

U.S. Population Mortality Observations

Updated with 2017 Experience

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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 2017¹ has been incorporated and added to prior available data to enable analysis of mortality experience over the period 1999-2017. This research is part of its ongoing longevity and mortality research initiatives.

The report begins in Section 2 with a set of high-level, summary observations obtained by looking across the overall population results and the results from the individual causes of death (CODs), subsequently analyzed in the report. Section 3 describes the methodology used in the report. Next, in section 4, the overall population mortality is reviewed. Results from the analyses of ten individual CODs follow in sections 5 and 6. Section 5 analyzes seven physiological CODs and section 6 analyzes three external CODs. Each of those sections has subsections for the CODs' combined effect and individually for each COD. The ten individual CODs were selected from the National Center for Health Statistics' (NCHS) list of rankable causes of death. Given the continued interest in opioid-related deaths, the report includes a subsection within Section 6 devoted to deaths from opioid drug overdoses. Each of the ten individual COD subsections and the opioid subsection also contain an analysis of mortality by income level. Here, the top 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.

¹ Murphy SL, Xu JQ, Kochanek KD, Arias E. Mortality in the United States, 2017. NCHS Data Brief, no 328. Hyattsville, MD: National Center for Health Statistics. 2018.

Section 2: Overall Summary Observations

The following observations were obtained by comparing the overall population results from section 4 and the results from the individual COD analyses in sections 5 and 6.

- The overall age-adjusted mortality rate (both genders) from all causes of death increased 0.4% in 2017, following a 0.6% decrease in 2016. The CDC reported that life expectancy at birth declined 0.1 years in 2016 and 2017². Generally, an increase in the mortality rate would be expected to produce a decrease in life expectancy as occurred in 2017. The converse is also true. When mortality decreases, life expectancy would normally increase, but 2016 was an anomalous year in that regard.

The anomaly that occurred in 2016 is explained by the differing impacts on life expectancy of mortality rate changes of different ages. In 2016, increased mortality rates in the younger and middle ages (mostly due to accidents) reduced life expectancy at birth more than it was extended by mortality improvement at older ages.

- 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.

² Ibid.

- U.S. Population deaths of 2,813,503 in 2017 were the highest in history³. Heart disease remains the number one killer and accidents were the highest external COD in 2017. The number of deaths in 2017 for the population by the CODs studied in this report are shown below in descending rank order. Except for heart disease and cancer, all CODs' mortality increased or were flat in 2017. In an attribution of the -0.4% improvement in 2017 to CODs, heart and cancer contributed 0.1% and 0.5%, respectively, while accidents and other causes (not studied in this report) each contributed -0.3%. Alzheimer's-dementia, pulmonary, diabetes, and suicide each contributed -0.1%.

2017 U.S. POPULATION MORTALITY BY COD

Cause of Death	Deaths	%	Age-Adjusted One Year Change	Attribution to All CODs*
Heart Disease	647,457	23.0%	0.2%	0.1%
Cancer	599,108	21.3%	2.1%	0.5%
Alzheimer's/Dementia	239,585	8.5%	-1.3%	-0.1%
Accidents	169,936	6.0%	-4.1%	-0.3%
Pulmonary	160,201	5.7%	-1.0%	-0.1%
Stroke	146,383	5.2%	-0.8%	0.0%
Diabetes	83,564	3.0%	-2.1%	-0.1%
Suicide	47,173	1.7%	-3.9%	-0.1%
Liver	41,743	1.5%	-1.4%	0.0%
Assault	19,510	0.7%	-0.2%	0.0%
Other	658,843	23.4%	-1.5%	-0.3%
All COD	2,813,503	100%	-0.4%	-0.4%

* The attribution method is described in section 3.

³ 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 12/30/2018).

- In an attribution of the -0.4% improvement in 2017 to age groups, the 85+ age group's 1.4% mortality increase in 2017 and their 31% share of deaths resulted in the largest contribution to the -0.4%. Ages 25-54 contributed -0.1% and all other ages, except 85+, made no net contribution to the 2017 0.4% mortality increase. This is a notable difference to prior years in which the recent negative trend was more concentrated in younger ages. Age 85+ mortality improvement in 2017 was most negatively pronounced, in descending order, for liver, suicide, pulmonary, accidents and stroke. We are not aware of any change in methodology of calculating mortality rates at the oldest ages.

