



Mortality and Longevity

U.S. Population Mortality Observations Updated with 2018 Experience



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U.S. Population Mortality Observations


Updated with 2018 Experience

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A purple banner with a white triangle on the left side. On the left, there is an icon of a laptop with a star in a speech bubble. The text "Give us your feedback!" is in large white font, followed by "Take a short survey on this report." in smaller white font. A green button with the text "Click here" is on the right. The Society of Actuaries logo is in the bottom right corner.

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Section 1: Introduction

The Society of Actuaries has developed this report to provide insights on the historical levels and emerging trends in U.S. population mortality. The most recently released U.S. population mortality experience from 2018 has been incorporated and added to prior available data to enable analysis of mortality experience over the period 1999-2018. This research is part of its ongoing longevity and mortality research initiatives.

The report begins in Section 2 with an Executive Summary broken into subsections of key highlights and other high-level summary observations obtained by looking across the overall population results and the results from the individual causes of death (CODs). Section 3 describes the methodology used in the report. The remaining content of the report is on-line in tables and graphs embedded on the same webpage where the pdf of this report is located. The report focuses on 11 individual CODs that were selected from the National Center for Health Statistics' (NCHS) list of rankable causes of death. The experience is shown for all CODs combined (total population mortality), individually for each of the listed 11 CODs, and with selected groupings or modifications to those CODs. The 11 listed CODs are also shown on a combined basis by physiological and external causes. Given the continued interest in opioid-related deaths, opioids are shown as a COD, as is the accidents without opioids analysis, and they are shown in an exhibit of deaths by opioid type for all ages and genders .

An analysis of experience by three county income groupings is also included. Here, the top 15%, middle 45-55%, and bottom 15% of the counties, based on the average, county-level median household income, were identified, and the mortality for this population subset was compared to the overall population. Average county-level median household income is used as a broad indicator for socio-economic status.

The on-line tables and graphs are contained in three dashboards embedded on the webpage where this report pdf was found. The COD variation of interest can be viewed in the first two dashboards by using a drop-down box at the top right of the dashboard. The "U.S. Population Mortality by Gender" dashboard includes a graph of age adjusted death rates from 1999-2018 by gender and both genders combined and a related table with corresponding average annual mortality improvement rates. The table shows experience by gender for all ages combined and by combined gender for age groups¹. The average annual mortality improvement rates are shown for 2017-2018, 2013-2018, and 1999-2018. The drop-down box below the COD choice enables the by gender analysis to be filtered by a selected county income group. The "U.S. Population Mortality by County Income Group" dashboard is like the "U.S. Population Mortality by Gender" dashboard except that the graph shows county variation rather than gender variation with a drop-down box choice to filter by a selected gender. The third dashboard, "Opioid Deaths by Opioid Type and County Income Group" shows the exhibit of opioid deaths by opioid type with variation by county income for all ages and genders combined. All data supporting this report are included in an appendix in the form of an Excel file that can be found on the same webpage where this report and these dashboards are located.

¹ The accidents without opioids COD variation does not contain any experience by age group for the county income groups other than 'All Counties'.

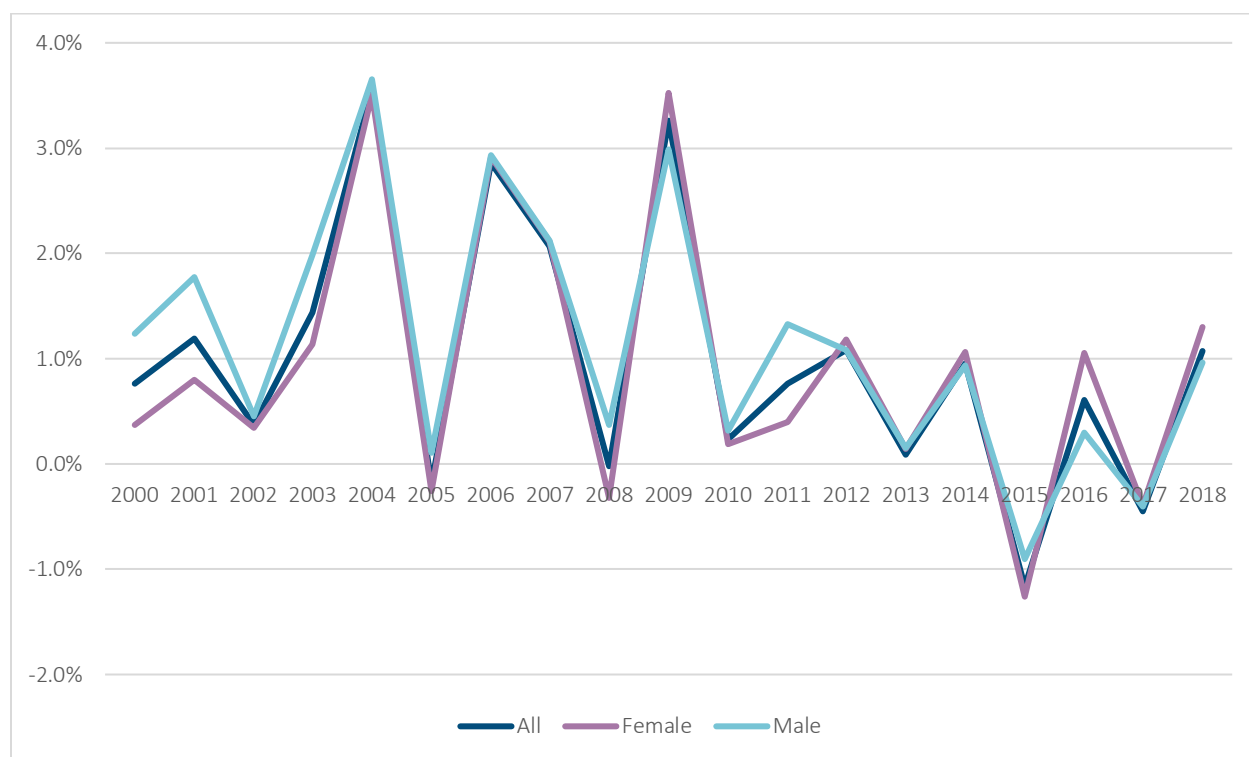
Section 2: Executive Summary

Key Highlights

Overall Mortality Improvement

The overall age-adjusted mortality rate² (both genders) from all causes of death decreased 1.1% in 2018 following a 0.4% increase in 2017. Annual mortality improvement rates have been volatile over the full period of this report. The reversal of mortality experience in 2018 versus 2017 continues a pattern of varying annual mortality experience swinging between improvement and disimprovement in recent years shown in the graph below. Recent experience does not show a trend, but has resulted in lower annual improvement compared to the earliest years of this report. Annual mortality improvement was 0.2% from 2013-2018 versus 1.0% from 1999-2018.

