (35.3–37.4)	2,405	5,065	−27.2%
Nephritis, nephrotic syndrome and nephrosis	16	9	24.6 (23.2–26.0)	29.9 (29.0–30.9)	1,506	4,591	21.5%
Alzheimer's	–	10	–	22.5 (21.6–23.4)	–	2,502	–
Colon and rectum cancers	13	11	27.1 (25.7–28.6)	22.3 (21.5–23.0)	1,585	3,802	−17.7%
Septicemia	32	12	4.7 (4.1–5.3)	19.4 (18.7–20.1)	387	3,090	312.8%
Hypertension without heart disease	17	13	17.0 (15.9–18.2)	18.8 (18.0–19.5)	1,018	2,926	10.6%
Pneumonia and influenza	4	14	86.6 (84.0–89.2)	18.2 (17.5–18.9)	5,979	2,732	−79.0%
Pancreatic cancer	18	15	16.5 (15.4–17.6)	14.9 (14.3–15.5)	1,008	2,602	−9.7%
Symptoms, signs and ill-defined conditions	7	16	71.8 (69.5–74.2)	12.7 (12.1–13.2)	4,781	2,356	−82.3%
Liver cancer	30	17	6.9 (6.2–7.6)	11.1 (10.6–11.6)	439	2,257	60.9%
Suicide and self-inflicted injury	21	18	10.0 (9.3–10.7)	11.0 (10.5–11.4)	804	2,421	10.0%
Chronic liver disease and cirrhosis	9	19	36.2 (34.8–37.6)	10.1 (9.6–10.5)	2,632	2,106	−72.1%
Human immunodeficiency virus (HIV)	–	20	–	9.5 (9.1–10.0)	–	2,002	–

Table 2 (*continued*)

Table 2 (*continued*)

All causes	Mortality rank		Age-adjusted mortality rate (95% CI)		Death count		Relative change in mortality (2017 *vs.* 1969)
	1969	2017	1969	2017	1969	2017	
Other males							
All causes of death	1	1	1,100.7 (1,075.1–1,126.7)	512.0 (507.4–516.7)	8,395	49,291	−53.5%
Heart diseases	2	2	341.3 (326.5–356.6)	116.0 (113.8–118.3)	2,211	10,768	−66.0%
Accidents and adverse effects	3	3	124.5 (117.2–132.0)	32.0 (31.0–33.1)	1,312	3,717	−74.3%
Cerebrovascular diseases	5	4	102.3 (94.0–111.0)	31.7 (30.5–32.9)	628	2,828	−69.0%
Lung and bronchus cancers	8	5	34.6 (30.2–39.4)	27.5 (26.5–28.6)	244	2,668	−20.5%
Diabetes mellitus	10	6	25.0 (21.1–29.3)	23.6 (22.6–24.6)	166	2,297	−5.6%
Chronic obstructive pulmonary disease and allied conditions	4	7	20.6 (17.2–24.6)	19.7 (18.7–20.6)	137	1,684	−4.4%
Pneumonia and influenza	–	8	53.1 (47.4–59.2)	16.2 (15.3–17.1)	387	1,371	−69.5%
Alzheimer's	12	9	–	12.3 (11.5–13.1)	–	924	–
Suicide and self-inflicted injury	11	10	17.4 (14.6–20.6)	11.7 (11.1–12.3)	167	1,495	−32.8%
Colon and rectum cancers	21	11	20.1 (16.8–23.9)	11.6 (10.9–12.3)	142	1,184	−42.3%
Nephritis, nephrotic syndrome and nephrosis	17	12	8.8 (6.8–11.3)	10.7 (10.0–11.4)	70	969	21.6%
Liver cancer	6	13	10.4 (8.1–13.2)	10.1 (9.4–10.7)	75	1,076	−2.9%
Chronic liver disease and cirrhosis	16	14	27.1 (23.6–31.0)	9.3 (8.8–9.9)	228	1,093	−65.7%
Prostate cancer	28	15	10.9 (8.2–14.0)	9.0 (8.4–9.7)	64	764	−17.4%
Hypertension without heart disease	15	16	5.0 (3.3–7.1)	8.7 (8.1–9.3)	31	766	74.0%
Pancreatic cancer	32	17	13.5 (10.7–16.8)	7.9 (7.4–8.5)	86	792	−41.5%
Septicemia	9	18	3.2 (2.1–4.7)	6.5 (5.9–7.0)	31	613	103.1%
Stomach cancer	7	19	23.7 (19.9–28.0)	5.9 (5.4–6.4)	152	578	−75.1%
Symptoms, signs and ill-defined conditions	22		26.8 (23.0–31.1)	4.9 (4.4–5.3)	214	505	−81.7%
Leukemia		19	6.8 (5.0–8.9)	4.9 (4.5–5.4)	62	472	−27.9%

Rank is based on the age-adjusted mortality rate. Age-adjusted mortality rates are per 100,000 population and are age-adjusted to the United States standard population in 2000. Other denotes other races and ethnicities, including American Indian/AK Native, Asian/Pacific Islander. Death count is the number of deaths. CI, confidence interval.

Table 3 Mortality rate changes [1969–2017] of the 10 leading causes of death in female by race and ethnicity, United States

All causes	Mortality rank		Age-adjusted mortality rate (95% CI)		Death count		Relative change in mortality (2017 vs. 1969)
	1969	2017	1969	2017	1969	2017	
White females							
All causes of death			988.7 (986.4–991.0)	622.2 (621.0–623.3)	738,063	1,165,866	−37.1%
Heart diseases	1	1	398.5 (397.0–400.0)	128.0 (127.5–128.5)	285,601	253,605	−67.9%
Chronic obstructive pulmonary disease and allied conditions	15	2	7.8 (7.6–8.0)	41.5 (41.2–41.8)	6,342	78,122	432.1%
Alzheimer's	–	3	–	36.1 (35.8–36.4)	–	75,411	–
Cerebrovascular diseases	2	4	142.9 (142.0–143.8)	35.6 (35.3–35.8)	99,170	70,644	−75.1%
Accidents and adverse effects	3	5	38.2 (37.8–38.7)	34.4 (34.1–34.7)	30,867	52,023	−9.9%
Lung and bronchus cancers	10	6	12.2 (11.9–12.4)	31.9 (31.7–32.2)	10,267	58,371	161.5%
Breast cancer	5	7	32.0 (31.6–32.4)	19.4 (19.2–19.6)	26,333	33,988	−39.4%
Diabetes mellitus	8	8	24.3 (24.0–24.7)	15.2 (15.0–15.4)	19,049	27,904	−37.4%
Pneumonia and influenza	4	9	36.9 (36.5–37.4)	12.7 (12.5–12.9)	26,139	24,823	−65.6%
Colon and rectum cancers	7	10	26.8 (26.5–27.2)	11.2 (11.1–11.4)	21,233	20,332	−58.2%
Nephritis, nephrotic syndrome and nephrosis	24	11	5.6 (5.5–5.8)	9.9 (9.7–10.0)	4,347	18,921	76.8%
Pancreatic cancer	14	12	8.6 (8.4–8.9)	9.5 (9.3–9.6)	7,005	17,468	10.5%
Septicemia	39	13	1.3 (1.2–1.3)	9.3 (9.1–9.4)	1,042	17,169	615.4%
Chronic liver disease and cirrhosis	12	14	10.3 (10.1–10.6)	8.2 (8.1–8.3)	8,634	13,275	−20.4%
Symptoms, signs and ill-defined conditions	13	15	8.7 (8.5–8.9)	8.0 (7.8–8.1)	6,658	14,674	−8.0%
Hypertension without heart disease	26	16	4.4 (4.3–4.6)	7.6 (7.4–7.7)	3,131	15,196	72.7%
Suicide and self-inflicted injury	16	17	7.6 (7.4–7.8)	6.9 (6.8–7.1)	6,148	9,151	−9.2%
Ovarian cancer	11	18	10.6 (10.4–10.8)	6.8 (6.7–7.0)	8,956	12,198	−35.8%
Leukemia	19	19	7.0 (6.8–7.2)	4.8 (4.7–4.9)	5,723	8,622	−31.4%
Corpus and uterine cancers	23	20	5.7 (5.5–5.9)	4.6 (4.5–4.7)	4,705	8,394	−19.3%