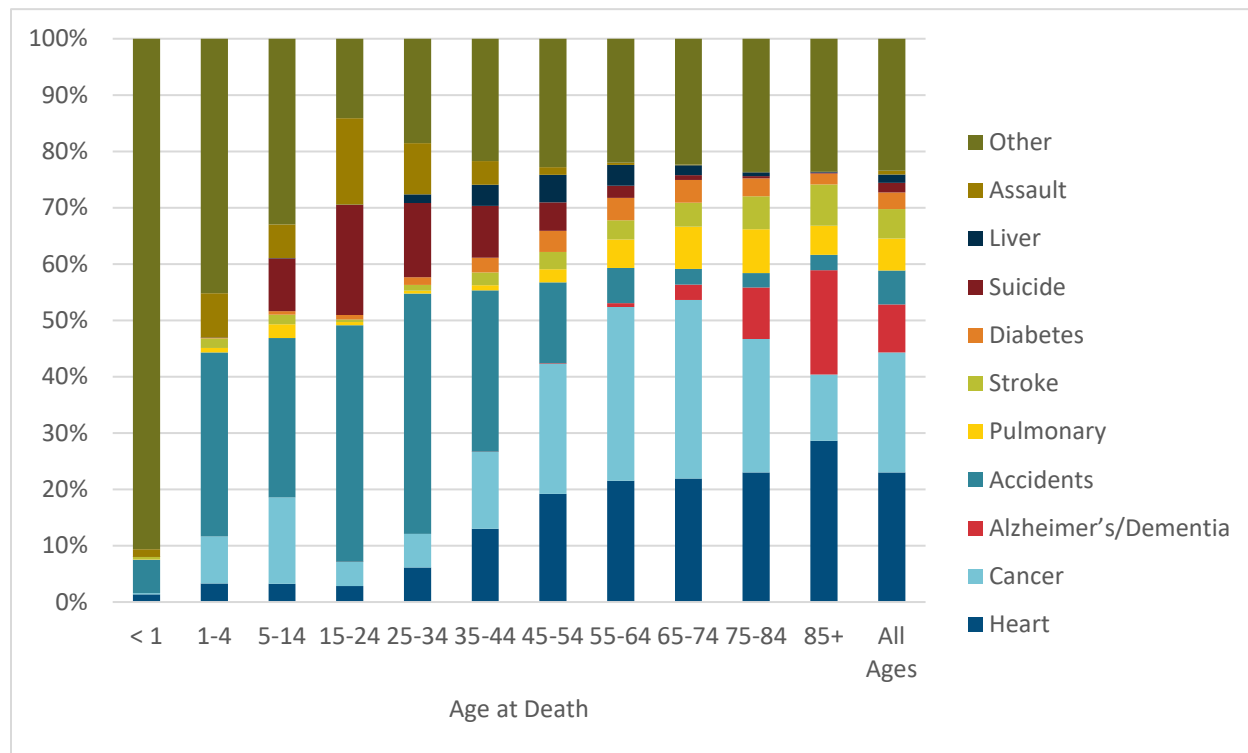
2017 U.S. POPULATION MORTALITY BY AGE

Age Group	Deaths	%	Age-Adjusted One Year Change	Attribution to All Ages*
< 1 year	22,335	0.8%	2.8%	0.0%
1-4 years	3,880	0.1%	4.0%	0.0%
5-14 years	5,571	0.2%	-1.5%	0.0%
15-24 years	32,025	1.1%	1.2%	0.0%
25-34 years	60,215	2.1%	-2.9%	-0.1%
35-44 years	79,796	2.8%	-1.6%	-0.1%
45-54 years	170,142	6.0%	1.0%	0.1%
55-64 years	372,006	13.2%	-0.2%	0.0%
65-74 years	531,610	18.9%	-0.1%	0.0%
75-84 years	657,759	23.4%	0.0%	0.0%
85+ years	878,035	31.2%	-1.4%	-0.4%
Not Stated	129	0.0%		
All Ages	2,813,503	100%	-0.4%	-0.4%

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

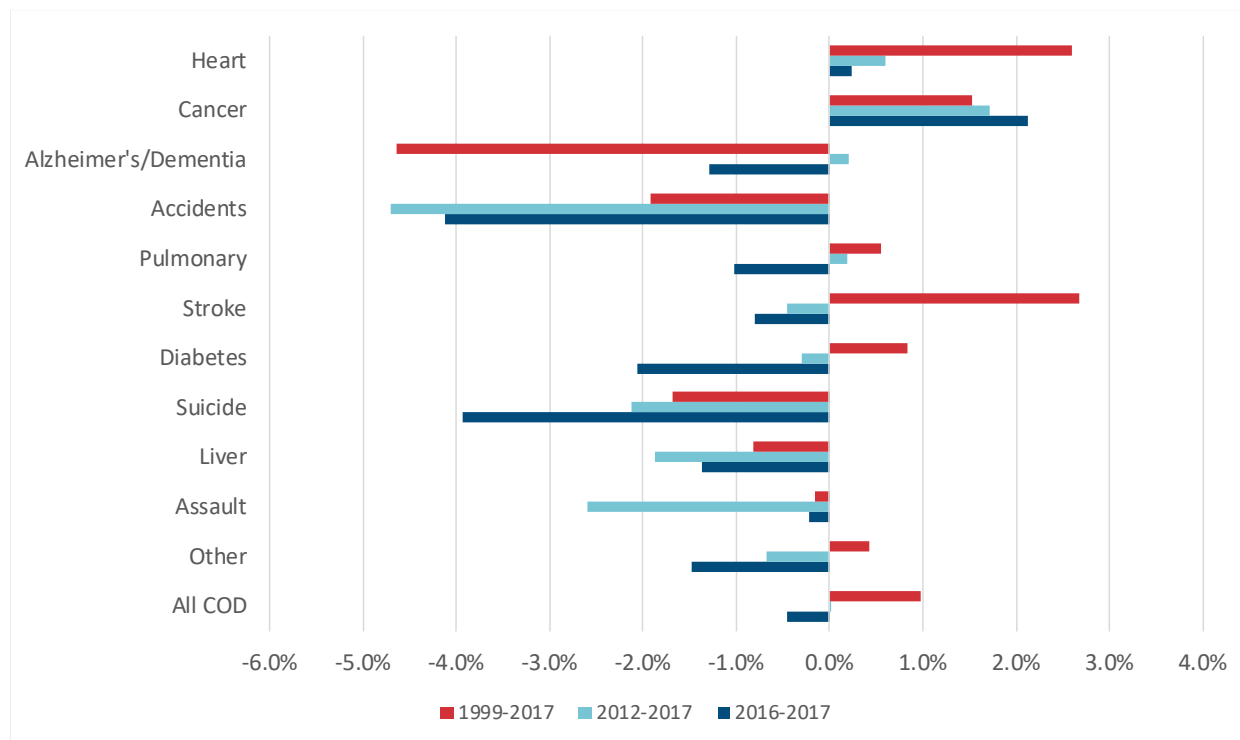
- Physiological CODs predominate for older ages and external CODs for younger ages. Although high mortality increases occurred for accidents and suicide, their lower mortality rates compared to physiological causes, e.g. heart disease and cancer, muted their impact on the increase of all CODs combined.