US POPULATION ANNUAL MORTALITY IMPROVEMENT YEARS ENDING 2000-2018



² Age-adjusted rates are calculated assuming the mix of ages in the population stays the same each year. Life expectancy is a composite of mortality rates over a single person’s future lifetime. This report focuses on age-adjusted rates (2010 baseline year), as opposed to life expectancy, because actuaries generally require mortality rates, not life expectancies, as an input assumption for their work.

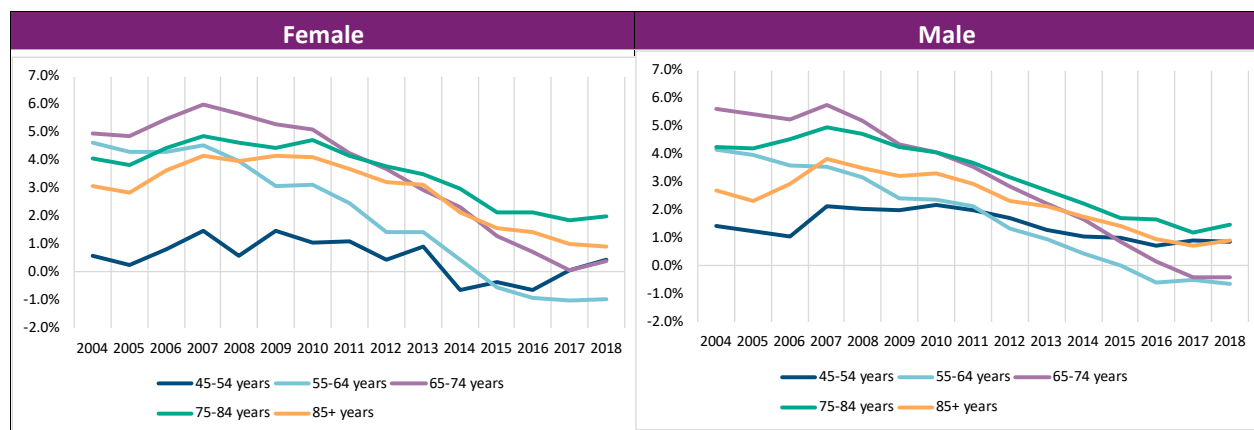
Life Expectancy

The Centers for Disease Control and Prevention (CDC) reported that life expectancy at birth increased 0.1 years in 2018 and decreased 0.1 years in 2017³. The changes in life expectancy in 2018 and 2017 followed the general principle that a decrease in the mortality rate would be expected to produce an increase in life expectancy and vice-versa.

Heart Disease

The death rate from heart disease was down 0.8% in 2018, which followed a 0.2% decrease in 2017. This 2018 improvement was slightly greater than the 0.7% annual improvement over 2013-2018, but it continues a trend where recent annual improvement was much lower than the 2.5% annual improvement from 1999-2018. The trend is similar for both genders and slightly higher for females when measured across all ages. When viewed across age groups, there are different trends by age group which are similar for both genders. The downward trend in five-year annual improvement was the highest for age groups 55-64 and 65-74. While starting with almost the highest five-year annual improvement rate for females in 2004, age group 55-64 went from 4.7% to -1.0%, the lowest age group rate in 2018. Similarly, male age group 65-74 decreased from 5.6%, the highest rate in 2004, to -0.4%, the lowest rate in 2018.