Table 3 (*continued*)

Table 3 (*continued*)

All causes	Mortality rank		Age-adjusted mortality rate (95% CI)		Death count		Relative change in mortality (2017 vs. 1969)
	1969	2017	1969	2017	1969	2017	
Black females							
All causes of death			1,299.5 (1,290.7–1,308.4)	708.8 (705.3–712.3)	98,316	163,305	−45.5%
Heart diseases	1	1	463.7 (458.2–469.3)	162.6 (160.9–164.3)	30,788	37,231	−64.9%
Cerebrovascular diseases	2	2	202.9 (199.2–206.6)	47.2 (46.3–48.2)	13,311	10,633	−76.7%
Diabetes mellitus	3	3	48.3 (46.6–49.9)	32.0 (31.2–32.7)	3,649	7,378	−33.7%
Alzheimer's	–	4	–	30.5 (29.8–31.3)	–	6,582	–
Lung and bronchus cancers	16	5	12.5 (11.7–13.3)	28.2 (27.5–28.9)	990	6,713	125.6%
Breast cancer	7	6	30.3 (29.1–31.6)	26.9 (26.2–27.6)	2,415	6,427	−11.2%
Accidents and adverse effects	6	7	44.2 (42.7–45.7)	25.9 (25.2–26.6)	4,368	6,136	−41.4%
Chronic obstructive pulmonary disease and allied conditions	24	8	7.1 (6.5–7.7)	24.5 (23.9–25.2)	596	5,671	245.1%
Nephritis, nephrotic syndrome and nephrosis	13	9	16.8 (15.8–17.8)	22.0 (21.3–22.6)	1,320	5,018	31.0%
Septicemia	33	10	3.1 (2.7–3.5)	15.4 (14.9–15.9)	297	3,551	396.8%
Hypertension without heart disease	15	11	12.6 (11.8–13.5)	15.1 (14.6–15.6)	942	3,434	19.8%
Colon and rectum cancers	9	12	25.4 (24.1–26.6)	14.5 (14.0–15.0)	1,832	3,407	−42.9%
Pneumonia and influenza	4	13	48.2 (46.6–49.9)	12.9 (12.4–13.4)	4,117	2,926	−73.2%
Pancreatic cancer	19	14	9.1 (8.4–9.8)	11.8 (11.4–12.3)	680	2,781	29.7%
Symptoms, signs and ill-defined conditions	5	15	46.6 (44.9–48.3)	9.8 (9.4–10.2)	3,594	2,246	−79.0%
Corpus and uterine cancers	17	16	9.7 (9.0–10.5)	8.8 (8.4–9.2)	748	2,152	−9.3%
Certain conditions originating in the perinatal period	8	17	26.0 (25.2–26.8)	6.9 (6.6–7.3)	4,461	1,645	−73.5%
Ovarian cancer	21	18	8.1 (7.5–8.8)	5.8 (5.5–6.2)	679	1,405	−28.4%
Homicide and legal intervention	14	19	14.2 (13.5–15.0)	5.4 (5.1–5.7)	1,457	1,301	−62.0%
Chronic liver disease and cirrhosis	11	20	19.5 (18.6–20.5)	5.0 (4.7–5.3)	1,676	1,245	−74.4%
Myeloma	32	20	3.4 (3.0–3.9)	5.0 (4.7–5.3)	261	1,132	47.1%

Table 3 (*continued*)

Table 3 (*continued*)

All causes	Mortality rank		Age-adjusted mortality rate (95% CI)		Death count		Relative change in mortality (2017 vs. 1969)
	1969	2017	1969	2017	1969	2017	
Other females							
All causes of death			643.0 (622.0–664.5)	363.9 (360.5–367.3)	4,426	45,183	−43.4%
Heart diseases	1	1	182.6 (170.6–195.2)	71.7 (70.1–73.2)	952	8,727	−60.7%
Cerebrovascular diseases	2	2	82.6 (74.6–91.0)	28.6 (27.7–29.6)	439	3,460	−65.4%
Alzheimer's	–	3	–	17.6 (16.8–18.3)	–	2,085	–
Lung and bronchus cancers	12	4	10.3 (7.8–13.2)	16.2 (15.5–17.0)	66	2,071	57.3%
Diabetes mellitus	5	5	24.4 (20.5–28.8)	16.1 (15.4–16.8)	150	1,980	−34.0%
Accidents and adverse effects	3	6	40.6 (36.3–45.3)	15.8 (15.1–16.5)	423	2,053	−61.1%
Breast cancer	10	7	10.7 (8.4–13.4)	11.8 (11.2–12.4)	80	1,585	10.3%
Chronic obstructive pulmonary disease and allied conditions	17	8	6.9 (4.9–9.3)	11.6 (11.0–12.2)	47	1,401	68.1%
Pneumonia and influenza	4	9	31.6 (27.0–36.7)	11.2 (10.6–11.8)	233	1,365	−64.6%
Colon and rectum cancers	9	10	13.4 (10.5–16.7)	7.9 (7.4–8.4)	80	1,011	−41.0%
Nephritis, nephrotic syndrome and nephrosis	15	11	7.0 (5.1–9.4)	7.8 (7.3–8.4)	51	950	11.4%
Hypertension without heart disease	33	12	2.5 (1.3–4.3)	7.7 (7.2–8.2)	15	926	208.0%
Pancreatic cancer	20	13	5.6 (3.7–7.9)	6.7 (6.3–7.2)	31	843	19.6%
Chronic liver disease and cirrhosis	6	14	19.8 (16.8–23.1)	5.7 (5.3–6.1)	175	771	−71.2%
Septicemia	35	15	1.5 (0.8–2.7)	4.8 (4.4–5.2)	18	599	220.0%
Suicide and self-inflicted injury	13	16	7.3 (5.5–9.4)	4.4 (4.0–4.7)	69	597	−39.7%
Ovarian cancer	21	16	4.9 (3.4–6.9)	4.4 (4.0–4.7)	35	590	−10.2%
Stomach cancer	8	18	14.0 (11.1–17.4)	3.8 (3.5–4.2)	86	488	−72.9%
Liver cancer	23	19	4.2 (2.6–6.2)	3.6 (3.3–3.9)	24	447	−14.3%
Symptoms, signs and ill-defined conditions	7	20	17.6 (14.2–21.4)	3.5 (3.2–3.9)	133	432	−80.1%

Rank is based on the age-adjusted mortality rate. Age-adjusted mortality rates are per 100,000 population and are age-adjusted to the United States standard population in 2000. Other denotes other races and ethnicities, including American Indian/AK Native, Asian/Pacific Islander. Death count is the number of deaths. CI, confidence interval.
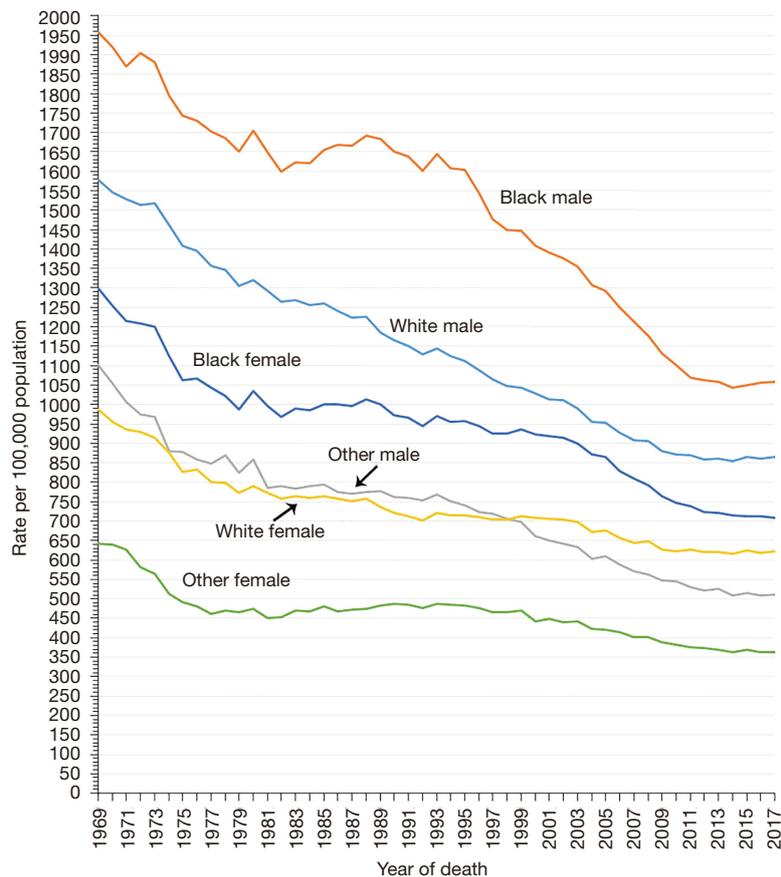
Figure 3 Trends in the overall mortality rates [1969–2017] by race and ethnicity, United States. Rates are age-adjusted to the United States standard population in 2000. Other denotes other races and ethnicities, including American Indian/AK Native, Asian/Pacific Islander.