COD PROPORTION OF DEATHS BY AGE GROUP



- Heart disease and cancer stand alone as the only two CODs that showed improvement (excluding CODs within the Other category) over 1999-2017, 2012-2017, and 2016-2017, but heart disease improvement has slowed notably in more recent periods. Conversely, cancer improvement accelerated. The combination of higher cancer improvement combined with slowing heart disease improvement and generally deteriorating mortality for most other CODs resulted in no mortality improvement for all CODs from 2012-2017. The slowdown of heart disease improvement and the near-term reversal of stroke improvement is very significant because these two CODs have been the overwhelming contributors to overall mortality improvement over the past 45 years⁴.

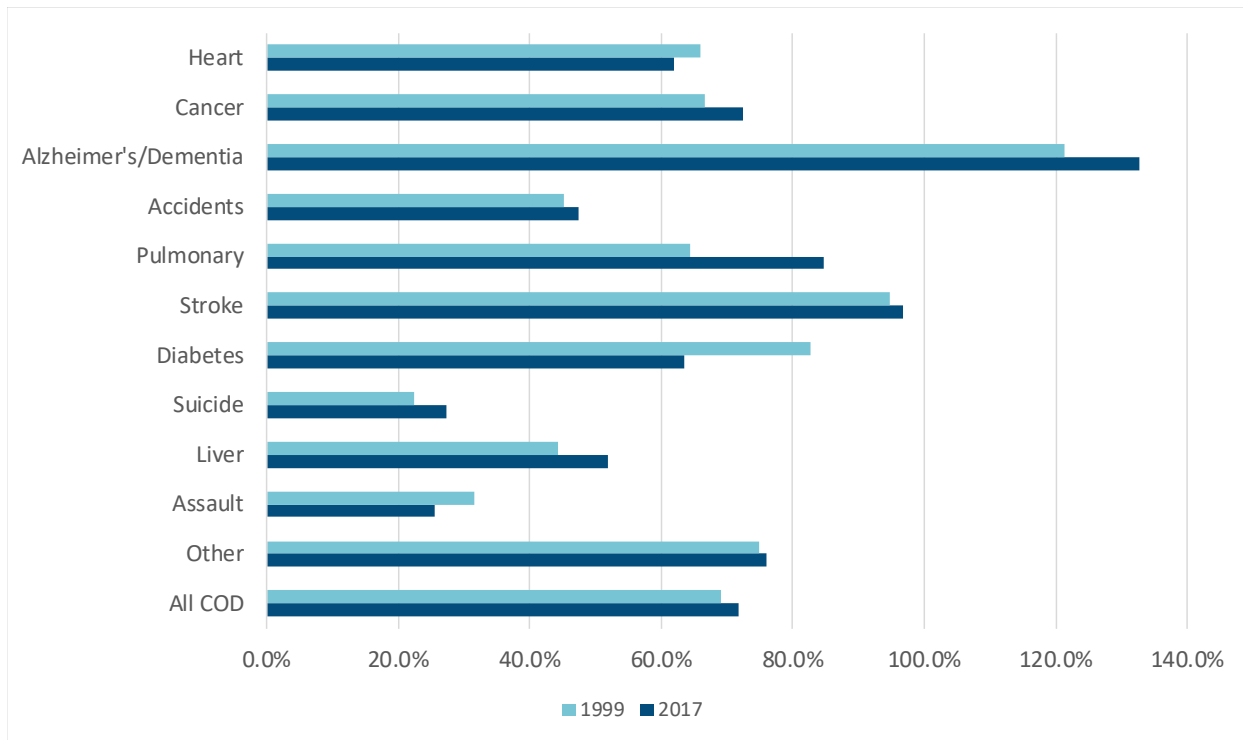
AGE-ADJUSTED ANNUAL MORTALITY IMPROVEMENT