HEART DISEASE FIVE-YEAR AVERAGE ANNUAL MORTALITY IMPROVEMENT YEARS ENDING 2004-2018



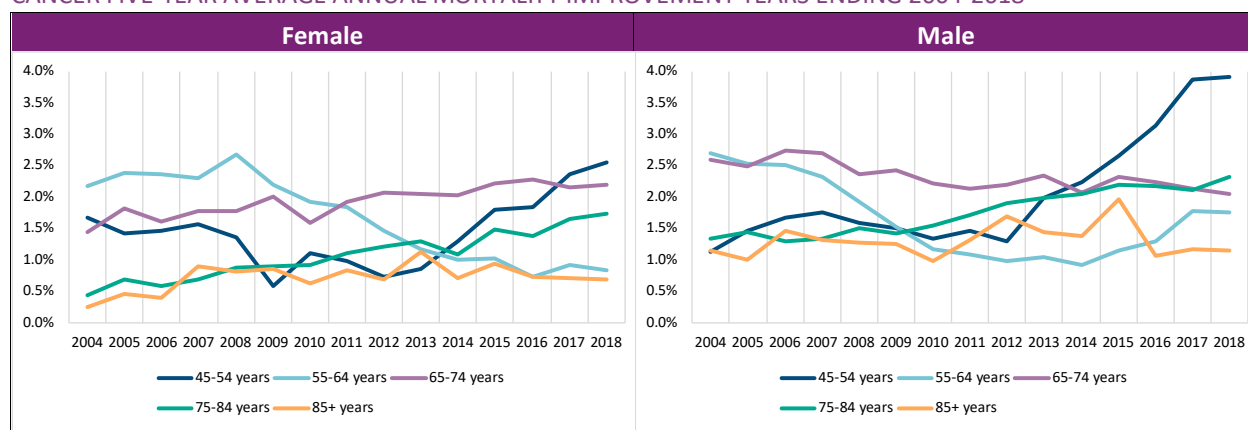
Cancer

The positive trend in the cancer death rate, which decreased, on an age adjusted basis, every year from 1999-2017 continued in 2018. Cancer mortality improved by 2.2% in 2018 and by 1.8% annually for all ages from 2013-2018. This continues a trend of accelerating improvement for all ages combined relative to annual improvement of 1.6% over 1999-2018. The trend was similar for both genders and slightly higher for males when measured across all ages. Like heart disease, the trend varied by age group and to a degree by gender. Whereas most age groups from 45 to 85+ have accelerating improvement, ages 55-64 slowed down for both genders. However, females in the 55-64 age group saw the only trend decrease for females, going from the highest age group five-year annual improvement rate of 2.2% in 2004 to 0.8%, almost the lowest one in 2018. Both genders saw a marked acceleration for age group 45-54 in recent years. It ended with the highest age group five-year annual

³ Xu JQ, Murphy SL, Kochanek KD, Arias E., Mortality in the United States, 2018. NCHS Data Brief, no 355. Hyattsville, MD: National Center for Health Statistics. 2020.

improvement rate in 2018 for both genders. For males, that age group had the lowest improvement rate in 2004 of 1.1% that ended 2018 at 3.9%.

CANCER FIVE-YEAR AVERAGE ANNUAL MORTALITY IMPROVEMENT YEARS ENDING 2004-2018



Opioids

The Opioid drug overdose death rate, a key component of accidental deaths, decreased 2.2% in 2018, which is the first year between 1999-2018 that the opioid death rate decreased. This follows the 11.9% increase in 2017 and an annual 12.6% increase over 2013-2018. There was a wide range of experience by age groups in 2018. The lowest and highest age groups saw the greatest death rate decreases for both genders combined. Age groups <1 year, 5-14, 15-24, and 85+ saw decreases of 19.2%, 32.3%, 11.1%, and 20.9%, respectively. This contrasted sharply with age group 65-74, which had the highest 2018 opioid death rate increase of 16.8%. While all female age groups saw decreased death rates in 2018, male age groups 65-74 and 75-84 saw continued sharp increases of 27.8% and 21.9%, respectively. These increases did not carry into male ages 85+ whose opioid death rates decreased 16.5%.

Suicide

The negative trend of increased suicide death rates (on an age adjusted basis) every year since 2006 continued in 2018. The suicide death rate increased 1.7% in 2018 and 2.4% annually from 2013-2018. The death rate varies widely and is volatile by age group. Age group 5-14 and those ranging from 55-84 had the highest one-year suicide death rate increases in 2018. Age group 5-14 had the highest increase in 2018 of 15.9% and age groups from 55-84 had increases ranging from 3.9% to 6.3%. When these age groups' experience is measured over five-year periods, there is no apparent trend change over recent years. For age group 5-14, 2013-2018 annual mortality improvement was -9.0% and that same measure over the prior five years (i.e., looking back to 2010-2014, 2011-2015, etc. experience) for age group 5-14 ranged from -10.9% to -8.5%. The combined experience of ages 55-84 was similar except with lower rates. The 2013-2018 annual improvement rate was -1.9% and looking back five years it ranged from -2.5% to -1.3%.

Other Observations

Mortality Improvement Attribution by COD

U.S. Population deaths of 2,839,205 in 2018 were the highest in history⁴. Heart disease remains the number one killer and accidents continued to be the highest external COD in 2018. The number of deaths in 2018 for the population by the CODs studied in this report are shown below in descending rank order. All CODs' mortality decreased in 2018 except for flu and pneumonia, suicide, liver, and other⁵. In an attribution of the 1.1% improvement in 2018 to CODs, cancer contributed 0.5%, almost half of the total improvement, and heart disease, accidents, and pulmonary each contributed 0.2%. Stroke contributed 0.1%, while flu and pneumonia and other each contributed -0.1%.

2018 U.S. POPULATION MORTALITY BY COD

Cause of Death	Deaths	%	Age-Adjusted 2017-2018 Mortality Improvement	Attribution to All CODs*
Heart Disease	655,381	23.1%	0.8%	0.2%
Cancer	599,274	21.1%	2.2%	0.5%
Alzheimer's/Dementia	239,221	8.4%	2.3%	0.2%
Accidents	167,127	5.9%	2.7%	0.2%
Pulmonary	159,486	5.6%	2.8%	0.2%
Stroke	147,810	5.2%	1.3%	0.1%
Diabetes	84,946	3.0%	0.4%	0.0%
Flu & Pneumonia	59,120	2.1%	-4.2%	-0.1%
Suicide	48,344	1.7%	-1.8%	0.0%
Liver	42,838	1.5%	-1.4%	0.0%
Assault	18,830	0.7%	3.7%	0.0%
Other	616,828	21.7%	-0.3%	-0.1%
All CODs	2,839,205	100%	1.1%	1.1%

* Rounded COD values do not sum to All CODs. The attribution method is described in section 3.

⁴ Based on individual years 1933 and later, National Center for Health Statistics. *Vital Statistics of the United States*, Volume II: Mortality, Part A. Washington, D.C.: Government Printing Office, various years. (Data obtained through the Human Mortality Database, www.mortality.org, on 2/3/2020).

⁵ Other is the aggregate of all other causes of death than the 11 CODs studied in this report.

Mortality Improvement Attribution by Age Group

In an attribution of the 1.1% improvement in 2018 to age groups, the two highest age groups 75-84 and 85+ contributed 0.5% and 0.3%, respectively, which was about three-fourths of the total improvement. Age groups 15-24, 25-34, 45-54, and 65-74 each contributed 0.1% and all other age groups made no net contribution. The four biggest contributors to 2018 mortality improvement for age groups 75-84 and 85+ were heart disease, cancer, Alzheimer's, and pulmonary. Those CODs for age groups 75-84 and 85+ combined produced 81% of their total improvement for 2018. Further, because those same age groups comprised about three-fourths of total improvement for all ages, those four CODs for those two age groups produced more than half the total 1.1% improvement for all ages.