in males aged 40–49 years in 2017 were accidents and adverse effects, heart diseases, and suicide and self-inflicted injury (Table S1 and Figure S3B), in males aged 50–59 years in 2017 were heart diseases, accidents and adverse effects, and lung and bronchus cancers (Table S1 and Figure S3C), in males aged 60–69 years in 2017 were heart diseases, lung and bronchus cancers, and chronic obstructive pulmonary disease and allied conditions (Table S1 and Figure S3D), and in males aged ≥70 years in 2017 were heart diseases, chronic obstructive pulmonary disease and allied conditions, and cerebrovascular diseases (Table S1 and Figure S3E). The top three causes of death in females aged between birth and 39 years in 2017 were accidents and adverse effects, certain conditions originating in the perinatal period, and suicide and self-inflicted injury (Table S2 and Figure S4A), in females aged 40–49 years in 2017 were accidents and adverse effects, heart diseases, and breast cancer (Table S2 and Figure S4B), in females aged

50–59 years in 2017 were heart diseases, accidents and adverse effects, and lung and bronchus cancers (Table S2 and Figure S4C), in females aged 60–69 years in 2017 were heart diseases, lung and bronchus cancers, and chronic obstructive pulmonary disease and allied conditions (Table S2 and Figure S4D), in females aged ≥70 years in 2017 were heart diseases, Alzheimer's, and cerebrovascular diseases (Table S2 and Figure S4E).

Discussion

A total of 109,836,044 deaths were recorded in the U.S. from 1969 to 2017. This represents substantial data that can truly reflect the real causes of death among Americans. From 1969 to 2017, health outcomes underwent dramatic changes across the U.S. (6). In the past 50 years, the rapid development of industrial technology has presented new problems. In 2017, accidents and adverse effects became
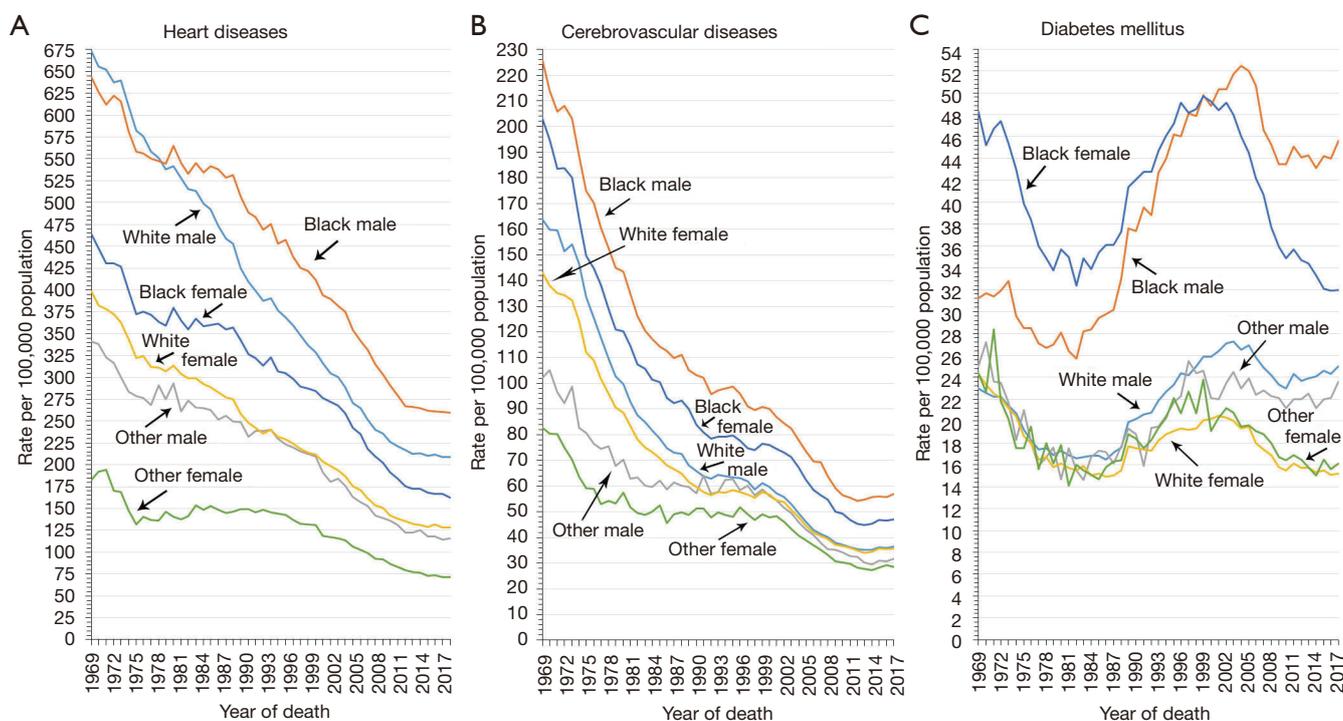
Figure 4 Trends in the mortality rates [1969–2017] of three chronic diseases by race and ethnicity, United States. Rates are age-adjusted to the United States standard population in 2000. Other denotes other races and ethnicities, including American Indian/AK Native, Asian/Pacific Islander. Heart diseases (A). Cerebrovascular diseases (B). Diabetes mellitus (C).

the second leading cause of death among males, and the fifth leading cause of death among females (*Figure 2*). The mortality rate per 100,000 population for accidents and adverse effects in males rose by 37.8%, from a minimum of 49.2 in 2000 to 67.8 in 2017, and increased by 53.1% in females, from a minimum of 20.9 in 1992 to 32.0 in 2017 (*Figure 2*). The main type of accidents and adverse effects were traffic accidents. The rise in the mortality rate of accidents is debatable, but it is speculated to be related to the use of smart phones (7,8). Suicide rates have also risen in the U.S. (9,10). The mortality rate per 100,000 population for suicide and self-inflicted injury in males rose by 26.6%, from a minimum of 17.7 in 2000 to 22.4 in 2017, and increased by 52.5% in females, from a minimum of 4.0 in 1999 to 6.1 in 2017 (*Table 1* and *Figure 2*). In 2017, suicide and self-inflicted injury was the second-leading cause of death in males between birth and 39 years, and the third-leading causes of death in females of the same age range (Figures S3A,S4A). Speculations explaining this rise in suicide rates have been proposed, but the exact causes for the increase remain unknown (9,11). Improving social connectedness, civic opportunities, and health insurance

coverage, as well as limiting access to lethal means, have the potential to reduce suicide rates (12). In addition, with the aging of the U.S. population, Alzheimer's is becoming an increasingly common cause of death. From 1979 to 2017, the mortality rate per 100,000 population for Alzheimer's increased by 4,900.0% (0.5 to 25.0) in males and 8,575.0% (0.4 to 34.7) in females (*Figure 2*). Alzheimer's is the only cause of death among the top 10 that cannot be prevented, cured, or even slowed (13). The rapid increase in the elderly population is responsible for the rapid increase in the mortality rate for Alzheimer's in the U.S. (14,15).