⁴ 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>

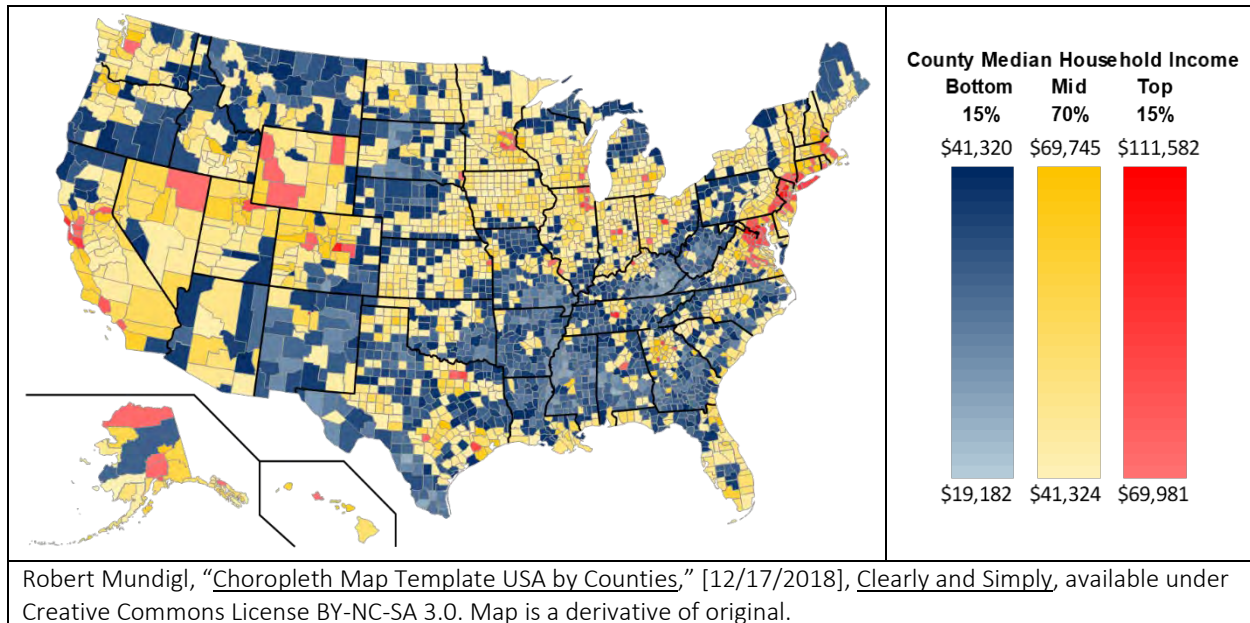
- The female to male mortality ratio increased over 1999-2017 for all CODs except heart disease, diabetes, and assault. Diabetes showed notable relative female improvement, while female pulmonary and Alzheimer’s – dementia mortality increased notably relative to males. Alzheimer’s - dementia was the only COD with higher female than male mortality.

FEMALE TO MALE MORTALITY RATIO



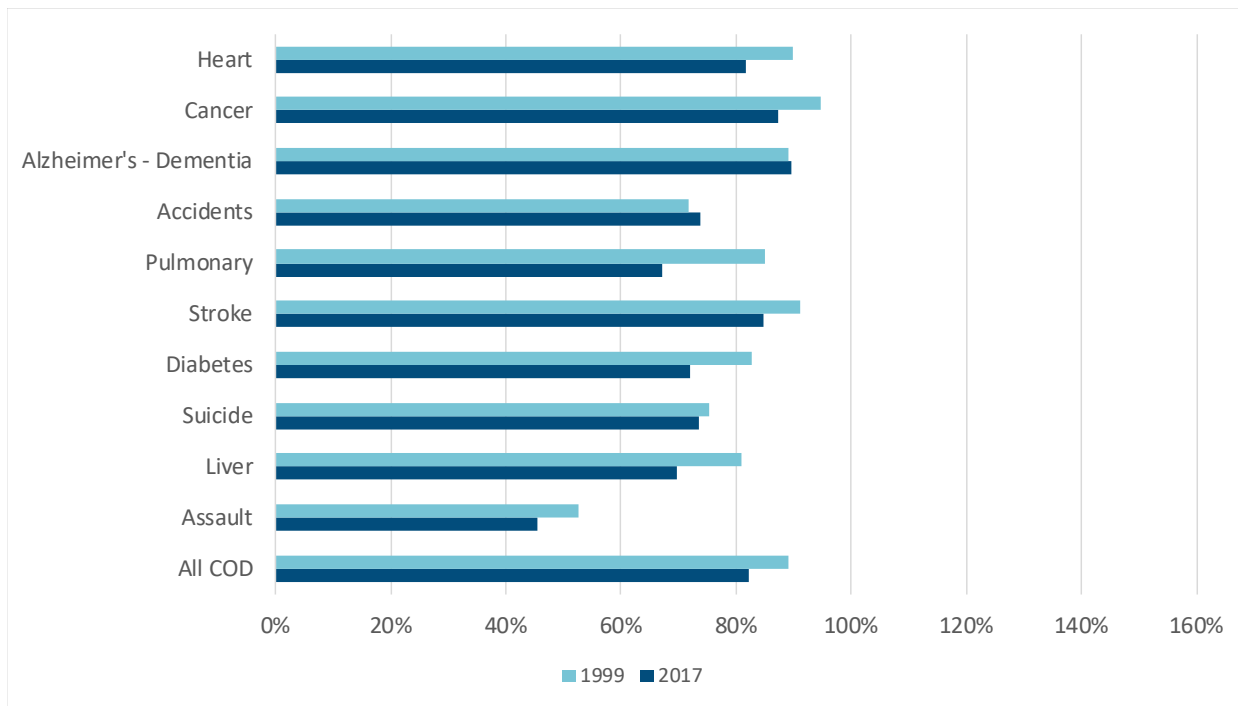
- Mortality was analyzed over the entire U.S. population (All Counties) and compared to mortality in the top 15 percentile counties (Top 15%) and bottom 15 percentile counties (Bottom 15%), based on median household income, as described in section 3. The map below shows the counties. Generally, the Top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