2018 U.S. POPULATION MORTALITY BY AGE

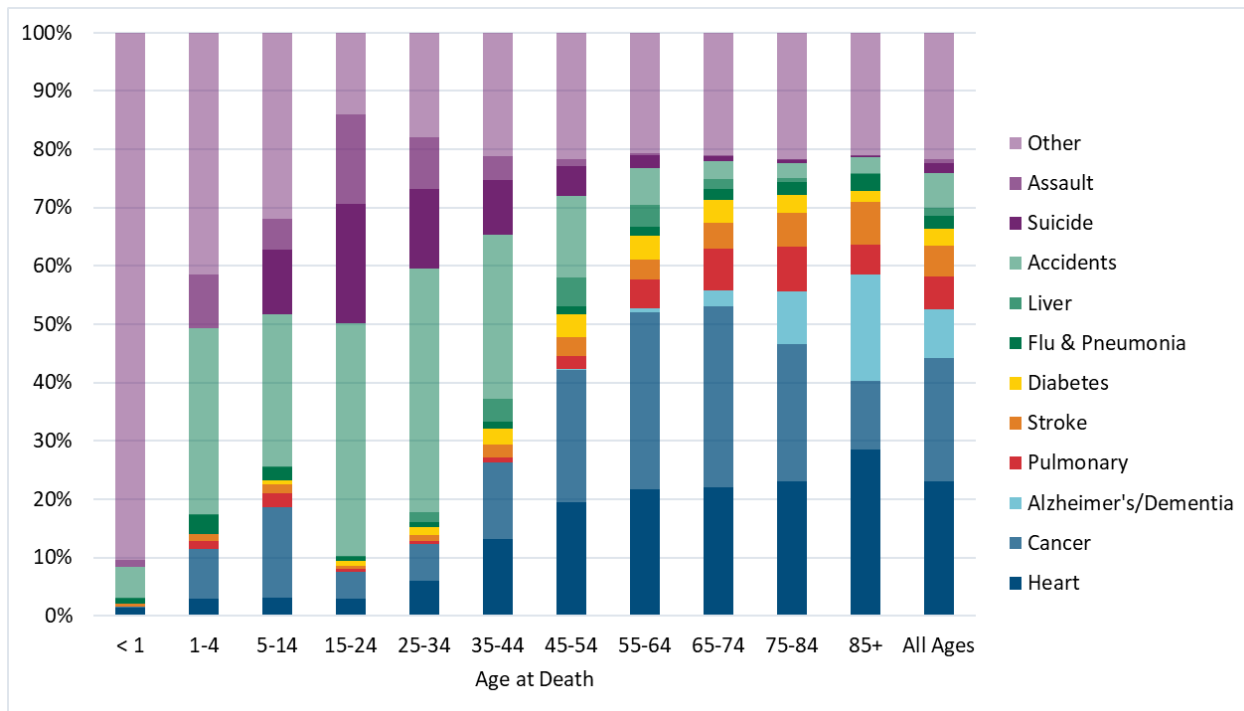
Age Group	Deaths	%	2017-2018 Mortality Improvement	Attribution to All Ages*
< 1 year	21,467	0.8%	1.6%	0.0%
1-4 years	3,830	0.1%	1.2%	0.0%
5-14 years	5,450	0.2%	2.2%	0.0%
15-24 years	30,154	1.1%	5.2%	0.1%
25-34 years	58,844	2.1%	3.0%	0.1%
35-44 years	80,380	2.8%	0.3%	0.0%
45-54 years	164,837	5.8%	1.4%	0.1%
55-64 years	374,836	13.2%	-0.1%	0.0%
65-74 years	543,778	19.2%	0.4%	0.1%
75-84 years	675,205	23.8%	1.9%	0.5%
85+ years	880,280	31.0%	0.9%	0.3%
Not Stated	144	0.0%		
All Ages	2,839,205	100%	1.1%	1.1%

* Rounded COD values do not sum to All Ages. The attribution method is described in section 3.

COD Distribution by Age Group

Physiological CODs predominate for older ages and external CODs (assault, suicide, and accidents) for younger ages. Although accidents had a relatively high improvement rate of 2.7% in 2018 and assault had the highest COD improvement of 3.7%, their lower mortality rates compared to heart disease and cancer mutes their overall impact on total annual mortality improvement.

COD PROPORTION OF DEATHS BY AGE GROUP



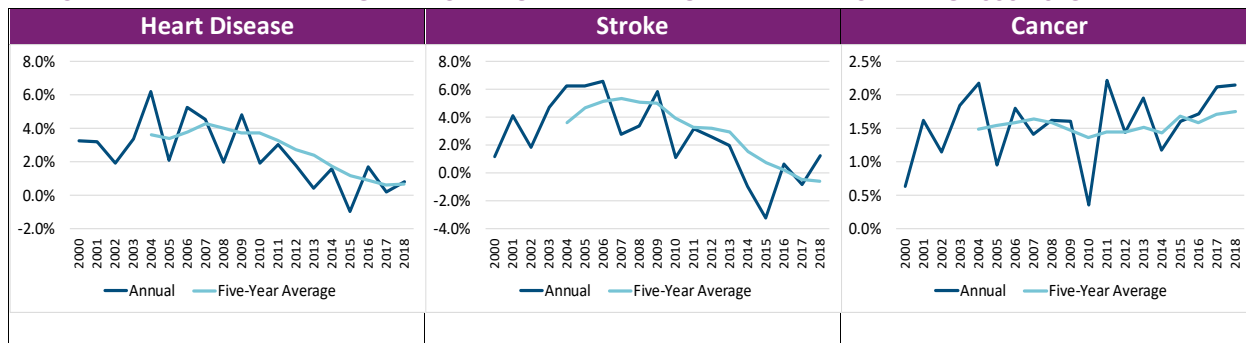
Mortality Improvement by Selected CODs

Three key physiological CODs with respect to the long-term progression of mortality rates (heart disease, stroke, and cancer) are shown below for all ages and genders combined on a national basis. Annual and average five-year mortality improvement rates are shown for each COD.