The advancement of medicine in the past half-century was also evident. The overall annual mortality rate of the U.S. population declined continuously from 1969 to 2017, and the overall life expectancy in the U.S. increased from 70.5 years in 1969 to 78.6 years in 2017 (16). The overall mortality rate in males per 100,000 population fell by 46.1%, from 1,610.0 in 1969 to 867.2 in 2017, and likewise, decreased by 39.3% in females, from 1,019.3 in 1969 to 619.2 in 2017 (*Table 1* and *Figure 1*). This decline in overall mortality was mainly due to a reduction in mortality caused by heart and cerebrovascular diseases. From 1969
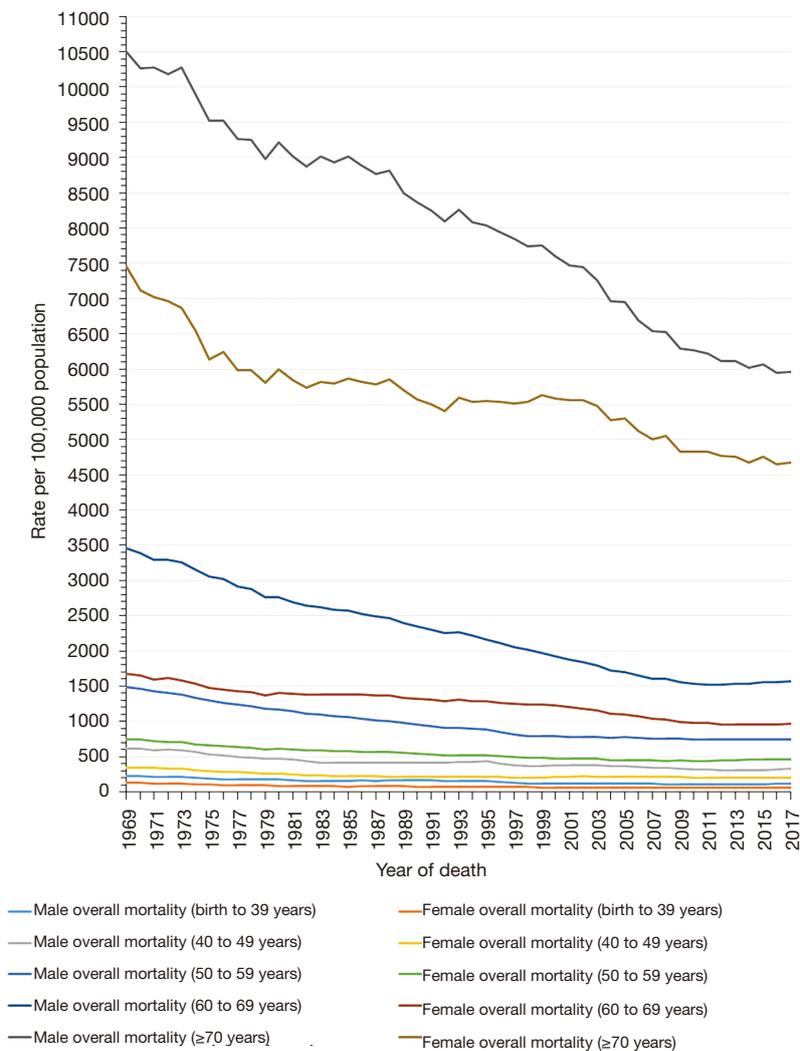
Figure 5 Trends in the overall mortality rates [1969–2017] by age intervals, United States. Rates are age-adjusted to the United States standard population in 2000.

to 2017, the mortality rates for heart and cerebrovascular diseases have continually declined (*Figure 2*). Although it has remained the leading cause of death among both males and females in the U.S., the mortality rate per 100,000 population for heart diseases in males dropped by 68.6%, from 668.2 in 1969 to 209.6 in 2017, and fell by 68.0% in females, from 404.4 in 1969 to 129.4 in 2017 (*Figure 2A,2B*). Similarly, from 1969 to 2017, the mortality rate per 100,000 population for cerebrovascular diseases decreased by 77.3% (168.4 to 38.2) in males and 75.3% (147.9 to 36.6) in females (*Figure 2A,2B*). The decrease in mortality rates due to heart and cerebrovascular diseases observed in this report across the entire U.S. population

has been well documented (17,18). This half-century decline in heart and cerebrovascular diseases mortality is a "milestone of progress" in medicine, and is the result of improved levels of treatment, advances in preventive measures, national policy support, among others (17-19). However, this downward trend in heart and cerebrovascular disease mortality has slowed, and even reversed, among certain demographics after 2012 (20). Further concerns exist with regards to cardiovascular and cerebrovascular drug innovations, quality of care, and healthcare costs (20). As the population ages, there is an urgent need for action to improve innovation in, treatment of, and payment for cardiovascular and cerebrovascular health

(18,20). At present, China's heart and cerebrovascular diseases mortality is still showing an upward trend. Some measures taken by the U.S. to reduce heart and cerebrovascular diseases mortality are worthy of our reference.

The mortality rate for all malignant cancers has also declined in the past 50 years (2). Among the 10 leading causes of death in 2016, there were two cancers in men (cancers of the lung and bronchus, and prostate), and similarly, three cancers in women (cancers of the lung and bronchus, breast, and colon and rectum). The mortality rates of these cancers for both sexes have continued to decline after 2002. Although the mortality rate for lung and bronchus cancers in males dropped by 50.9% from 1990 to 2017, and decreased in females by 26.4% from 2002 to 2017, it has remained the leading cause of cancer death among both males and females in 2017 (*Figure 2A,2B*). The 5-year relative survival rate for all cancers combined, diagnosed in 2008–2014, was 67% in whites and 62% in blacks, but only 19% for lung and bronchus cancer (2). Therefore, low-dose computed tomographic screening needs to be strengthened for earlier diagnosis of lung cancer, which could significantly reduce mortality (21).

In addition, there are marked sex and race disparities in overall mortality. From 1969 to 2017, the mortality rate of all causes of death was higher for males than females (*Figure 1*), and in blacks than whites for both sexes (*Figure 3*). Throughout the world, women tend to live longer than men. Although biological, behavioral, and environmental factors are known contributory factors, the relative contribution of each of these factors remains unclear (22,23). Also, overall mortality varied considerably between racial and ethnic groups. Blacks had significantly lower educational attainment and homeownership and almost twice the proportion of households below the poverty level compared with whites, over a life span (24). These trends might help to explain the disparities in mortality attributed to chronic disease-related behaviors, health-related quality of life, and health care utilization (2,24). This study showed that the mortality rates of heart diseases, cerebrovascular diseases, and diabetes were all higher in blacks than in whites for both sexes (*Figure 4*). Universal and targeted interventions are needed to reduce black-white health disparities over a life span. Finally, it is not surprising that the causes of death among different age intervals also exhibit distinct characteristics. In 2017, the leading cause of death for both males and females aged between birth and 49 years was accidents and adverse effects, and heart diseases in those aged ≥50 years (Figures S3,S4). Depending on the age characteristics of the causes of death, targeted interventions for disease prevention and control, according to the different age intervals, would produce better health outcomes.

Limitations

A strength of our study is the use of nationwide, high-quality, population-based data on mortality for all causes of death from the SEER database. However, our study has several limitations that should be noted. Firstly, although the SEER database includes large and accurate mortality data, the data for non-fatal outcomes is lacking. Secondly, due to the nearly 50-year time span, the diagnostic technologies and standards for certain diseases might have changed, thereby potentially affecting the time trends of these diseases. Thirdly, the SEER database only contains data on people within the U.S. and does not represent changes in mortality worldwide. Therefore, it is necessary to establish a similar database in China, which will represent 1.4 billion people.

Conclusions

The continuous decline in the overall mortality rate from 1969 to 2017 has resulted in an overall decrease in the mortality rate of 46.1% in males and 39.3% in females. This decline in overall mortality is mainly due to a corresponding decrease in mortality caused by heart diseases and cerebrovascular diseases. From 1969 to 2017, the mortality rates of all causes of death were higher in males than females, and in blacks than whites for both sexes. From 1979 to 2017, the mortality rates of heart diseases, cerebrovascular diseases, and diabetes were all higher in blacks than in whites for both sexes. Our results provide important evidence for health policy development and interventions. These findings can be used by governments at the national level to identify major health problems and facilitate priority-setting. In addition, the time trends of population mortality rates from 1969 to 2017 can be used to help guide appropriate health policies in other countries throughout the world.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://dx.doi.org/10.21037/apm-21-2835

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://dx.doi.org/10.21037/apm-21-2835). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

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Figure S1 Trends in the mortality rate for the 10 leading causes of death in males by race and ethnicity, United States, 1969 to 2017. Rates are age-adjusted to the 2000 United States standard population. Male, white (A). Male, black (B). Male, other races and ethnicities (C).