U.S. CENSUS BUREAU 2008 COUNTY MEDIAN HOUSEHOLD INCOME ESTIMATES

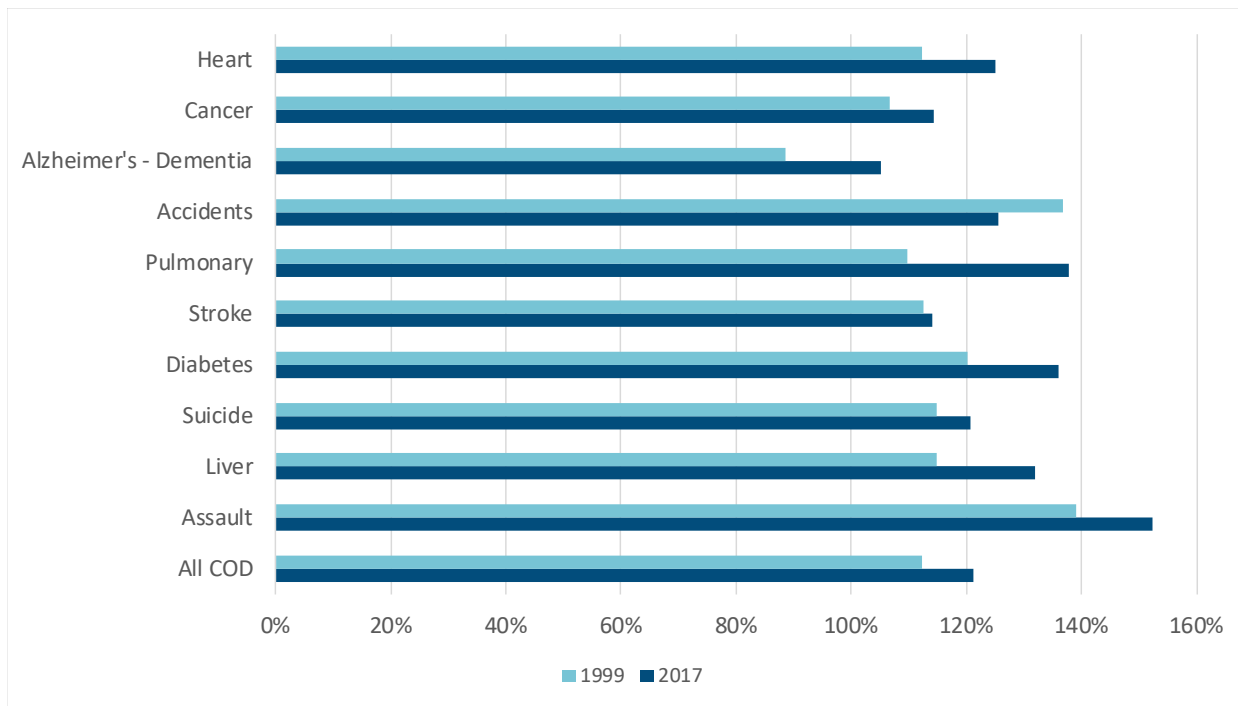


- Relative to All Counties' mortality, the Top 15% generally decreased over 1999-2017 while the Bottom 15% increased. Exceptions to this among the 10 key CODs, were increases from 1999 to 2017 in the Top 15% for Alzheimer's - dementia and accidents and a decrease for accidents in the Bottom 15%. No COD was higher in the Top 15% than the Bottom 15% in 2017.

TOP 15% TO ALL COUNTIES MORTALITY RATIO



BOTTOM 15% TO ALL COUNTIES ALL AGES MORTALITY RATIO



- Male mortality improved more than female mortality for most CODs during 1999-2017. Heart disease is an exception where mortality improved more for females than males.

In most cases, the relationship of female versus male improvement (female higher or lower than male) in the Top 15% and Bottom 15% was consistent with the relationship of improvement in All Counties. The limited number of inconsistencies are shown below. The bolded, italicized values in the table below show where the inconsistencies arise. For example, in 2016-2017, All Counties' female and male mortality improvement for cancer was 1.9% and 2.4%, respectively. The Top 15% was inconsistent with All Counties because female mortality improvement was higher, 3.9%, than that for males, 3.4%, compared to All Counties where female improvement was lower, 1.9%, than male improvement, 2.4%.

TOP 15% AND BOTTOM 15% FEMALE VS. MALE MORTALITY IMPROVEMENT INCONSISTENCIES*

	All Counties		Bottom 15%		Top 15%	
	Female	Male	Female	Male	Female	Male
1999-2017						
Accidents	-2.0%	-1.8%	-1.7%	-1.2%	-1.8%	-2.2%
Stroke	2.7%	2.8%	2.7%	2.6%	3.0%	3.2%
2012-2017						
Stroke	-0.4%	-0.5%	1.1%	0.4%	-0.7%	-0.5%
Assault	-2.2%	-2.7%	-3.8%	-3.5%	-0.4%	-0.9%
2016-2017						
Heart	0.5%	0.0%	2.6%	0.1%	-0.4%	0.7%
Cancer	1.9%	2.4%	1.5%	2.7%	3.9%	3.4%
Alzheimer's - Dementia	-1.6%	-1.0%	-0.8%	-1.7%	-3.9%	-2.6%
Pulmonary	-2.1%	0.1%	-4.6%	-0.3%	-1.6%	-2.2%
All COD	-0.4%	-0.4%	0.2%	-0.5%	-0.4%	0.3%

* Bolded, italicized cells highlight inconsistencies of female vs. male mortality improvement in the Top 15% and Bottom 15% compared to All Counties' female vs. male mortality improvement.

- The highest increase in 2017 mortality, 11.9%, occurred in the opioid COD. However, opioid deaths only made up 1.7% of all the deaths in 2017. Opioid mortality rates did not differ much by the county groups analyzed in this report, but did vary by gender, with the female mortality rate at 47% of the male rate in 2017.

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 December 2017. 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 and lowest 15%, by population, of median household income based on 2008 census data was obtained from the U.S. Census Bureau’s Small Area Income and Poverty Estimates Program⁵. These counties were used in WONDER to obtain the mortality rates for the top 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 similar to privately-insured lives (Top 15%) versus those that may be covered by government insurance programs (Bottom 15%). Any reference to the “Top 15%” or “Bottom 15%” refers to the top or bottom 15 percentile counties, respectively, and any reference to “All Counties” refers to the entire U.S. population or all U.S. counties.