1. Heart disease improvement has slowed notably in more recent periods. The annual five-year improvement rate that peaked in 2002-2007 at 4.3% decreased to 0.7% for 2013-2018.
2. Stroke mortality improvement followed a similar trend. Its five-year mortality improvement rate also peaked in 2002-2007 at 5.3% and decreased to -0.6% for 2013-2018.
3. Cancer had mortality improvement that has trended up during 1999-2018 and is the only COD, of the 11 in this report, whose mortality improved every year during that time. The cancer five-year annual improvement rate increased from 1.5% in 1999-2004 to 1.8% in 2013-2018.

The slowdown of heart disease improvement and the near-term reversal of stroke improvement continues to be very significant because these two CODs have been the overwhelming contributors to overall mortality improvement over the past 45 years⁶. While heart disease mortality improved by 0.8% in 2018 versus 0.2% in 2017, there is not enough experience to establish whether the flattening of heart disease improvement rates will continue or reverse to higher improvement rates seen in earlier periods.

ANNUAL AND FIVE-YEAR AVERAGE ANNUAL MORTALITY IMPROVEMENT YEARS ENDING 2000-2018

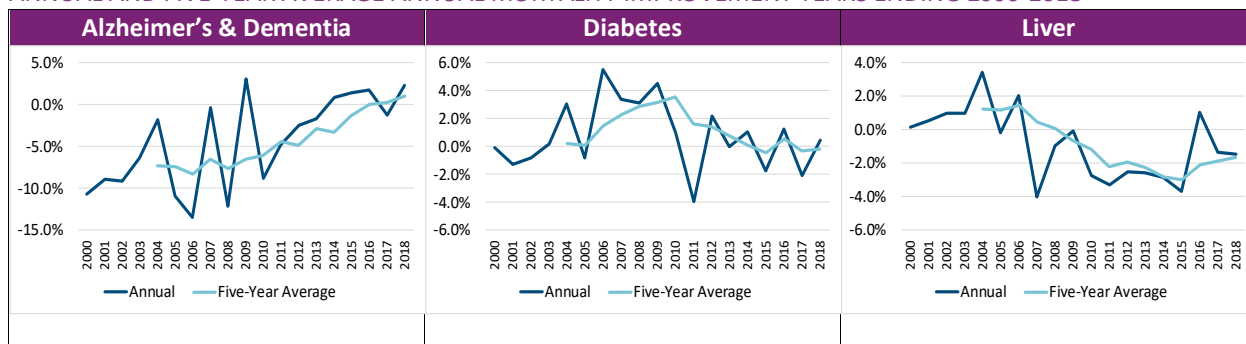


Three other CODs with notable trend patterns are shown below. Although neither Diabetes or Liver contributed measurably to the 1.1% overall annual 2018 age adjusted mortality improvement rate, both with long term downtrends, have held back overall mortality improvement.

1. Alzheimer’s combined with dementia trended up strongly through the report period. The five-year average annual improvement rate increased from -7.3% in 1999-2004 to 1.0% in 2013-2018 with a 2.3% annual improvement in 2017-2018.
2. Diabetes five-year average annual mortality improved and then regressed to slightly below its starting level from years ending 2004-2018. Using the five-year measure, diabetes mortality improvement was 0.2% in 2004, peaked in 2010 at 3.5%, and then declined to -0.2% in 2018.
3. Liver mortality improvement also decreased during the reporting period, but made a recent turnaround (on a five-year average annual basis) that started in 2016. However, even with recent improvement from an earlier low in 2015, the annual and five-year mortality average annual improvement rates ended 2018 at -1.4% and -1.6%, respectively.

⁶ Ed Hui, “Recent Mortality Trends by Cause of Death”
 2017 Society of Actuaries Annual Meeting, Session 063PD, Mortality Hot Topics
<https://www.soa.org/pd/events/2017/annual-meeting/pd-2017-10-annual-session-063.pdf>

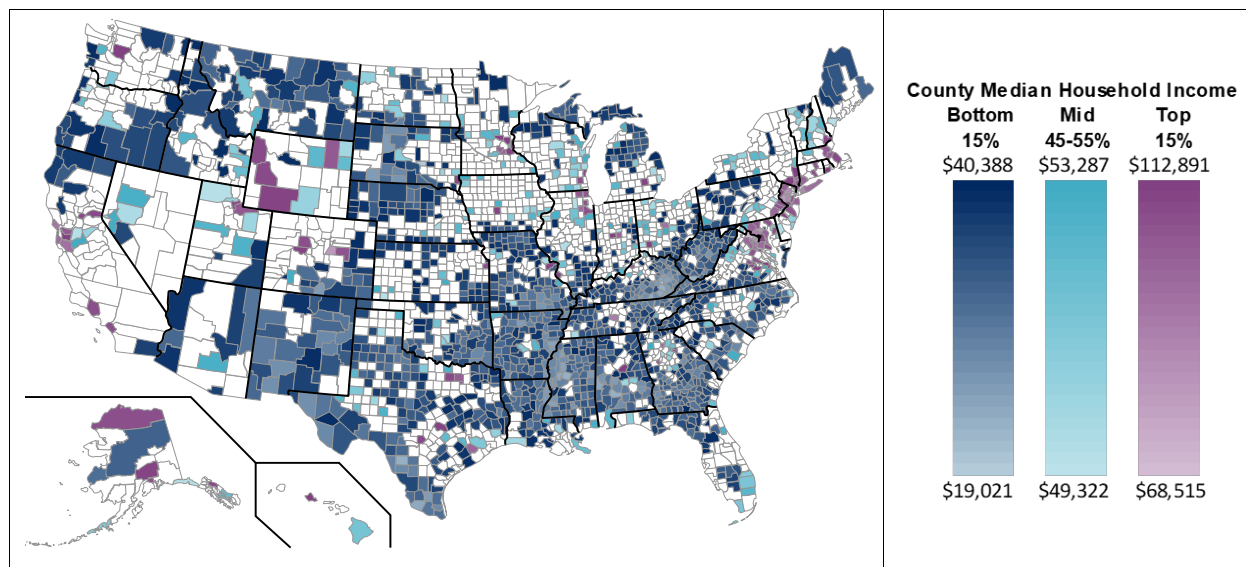
ANNUAL AND FIVE-YEAR AVERAGE ANNUAL MORTALITY IMPROVEMENT YEARS ENDING 2000-2018