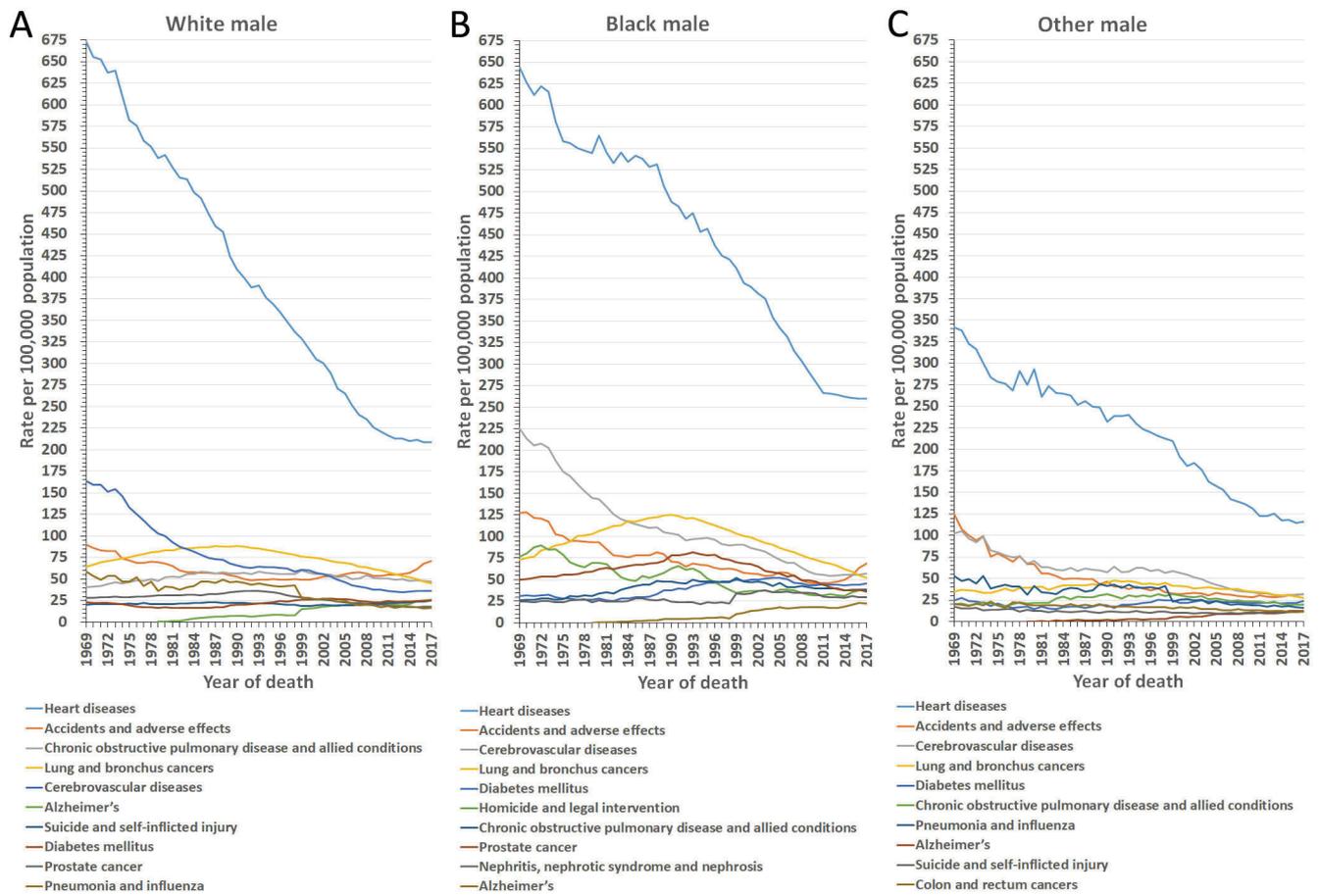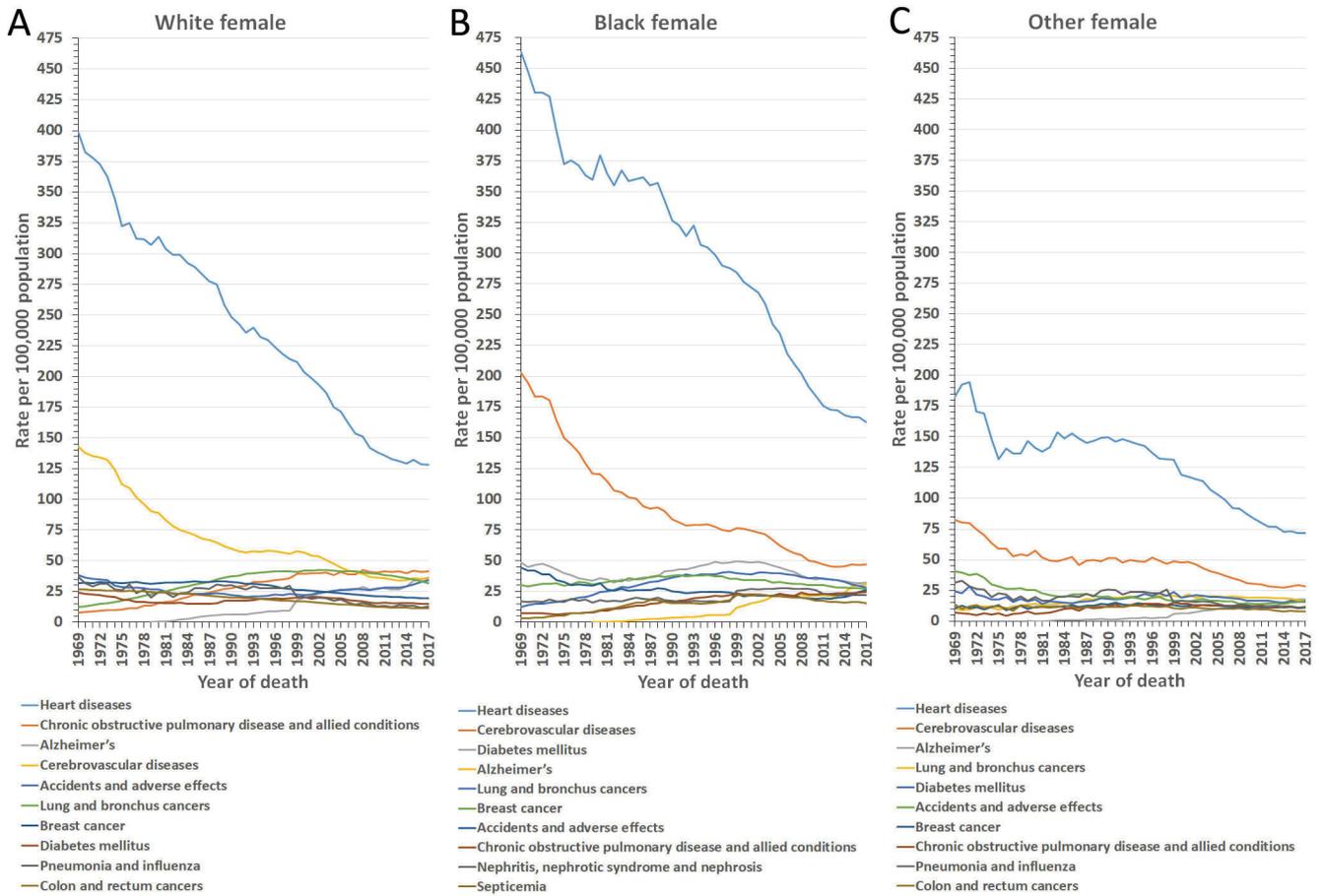**Figure S2** Trends in mortality rate for the 10 leading causes of death in females by race and ethnicity, United States, 1969–2017. Rates are age-adjusted to the 2000 United States standard population. Female, white (A). Female, black (B). Female, other races and ethnicities (C).