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, 1999-2017, covered in this report. To achieve consistent comparisons across gender and across the Top 15%, Bottom 15%, and All Counties, all age-adjusted rates were determined using the 2010 national, combined, female and male age 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.

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 (eleven age groups)

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

q_{Age_n} = 2016 Crude q_x for age group n

$Improvement_{Age_n}$ = Age group n 2017 mortality improvement rate

⁵ Source: U.S. Census Bureau, Small Area Estimates Branch. <https://www.census.gov/data/datasets/2008/demo/saie/2008-state-and-county.html> Release date: 11.2009

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 methodology⁶.

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:

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

Where:

q^{COD_n} = 2016 COD n age adjusted mortality rate

$q^{COD_{All}}$ = 2016 age adjusted mortality rate for all causes of mortality

$Improvement_{COD_n}$ = COD n 2017 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. Also, comparisons of the Top 15% or Bottom 15% versus the All Counties’ death rates for age groups where the deaths in 1999-2017, in either the Top 15%, Bottom 15%, or the All Counties’ total deaths, were less than ten, are not shown.

The NCHS’s rankable causes of death are a subset of its “113 Selected Causes of Death.” The selected ten causes of death covered in the report were chosen in a review of the top five rankable causes of death for each of the ten-year age groups available in WONDER. Below is a table of the ten selected causes of death covered in this report and their International Classification of Diseases, Tenth Revision⁷ (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)
Accidents	GR113-112	#Accidents (unintentional injuries) (V01-X59,Y85-Y86)
Alzheimer’s/Dementia ⁸	GR113-052	#Alzheimer’s disease (G30)
Assault	GR113-127	#Assault (homicide) (*U01-*U02,X85-Y09,Y87.1)
Cancer	GR113-019	#Malignant neoplasms (C00-C97)
Diabetes	GR113-046	#Diabetes mellitus (E10-E14)
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)
Suicide	GR113-124	#Intentional self-harm (suicide) (*U03,X60-X84,Y87.0)

⁶ Source: <https://wonder.cdc.gov/wonder/help/ucd.html#>

⁷ World Health Organization <https://icd.who.int/browse10/2016/en>

⁸ 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)

For section 6.5, the method to identify drug overdose deaths involving opioids was taken from the Increases in Drug and Opioid Overdose Deaths – United States, 2010-2015⁹. 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.
- C. Ratios of Top 15% to All Counties’ age-adjusted mortality rates and Bottom 15% to All Counties’ age-adjusted mortality rates used in observations in this report.
- D. Ratios of Top 15% to All Counties’ mortality rates and Bottom 15% to All Counties’ mortality rates used in observations in this report.
- E. The Total Population Analysis graph for all CODs from section 4.1;
- F. The Income Analysis graph for all CODs from section 4.2;
- G. Links to the CDC WONDER queries¹⁰ to pull values for the All CODs analyses in section 4
- H. Links to the CDC WONDER queries¹⁰ to pull values for the Opioid analyses in section 6.
- I. List of the Bottom 15% counties; and
- J. List of the Top 15% counties

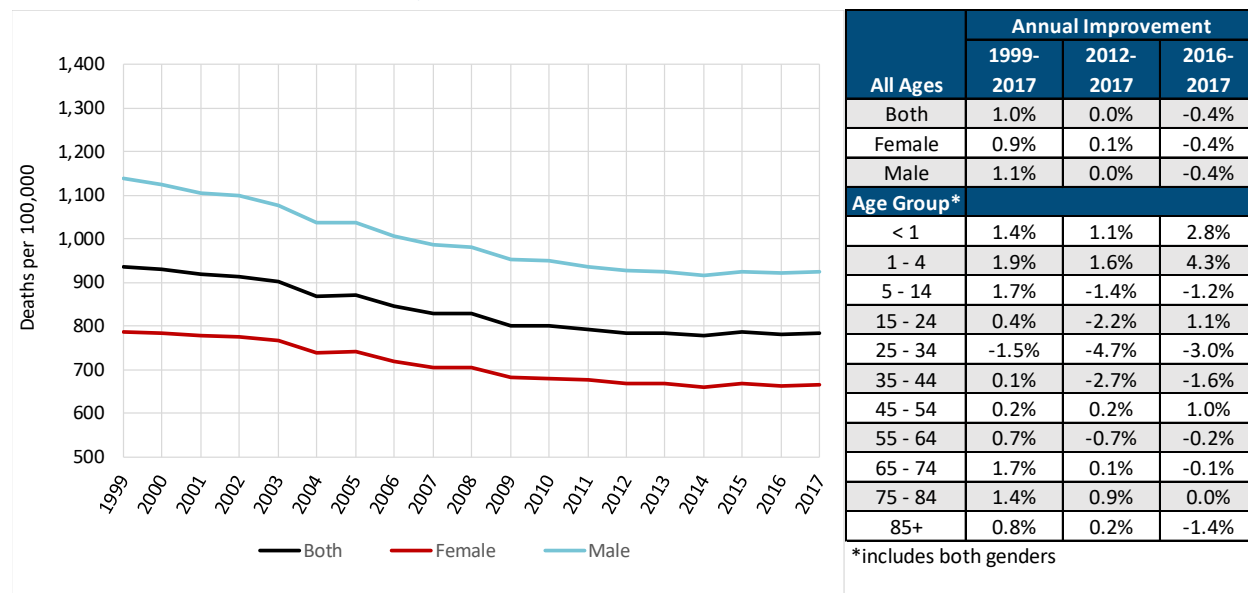
⁹ Rudd RA, Seth P, David F, Scholl, L. Increases in drug and opioid overdose deaths—United States, 2000–2015. *MMWR Early Release* 2016;64:1378–82. [CrossRefPubMed](#)

¹⁰ The SOA is not responsible if these links do not continue to work and will not update them if they break.