Mortality by County Groups

Mortality was analyzed over the entire U.S. population (All Counties) and compared to mortality in the top 15 percentile counties (Top 15%), middle 45-55 percentile counties (Middle 45-55%), and bottom 15 percentile counties (Bottom 15%), based on median household income, as described in section 3. The map below shows the counties. Generally, the Top 15% and Middle 45-55% are geographically small concentrated regions. The Top 15% are mostly metro areas and the Middle 45-55% are often nearby large metro areas. The Bottom 15% are widely dispersed large rural areas.

U.S. CENSUS BUREAU AVERAGE OF 2008 AND 2009 COUNTY MEDIAN HOUSEHOLD INCOME ESTIMATES



Robert Mundigl, "Choropleth Map Template USA by Counties," [12/17/2018], [Clearly and Simply](#), available under [Creative Commons License BY-NC-SA 3.0](#). Map is a derivative of original.

Generally, mortality rates by county grouping follow a rank order of the lowest mortality for the Top 15% and highest mortality for the Bottom 15%. The Middle 45-55% mortality rate is generally slightly below the All counties rate because the Bottom 15% skews the mean downward. There is a corresponding pattern for mortality improvement, which is generally higher for the Top 15% and lower for the Bottom 15%. Examining five-year average annual mortality improvement of the county income groups over time gives insight on the counties' evolving mortality rank-order relationships to one another.

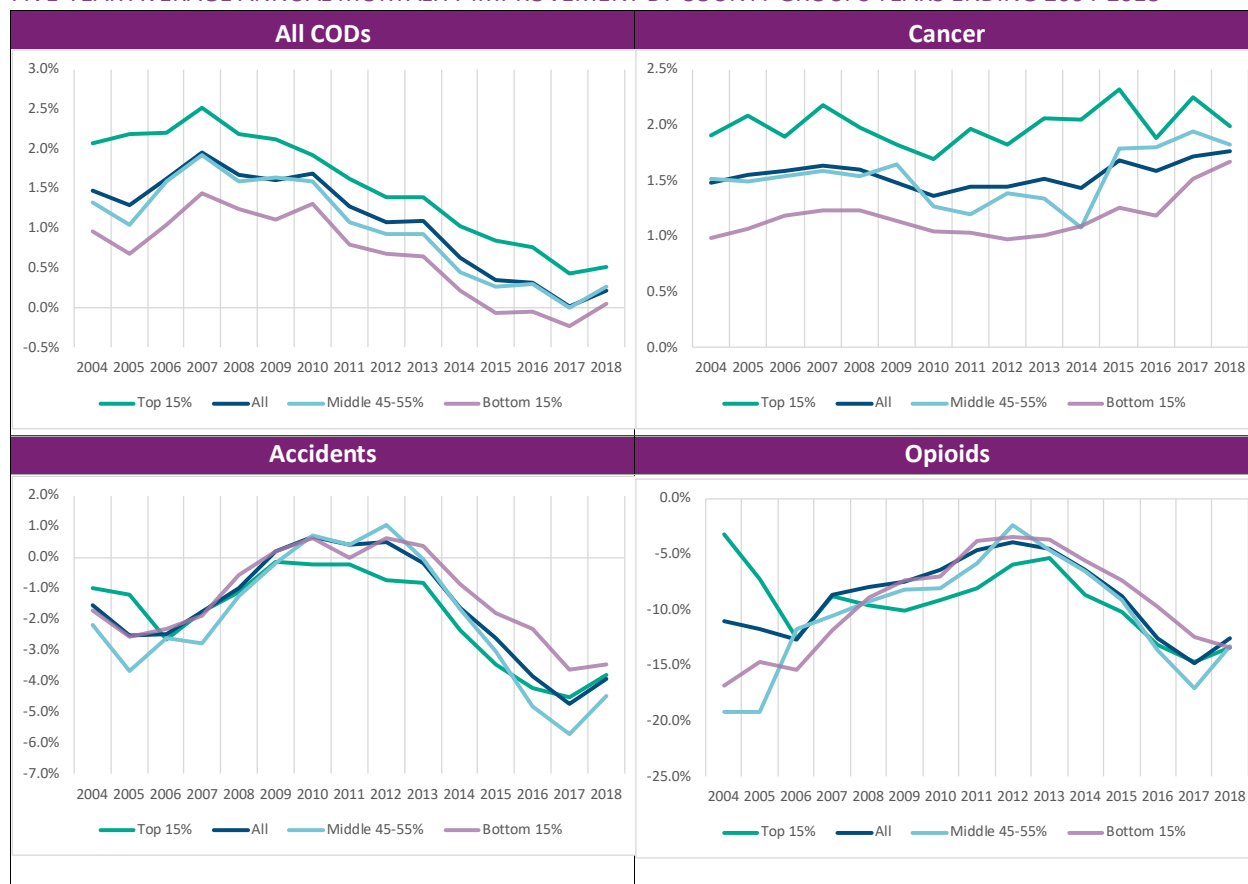
The graphs below show five-year average annual mortality improvement by county groups for All CODs, which is representative of the general county relationships and three CODs that are exceptions to that. All of the following references to mortality improvement in this section imply a five-year annual average in the ending of the year noted. Note that, because the range of mortality improvement is wide across CODs, the scales are different in each of the four graphs.