Table S1 Mortality rate changes from 1969 to 2017 for the leading 10 causes of death in male by age intervals, United States

All causes	Mortality rank		Age-adjusted mortality rate (95% CI)		Death count		Relative change in mortality (2017 vs. 1969)
	1969	2017	1969	2017	1969	2017	
Male (birth to 39 years)							
All causes of death			226.9 (225.6–228.1)	123.4 (122.6–124.1)	136,744	107,726	−45.6%
Accidents and adverse effects	1	1	72.8 (72.1–73.5)	45.2 (44.7–45.6)	44,076	40,174	−37.9%
Suicide and self-inflicted injury	6	2	10.4 (10.1–10.7)	16.3 (16.1–16.6)	5,438	14,614	56.7%
Homicide and legal intervention	4	3	14.6 (14.3–14.9)	12.5 (12.3–12.7)	7,848	11,320	−14.4%
Certain conditions originating in perinatal period	2	4	34.5 (34.1–34.9)	7.7 (7.5–7.9)	25,343	6,291	−77.7%
Heart diseases	3	5	14.7 (14.3–15.1)	7.2 (7.0–7.4)	6,483	6,003	−51.0%
Congenital anomalies	5	6	11.3 (11.1–11.6)	4.1 (4.0–4.2)	8,143	3,415	−63.7%
Symptoms, signs and ill-defined conditions	8	7	5.9 (5.7–6.1)	3.9 (3.8–4.1)	3,615	3,331	−33.9%
Chronic liver disease and cirrhosis	9	8	4.0 (3.8–4.2)	1.6 (1.5–1.7)	1,703	1,320	−60.0%
Diabetes mellitus	14	9	1.7 (1.5–1.8)	1.4 (1.3–1.4)	774	1,145	−17.6%
Cerebrovascular diseases	10	10	3.6 (3.4–3.7)	1.2 (1.1–1.2)	1,753	973	−66.7%
Male (40 to 49 years)							
All causes of death			616.7 (612.2–621.2)	327.7 (325.3–330.3)	73,411	66,910	53.1%
Accidents and adverse effects	2	1	78.0 (76.4–79.6)	76.4 (75.2–77.7)	9,158	15,372	97.9%
Heart diseases	1	2	211.4 (208.8–214.0)	60.9 (59.9–62.0)	25,341	12,541	28.8%
Suicide and self-inflicted injury	6	3	24.6 (23.7–25.5)	28.9 (28.2–29.7)	2,902	5,831	117.5%
Chronic liver disease and cirrhosis	3	4	36.2 (35.1–37.3)	15.5 (15.0–16.0)	4,294	3,196	42.8%
Diabetes mellitus	10	5	8.7 (8.2–9.2)	11.0 (10.6–11.5)	1,034	2,275	126.4%
Homicide and legal intervention	7	6	18.4 (17.6–19.2)	10.8 (10.3–11.3)	2,138	2,148	58.7%
Cerebrovascular diseases	5	7	26.0 (25.1–26.9)	8.5 (8.1–8.9)	3,101	1,746	32.7%
Colon and rectum cancers	11	8	8.6 (8.0–9.1)	7.4 (7.0–7.8)	1,025	1,532	86.0%
Lung and bronchus cancers	4	9	33.5 (32.5–34.6)	5.9 (5.6–6.2)	4,022	1,235	17.6%
Symptoms, signs and ill-defined conditions	9	10	12.8 (12.1–13.4)	4.5 (4.2–4.8)	1,517	913	35.2%
Male (50 to 59 years)							
All causes of death			1,488.5 (1,481.0–1,496.1)	743.4 (739.8–747.1)	151,450	161,968	−50.1%
Heart diseases	1	1	633.8 (628.9–638.7)	176.3 (174.6–178.1)	64,568	38,530	−72.2%
Accidents and adverse effects	3	2	88.4 (86.6–90.2)	84.9 (83.6–86.2)	8,882	17,996	−4.0%
Lung and bronchus cancers	2	3	114.7 (112.6–116.8)	41.4 (40.5–42.2)	11,703	9,263	−63.9%
Chronic liver disease and cirrhosis	5	4	59.6 (58.1–61.2)	36.4 (35.6–37.2)	6,014	7,867	−38.9%
Suicide and self-inflicted injury	9	5	29.3 (28.3–30.4)	30.8 (30.1–31.6)	2,944	6,536	5.1%
Diabetes mellitus	11	6	21.3 (20.4–22.2)	29.9 (29.2–30.6)	2,168	6,520	40.4%
Cerebrovascular diseases	4	7	77.3 (75.6–79.0)	22.4 (21.8–23.0)	7,893	4,881	−71.0%
Chronic obstructive pulmonary disease and allied conditions	7	8	33.5 (32.4–34.7)	21.0 (20.4–21.6)	3,451	4,710	−37.3%
Colon and rectum cancers	8	9	32.1 (31.0–33.2)	20.3 (19.7–20.9)	3,279	4,407	−36.8%
Pancreas cancer	12	10	17.9 (17.1–18.7)	13.5 (13.0–13.9)	1,827	2,979	−24.6%
Male (60 to 69 years)							
All causes of death			3,456.0, (3442.2–3469.9)	1,567.8 (1561.9–1573.7)	239,330	272,206	−54.6%
Heart diseases	1	1	1,533.0 (1523.7–1542.2)	388.7 (385.8–391.6)	106,147	67,490	−74.6%
Lung and bronchus cancers	3	2	259.0 (255.2–262.8)	130.5 (128.8–132.2)	18,004	22,618	−49.6%
Chronic obstructive pulmonary disease and allied conditions	4	3	121.9 (119.3–124.5)	84.7 (83.4–86.1)	8,409	14,666	−30.5%
Accidents and adverse effects	5	4	108.1 (105.7–110.6)	71.6 (70.3–72.8)	7,561	12,503	−33.8%
Diabetes mellitus	9	5	58.2 (56.4–60.0)	65.9 (64.7–67.1)	4,013	11,440	13.2%
Cerebrovascular diseases	2	6	260.6 (256.8–264.5)	55.6 (54.5–56.8)	17,894	9,649	−78.7%
Chronic liver disease and cirrhosis	8	7	69.5 (67.5–71.5)	47.5 (46.5–48.6)	4,891	8,303	−31.7%
Colon and rectum cancers	6	8	89.4 (87.2–91.6)	41.6 (40.7–42.6)	6,180	7,228	−53.5%
Pancreas cancer	13	9	44.1 (42.5–45.7)	39.3 (38.3–40.2)	3,052	6,805	−10.9%
Liver cancer	26	10	14.1 (13.3–15.0)	34.5 (33.6–35.4)	980	6,005	144.7%
Male (≥70 years)							
All causes of death			10,505.6 (10474.3–10537.0)	5,962.2 (5,949.3–5,975.1)	479,584	830,210	−43.2%
Heart diseases	1	1	4,828.4 (4,807.1–4,849.7)	1,608.3 (1,601.6–1,615.0)	219,190	223,290	−66.7%
Chronic obstructive pulmonary disease and allied conditions	7	2	269.1 (264.4–273.8)	389.3 (386.0–392.6)	13,642	54,417	44.7%
Cerebrovascular diseases	2	3	1462.2 (1450.3–1474.3)	321.6 (318.6–324.6)	63,562	44,395	−78.0%
Lung and bronchus cancers	5	4	296.5 (291.8–301.3)	318.0 (315.1–321.0)	16,043	45,362	7.3%
Alzheimer's	-	5	–	264.5 (261.7–267.2)	–	35,836	–
Diabetes mellitus	10	6	160.9 (157.2–164.7)	176.5 (174.3–178.7)	7,693	24,921	9.7%
Prostate cancer	6	7	269.2 (264.3–274.3)	174.4 (172.2–176.6)	12,348	24,149	−35.2%
Accidents and adverse effects	8	8	244.4 (239.6–249.3)	170.1 (167.9–172.3)	10,962	23,663	−30.4%
Pneumonia and influenza	3	9	468.0 (461.1–474.9)	141.9 (140.0–144.0)	19,857	19,546	−69.7%
Nephritis, nephrotic syndrome and nephrosis	18	10	63.3 (60.9–65.8)	130.5 (128.6–132.4)	2,857	18,081	106.2%

Rank is based on the age-adjusted mortality rate. Age-adjusted mortality rates are per 100,000 population and age-adjusted to the 2000 United States standard population. Death count is the number of deaths. CI, confidence interval.

Figure S3 Trends in the mortality rate for the 10 leading causes of death in males by age intervals, United States, 1969–2017. Rates are age-adjusted to the 2000 United States standard population. Birth to 39 years (A); 40–49 years (B); 50–59 years (C); 60–69 years (D); ≥70 years (E).

Table S2 Mortality rate changes from 1969 to 2017 for the leading 10 causes of death in female by age intervals, United States

All causes	Mortality rank 1969	Mortality rank 2017	Age-adjusted mortality rate (95% CI) 1969	Age-adjusted mortality rate (95% CI) 2017	Death count 1969	Death count 2017	Relative change in mortality (2017 vs. 1969)
Female (birth to 39 years)							
All causes of death			129.9 (129.0–130.8)	63.8 (63.3–64.4)	79,400	53,201	−50.9%
Accidents and adverse effects	2	1	22.2 (21.8–22.6)	18.0 (17.7–18.3)	14,150	15,449	−18.9%
Certain conditions originating in perinatal period	1	2	25.2 (24.8–25.6)	6.1 (5.9–6.3)	17,773	4,795	−75.8%
Suicide and self-inflicted injury	6	3	4.4 (4.2–4.6)	4.5 (4.3–4.6)	2,298	3,830	2.3%
Heart diseases	5	4	6.3 (6.1–6.6)	3.8 (3.6–3.9)	3,142	3,110	−39.7%
Congenital anomalies	3	5	9.9 (9.7–10.2)	3.7 (3.6–3.9)	6,906	2,977	−62.6%
Homicide and legal intervention	9	6	3.7 (3.5–3.8)	2.8 (2.7–2.9)	2,099	2,369	−24.3%
Symptoms, signs and ill-defined conditions	7	7	4.0 (3.8–4.2)	2.6 (2.5–2.7)	2,481	2,097	−35.0%
Breast cancer	10	8	2.7 (2.5–2.8)	1.3 (1.3–1.4)	1,162	1,063	−51.9%
Chronic liver disease and cirrhosis	11	9	2.6 (2.4–2.7)	1.1 (1.0–1.1)	1,171	853	−57.7%
Diabetes mellitus	14	10	1.4 (1.3–1.5)	1.0 (0.9–1.0)	720	801	−28.6%
Female (40 to 49 years)							
All causes of death			345.5 (342.3–348.8)	200.4 (198.4–202.3)	43,823	41,683	−42.0%
Accidents and adverse effects	4	1	24.2 (23.3–25.1)	32.9 (32.1–33.7)	3,034	6,738	36.0%
Heart diseases	1	2	59.6 (58.2–60.9)	26.8 (26.1–27.5)	7,601	5,598	−55.0%
Breast cancer	2	3	35.3 (34.3–36.4)	14.8 (14.3–15.3)	4,492	3,076	−58.1%
Suicide and self-inflicted injury	6	4	12.3 (11.7–12.9)	9.8 (9.4–10.2)	1,538	2,012	−20.3%
Chronic liver disease and cirrhosis	5	5	20.1 (19.3–20.9)	8.6 (8.2–9.0)	2,538	1,799	−57.2%
Diabetes mellitus	12	6	7.2 (6.7–7.6)	6.7 (6.4–7.1)	911	1,407	−6.9%
Cerebrovascular diseases	3	7	24.8 (23.9–25.6)	6.3 (6.0–6.7)	3,148	1,326	−74.6%
Colon and rectum cancers	11	8	9.1 (8.6–9.7)	5.7 (5.4–6.1)	1,166	1,207	−37.4%
Lung and bronchus cancers	7	9	11.1 (10.5–11.7)	5.4 (5.1–5.7)	1,415	1,159	−51.4%
Chronic obstructive pulmonary disease and allied conditions	15	10	4.1 (3.8–4.5)	3.9 (3.6–4.1)	525	814	−4.9%
Female (50 to 59 years)							
All causes of death			741.0 (735.9–746.1)	458.5 (455.7–461.3)	81,512	104,574	−38.1%
Heart diseases	1	1	194.5 (191.9–197.1)	72.9 (71.8–74.1)	21,568	16,709	−62.5%
Accidents and adverse effects	4	2	31.3 (30.2–32.3)	36.1 (35.3–36.9)	3,402	7,974	15.3%
Lung and bronchus cancers	7	3	27.0 (26.1–28.0)	33.9 (33.1–34.7)	2,969	7,929	25.6%
Breast cancer	2	4	65.9 (64.4–67.5)	31.9 (31.2–32.7)	7,200	7,207	−51.6%
Chronic obstructive pulmonary disease and allied conditions	13	5	10.6 (10.0–11.3)	22.3 (21.7–22.9)	1,174	5,211	110.4%
Chronic liver disease and cirrhosis	6	6	28.8 (27.8–29.9)	18.1 (17.6–18.7)	3,123	4,074	−37.2%
Diabetes mellitus	9	7	21.7 (20.9–22.6)	16.8 (16.3–17.4)	2,404	3,847	−22.6%
Cerebrovascular diseases	3	8	58.0 (56.6–59.5)	15.8 (15.3–16.3)	6,399	3,614	−72.8%
Colon and rectum cancers	5	9	29.0 (28.0–30.0)	13.7 (13.3–14.2)	3,198	3,122	−52.8%
Suicide and self-inflicted injury	12	10	11.9 (11.3–12.6)	10.1 (9.6–10.5)	1,284	2,214	−15.1%
Female (60 to 69 years)							
All causes of death			1,679.6 (1,670.8–1,688.5)	965.8 (961.4–970.2)	138,649	185,789	−42.5%
Heart diseases	1	1	637.1 (631.7–642.6)	170.8 (169.0–172.7)	52,493	32,853	−73.2%
Lung and bronchus cancers	8	2	37.4 (36.1–38.8)	88.8 (87.5–90.1)	3,102	17,074	137.4%
Chronic obstructive pulmonary disease and allied conditions	12	3	20.2 (19.2–21.2)	70.6 (69.4–71.8)	1,673	13,569	249.5%
Breast cancer	3	4	85.5 (83.5–87.5)	51.7 (50.7–52.8)	7,097	9,963	−39.5%
Cerebrovascular diseases	2	5	177.9 (175.0–180.8)	39.1 (38.2–40.0)	14,647	7,517	−78.0%
Diabetes mellitus	5	6	64.8 (63.1–66.5)	38.4 (37.5–39.3)	5,346	7,383	−40.7%
Accidents and adverse effects	6	7	42.6 (41.2–44.1)	29.8 (29.0–30.5)	3,529	5,745	−30.0%
Pancreas cancer	11	8	25.2 (24.2–26.3)	26.0 (25.3–26.7)	2,085	4,996	3.2%
Colon and rectum cancers	4	9	68.7 (66.9–70.5)	25.6 (24.9–26.3)	5,673	4,918	−62.7%
Chronic liver disease and cirrhosis	10	10	26.4 (25.3–27.5)	20.5 (19.9–21.2)	2,191	3,963	−22.3%
Female (≥70 years)							
All causes of death			7,457.6 (7,436.4–7,478.8)	4,673.1 (4,663.7–4,682.4)	497,421	989,107	−37.3%
Heart diseases	1	1	3,511.1 (3,496.5–3,525.7)	1,112.8 (1,108.3–1,117.4)	232,537	241,293	−68.3%
Alzheimer's	–	2	–	368.3 (365.8–370.9)	–	82,155	–
Cerebrovascular diseases	2	3	1,329.6 (1320.6–1338.6)	331.2 (328.8–333.7)	86,840	71,557	−75.1%
Chronic obstructive pulmonary disease and allied conditions	14	4	44.4 (42.8–46.0)	322.2 (319.6–324.7)	3,140	65,191	625.7%
Lung and bronchus cancers	13	5	47.4 (45.8–49.0)	211.1 (209.0–213.2)	3,530	40,841	345.4%
Diabetes mellitus	5	6	188.1 (184.8–191.3)	117.5 (116.0–119.0)	13,467	23,824	−37.5%
Accidents and adverse effects	7	7	175.8 (172.6–179.1)	113.5 (112.0–114.9)	11,543	24,306	−35.4%
Pneumonia and influenza	3	8	300.3 (295.9–304.7)	108.6 (107.2–110.0)	18,970	23,476	−63.8%
Breast cancer	8	9	122.2 (119.6–124.8)	103.3 (101.8–104.7)	8,877	20,691	−15.5%
Nephritis, nephrotic syndrome and nephrosis	18	10	38.4 (36.9–39.9)	91.2 (89.8–92.5)	2,618	18,978	137.5%