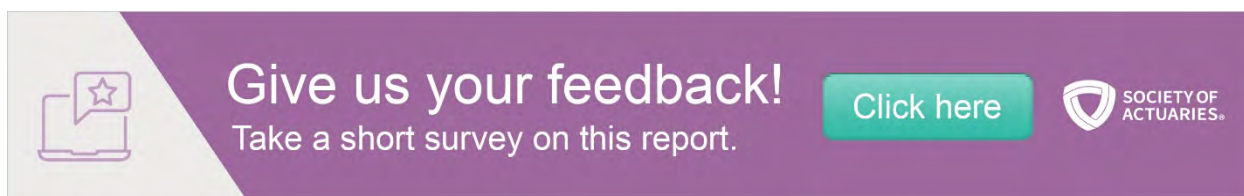
The All CODs show a similar pattern for each county group with rank order preserved for the Top 15% and Bottom 15%, but the gap between their improvement rates is less in 2018 than 2004. This indicates that the speed of a continued widening mortality rate gap slowed down in the last few years.

There are three CODs that showed notable exceptions to the All CODs patterns.

1. Cancer showed a narrowing gap between the Top 15% and Bottom 15%, but that resulted from a mostly flat improvement rate for the Top 15% and an increasing one for the Bottom 15%.
2. Accidents did not show much change in the spread between the improvement rates of the Top 15% and Bottom 15%. However since 2008, the Bottom 15% had higher improvement (or less severe disimprovement) than the Top 15% in every year.
3. Opioids showed a wide gap between the Top 15% and Bottom 15% in 2004 that almost merged in 2018. Since 2008 when they crossed over, the Top 15% had more severe disimprovement than the Bottom 15% in all of the following years.

FIVE-YEAR AVERAGE ANNUAL MORTALITY IMPROVEMENT BY COUNTY GROUPS YEARS ENDING 2004-2018





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SOCIETY OF ACTUARIES

Section 3: Methodology

The source of the mortality rates found in this report was the Centers for Disease Control and Prevention’s (CDC) Wide-ranging Online Data for Epidemiologic Research (WONDER) database, released in February 2020⁷. It is well known that mortality varies by socio-economic status. Education level could be used as an indicator of socio-economic status, but it is not consistently populated in WONDER. Counties were chosen as a data element available for virtually all records in WONDER that could be tied to income. The data used to develop the list of U.S. counties with the highest 15%, middle 45-55%, and lowest 15%, by population, of median household income based on the average of 2008 and 2009 census data was obtained from the U.S. Census Bureau’s Small Area Income and Poverty Estimates Program⁸. These counties were used in WONDER to obtain the mortality rates for the top 15, middle 45-55, and bottom 15 percentile counties. Although county income is an imperfect measure at a household level due to variations within large counties, these county groupings are intended to cover mortality like privately-insured lives (Top 15%) versus those that may be covered by government insurance programs (Bottom 15%). The middle 45-55% group of counties is intended to represent the median of experience. Any reference to the “Top 15%,” “Middle 45-55%,” or “Bottom 15%” refers to the top 15, middle 45-55, or bottom 15 percentile counties, respectively, and any reference to “All Counties” refers to the entire U.S. population or all U.S. counties.

Age group mortality rates in this report are derived using calendar year deaths and population from WONDER with rates per 100,000 rounded to six decimal places. All subsequent calculations for mortality improvement and age-adjusted mortality rates use these rounded rates.

Mortality improvement rates in this report are geometric average annual rates of improvement. They are derived as follows for age x over an n year period ending in calendar year CY .

$$1 - \left(\frac{q_x^{CY}}{q_x^{CY-n}} \right)^{\left(\frac{1}{n}\right)}$$

All mortality rates shown in this report, other than those shown for ten-year age groups, are age-adjusted rates based on the CDC’s non-standard population option of 2010. The non-standard population in 2010 was chosen here as opposed to the 2000 standard population, used in age-adjusted rates published by the CDC, because 2010 was more central to the mid-point of the years of data, 1999-2018, covered in this report. To achieve consistent comparisons across gender, all age-adjusted rates were determined using the 2010 combined female and male age

⁷ Centers for Disease Control and Prevention, National Center for Health Statistics. Underlying Cause of Death 1999-2018 on CDC WONDER Online Database, released in 2020. Data are from the Multiple Cause of Death Files, 1999-2018, as compiled from data provided by the 57 vital statistics jurisdictions through the Vital Statistics Cooperative Program. Accessed at <http://wonder.cdc.gov/ucd-icd10.html> on various dates February 2020.

⁸ Source: U.S. Census Bureau, Small Area Estimates Branch. <https://www.census.gov/data/datasets/2008/demo/saibe/2008-state-and-county.html>, Release date: 11.2009 and <https://www.census.gov/data/datasets/2009/demo/saibe/2009-state-and-county.html>, Release date: 12 2010.

group distribution. Age-adjusted mortality rates and improvement in this report are based on age only with no demographic adjustments for mixes of gender or race.

Age adjusted rates in this report are calculated as follows using 2010 as the base year and rounded to six decimal places.

$$\sum_{n=1}^{11} Pct_{Age_n} * q_{Age_n}$$

Where:

Age_n = Age group n (11 age groups)

Pct_{Age_n} = % of age group n 2010 Population

q_{Age_n} = Calendar year crude q_x for age group n

Attributions of mortality improvement by ages and CODs shown in section 2 are determined as follows:

Age Group Attribution

Age group n attribution to all ages improvement is:

$$\frac{Pct_{Age_1} * q_{Age_1}}{\sum_{n=1}^{11} Pct_{Age_n} * q_{Age_n}} * Improvement_{Age_1}$$

Where:

Age_n = Age group n (11 age groups)

Pct_{Age_n} = % of age group n 2010 Population

q_{Age_n} = 2017 Crude q_x for age group n

$Improvement_{Age_n}$ = Age group n 2018 mortality improvement rate

q_{Age_n} and $Improvement_{Age_n}$ are based on crude rates per 100,00 lives rounded to one decimal place, which is consistent with age-adjustment calculation methodology⁹.