Rank is based on the age-adjusted mortality rate. Age-adjusted mortality rates are per 100,000 population and age-adjusted to the 2000 United States standard population. Death count is the number of deaths. CI, confidence interval.
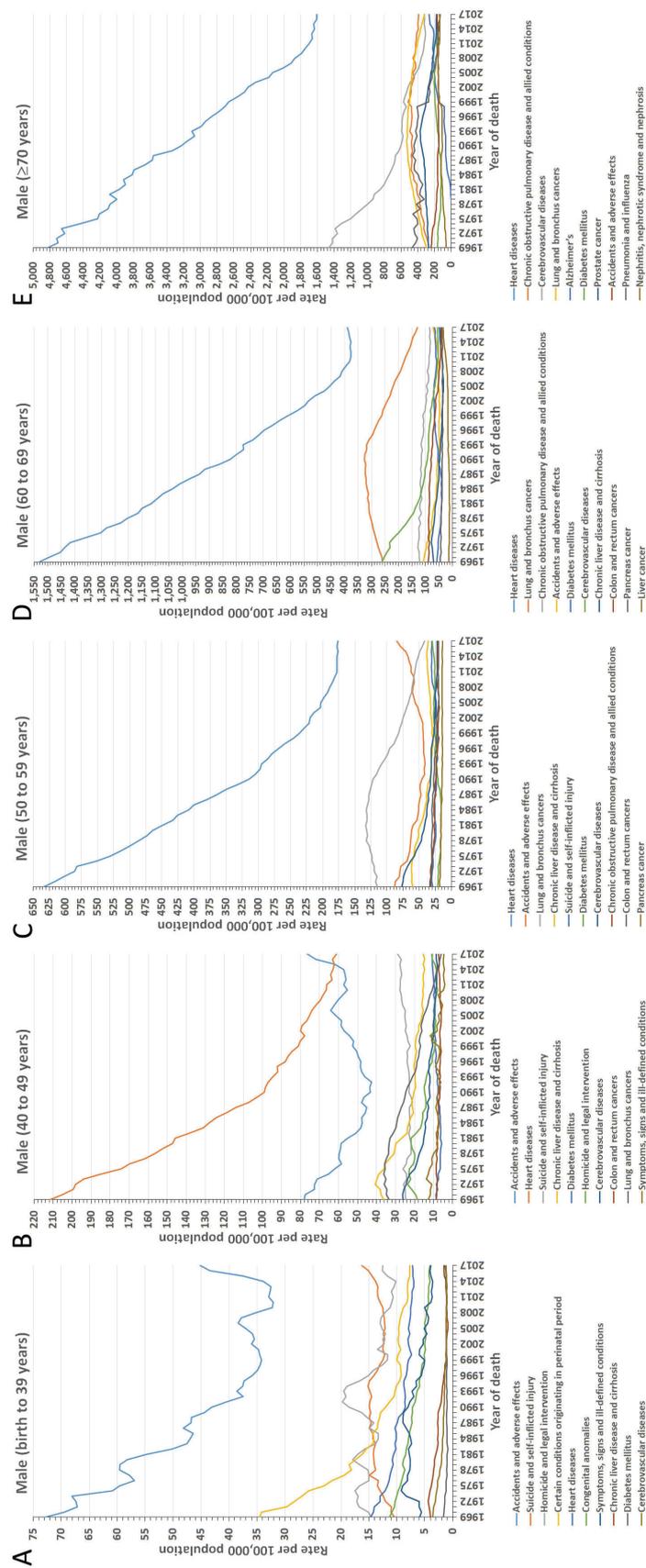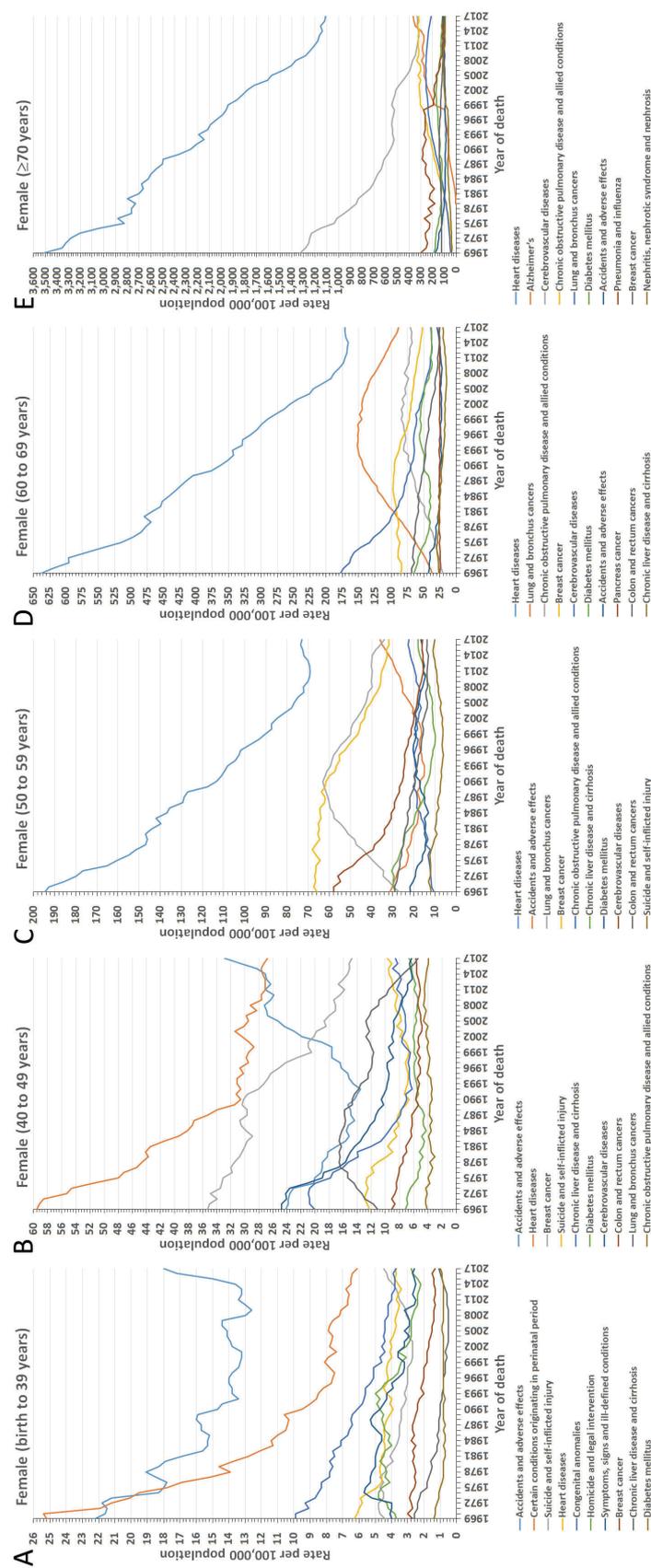
Figure S4 Trends in the mortality rate for the 10 leading causes of death in females by age intervals, United States, 1969–2017. Rates are age-adjusted to the 2000 United States standard population. Birth to 39 years (A); 40–49 years (B); 50–59 years (C); 60–69 years (D); ≥70 years (E).