COD Attribution

COD is simpler because COD mortality improvement is already expressed on an age-adjusted basis. Unrounded values are used.

COD_n attribution to all causes mortality improvement is:

$$\frac{q^{COD_n}}{q^{COD_{Au}}} * Improvement_{COD_n}$$

Where:

q^{COD_n} = 2017 COD_n age-adjusted mortality rate

⁹ Source: <https://wonder.cdc.gov/wonder/help/ucd.html#>

$q^{COD_{All}}$ = 2017 age-adjusted mortality rate for all causes of mortality

$Improvement_{COD_n}$ = COD_n 2018 mortality improvement rate

To meet the CDC’s privacy data use requirements, calculated annual improvement values are not shown for age groups where the number of deaths for that age group was less than ten in any one year.

The NCHS’s rankable causes of death are a subset of its “113 Selected Causes of Death.” The selected 11 causes of death covered in the report are, with two exceptions, the top five rankable causes of death in 2018 for each of the ten-year age and gender groups available in WONDER. Because of limited interest, two of the top five rankable CODs for age <1 were excluded¹⁰. Below is a table of the 11 selected causes of death covered in this report and their International Classification of Diseases, Tenth Revision¹¹ (ICD-10) 113 Code and Cause List as they appear in WONDER.

Report Cause of Death	ICD-10 113 Code	ICD-10 113 Cause List (with ICD-10 codes)
Physiological:		
Alzheimer's/Dementia ¹²	GR113-052	#Alzheimer's disease (G30)
Cancer	GR113-019	#Malignant neoplasms (C00-C97)
Diabetes	GR113-046	#Diabetes mellitus (E10-E14)
Flu/Pneumonia	GR113-076	#Influenza and pneumonia (J09-J18)
Heart	GR113-054	#Diseases of heart (I00-I09,I11,I13,I20-I51)
Liver	GR113-093	#Chronic liver disease and cirrhosis (K70,K73-K74)
Pulmonary	GR113-082	#Chronic lower respiratory diseases (J40-J47)
Stroke	GR113-070	#Cerebrovascular diseases (I60-I69)
External:		
Accidents	GR113-112	#Accidents (unintentional injuries) (V01-X59,Y85-Y86)
Assault	GR113-127	#Assault (homicide) (*U01-*U02,X85-Y09,Y87.1)
Suicide	GR113-124	#Intentional self-harm (suicide) (*U03,X60-X84,Y87.0)

For opioid deaths by opioid type , the method to identify drug overdose deaths involving opioids was taken from the Increases in Drug Overdose Deaths in the United States, 1999–2018¹³. These deaths were identified by the ICD-10 underlying cause-of-death codes X40–44 (unintentional), X60–64 (suicide), X85 (homicide), or Y10–Y14 (undetermined intent) in combination with any one of the following multiple cause-of-death codes: T40.0 (opium); heroin (T40.1); natural/semisynthetic opioids (T40.2); methadone (T40.3); synthetic opioids other than methadone (T40.4); or other and unspecified narcotics (T40.6).

Appendices with the following data and information can be found in an accompanying Excel file.

- A. Age-Adjusted Death Rates used to produce graphs, tables, and observations in this report.
- B. Age Group Rates used to produce tables and observations in this report.

¹⁰ GR113-108 - Certain conditions originating in the perinatal period (P00-P96) and GR113-109 - Congenital malformations, deformations and chromosomal abnormalities (Q00-Q99)

¹¹ World Health Organization <https://icd.who.int/browse10/2016/en>

¹² Dementia is not one of the NCHS’s rankable causes of death but has been included with the review of Alzheimer’s. The ICD-10 codes for Dementia are (F01,F03)

¹³ Hedegaard H, Miniño AM, Warner M. Drug overdose deaths in the United States, 1999–2018. NCHS Data Brief, no 356. Hyattsville, MD: National Center for Health Statistics. 2020.

- C. Age-Adjusted Rates by Opioid Type used to produce tables and observations in this report.
- D. Links to sample CDC WONDER queries¹⁴ used to pull values for the 'All' and 'Opioid' CODs analyses.
- E. Listings of the top 15 percentile, the middle 45-55 percentile, and bottom 15 percentile counties by income.

¹⁴ The SOA is not responsible if these links do not continue to work and will not update them if they break.

Section 4: Reliance and Limitations

Data to calculate mortality rates in this report were drawn from the Centers for Disease Control and Prevention (CDC) Wide-ranging Online Data for Epidemiologic Research (WONDER) database. There are limited instances where the mortality rates, associated mortality improvement, or comparative results between the Top 15%, Middle 45-55%, Bottom 15%, and All Counties are not shown. This is because death counts of less than ten for sub-national data are suppressed by WONDER.

Data provided through WONDER is subject to restricted use for health statistical reporting and analysis. This research confines itself to those parameters. While the data may be useful for application in specific purposes, no assessment has been made concerning the applicability of this experience to other such purposes.

Opioid deaths overlap with the accident, assault, and suicide deaths analyzed in this report. The opioid deaths have a meaningful impact on the accident results and, therefore, have been removed from accident deaths in a separate COD analysis shown as Accident no Opioids. The impact of opioid deaths in the assault and suicide analyses was deemed to be immaterial and, therefore, not included in this report.

This report does not attempt to comment on changes or improvements in the process to record cause of death codes over the report horizon and their potential impact on observations noted in this report. For example, given some possible limitations regarding the accuracy or completeness of the assignment of COD, some of the deaths associated with the increases in 2016-2018, where opioid deaths were removed from the accident death analysis, could in fact be opioid-related. Potential changes in recording processes should be considered if utilizing the information provided in this report.

About The Society of Actuaries

The Society of Actuaries (SOA), formed in 1949, is one of the largest actuarial professional organizations in the world dedicated to serving 32,000 actuarial members and the public in the United States, Canada and worldwide. In line with the SOA Vision Statement, actuaries act as business leaders who develop and use mathematical models to measure and manage risk in support of financial security for individuals, organizations and the public.

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