Section 4: All Causes of Death

4.1 Total Population Analysis

AGE-ADJUSTED MORTALITY 1999-2017

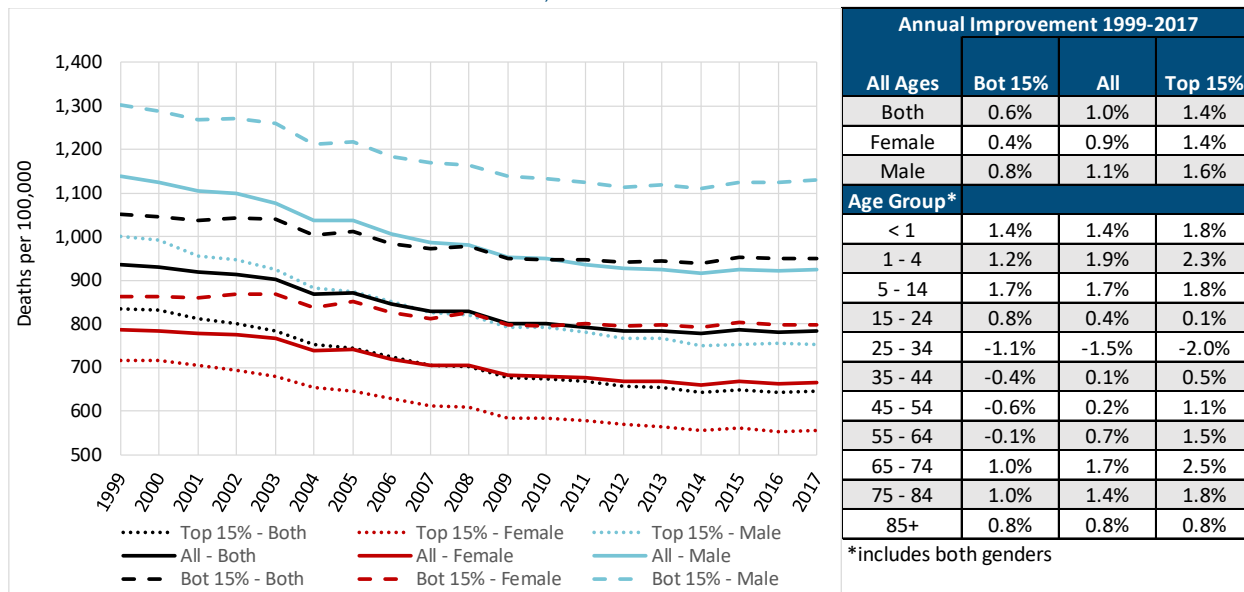


Observations:

1. The overall mortality rate (both genders) from all causes of death increased 0.4% in 2017, which followed a 0.6% decrease in 2016. Mortality has not improved cumulatively (both genders) since 2012.
2. Male mortality improved faster than female mortality from 1999-2017, 1.1% versus 0.9% annual improvement, but the difference in improvement rates has disappeared and slightly reversed in recent years. The female to male mortality ratio was 69.1% in 1999, peaked at 72.4% in 2015, and was 71.8% in 2017.
3. Because 92.8% of deaths in 2017 occurred in ages 45 and higher, the experience of ages less than that has a comparatively small impact on overall mortality. Within ages 45 and higher, ages 85+ had the largest impact on 2017 annual improvement. Its 1.4% increase contributed 0.4% to the 2017 increase for all ages combined. All other ages combined netted to no change.

4.2 Income Analysis

AGE-ADJUSTED MORTALITY 1999-2017 – TOP 15%, BOTTOM 15% VS. ALL COUNTIES – ALL CAUSES OF DEATH



Observations:

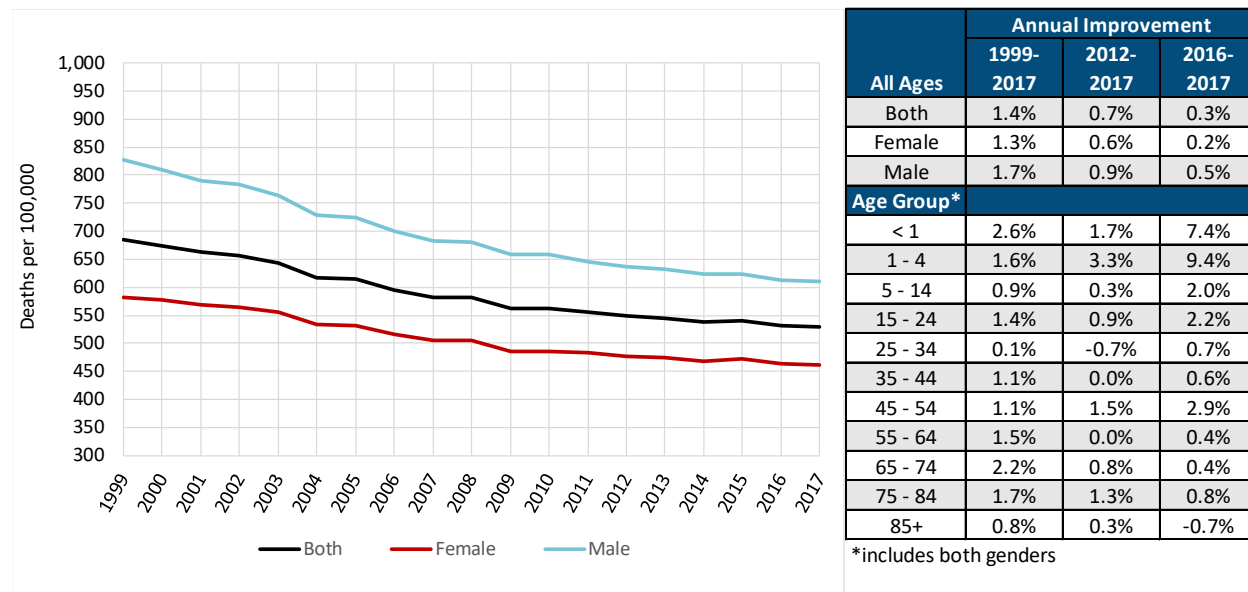
- Over 1999-2017, the overall (both genders) Top 15% all causes' mortality rate decreased more than the Bottom 15% rate. The Top 15% rate decreased at a 1.4% average rate and the Bottom 15% rate decreased at a 0.6% average rate. Female and male rates also decreased more in the Top 15% than in the Bottom 15%.
- The pace of divergence of Top 15% and Bottom 15% mortality (both genders) to All Counties slowed in recent years. From 1999-2012, the Top 15% decreased by 0.5% annually from 1999-2012, and 0.4% from 2012-2017. The ratio of the Bottom 15% to All Counties' mortality increased annually by 0.5%, and by 0.2% from 2012-2017.
- The Top 15% and Bottom 15% mortality ratios to All Counties were 89.1% and 112.3%, respectively, in 1999, and 82.1% and 121.2%, respectively, in 2017.
- Female mortality improved more relative to male mortality in the Top 15% versus Bottom 15%. The female to male ratios for the Top 15% and Bottom 15% were 71.6% and 66.2%, respectively, in 1999, and 70.5% and 73.6%, respectively, in 2017.
- Mortality improvement is generally higher for the Top 15% than the Bottom 15%. Ages 15-34 were a notable exception. During 1999-2017, the Top 15% annual mortality improvement was 0.7% less for ages 15-24, and 0.9% less for ages 25-34 than the Bottom 15% improvement for those ages.

Section 5: Physiological Causes

5.1 Total Physiological Causes

5.1.1 Total Population Analysis

AGE-ADJUSTED MORTALITY 1999-2017

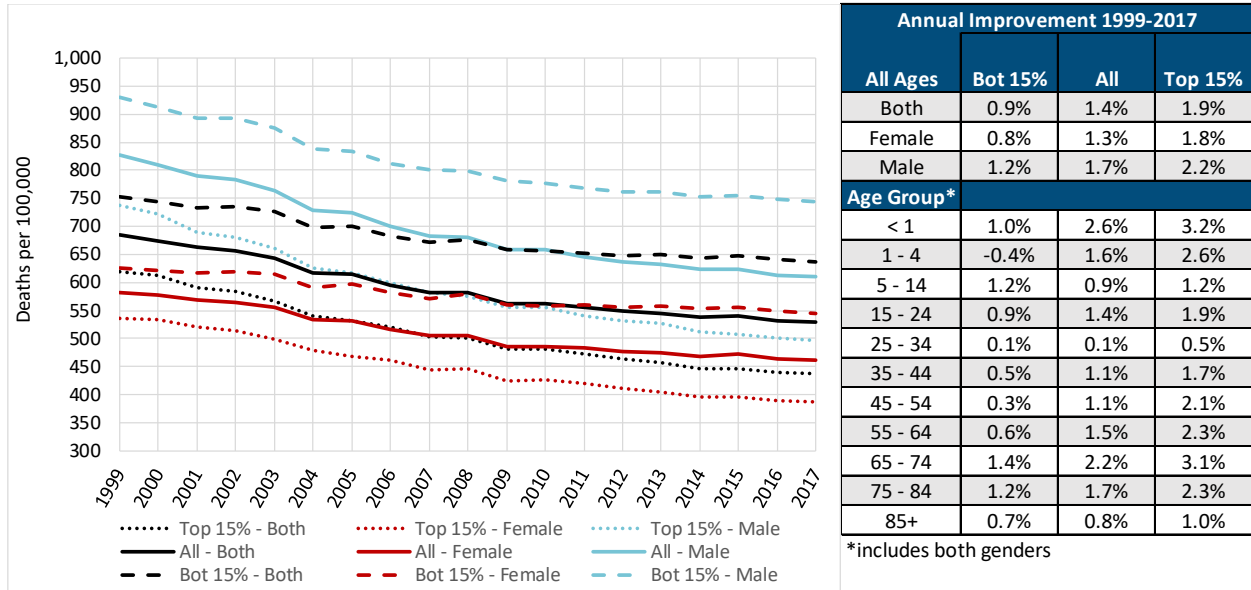


Observations:

1. Physiological causes of death include the seven natural causes of death analyzed separately in this report. They are, in descending number of 2017 deaths, heart disease, cancer, Alzheimer’s - dementia, pulmonary, stroke, diabetes, and liver.
2. The overall mortality rate (both genders) from physiological causes of death decreased 0.3%, which followed a 1.6% decrease in 2016. Mortality experience from these CODs had lower mortality improvement in recent years. While annual mortality improvement was 1.4% from 1999-2017, it was 0.7% from 2012-2017.
3. Both genders had decreased mortality improvement in recent years, but male mortality improved annually more than female mortality over all three measuring periods in the table above within a range of 0.3%-0.4%. The female to male mortality ratio was 70.3% in 1999, and 75.6% in 2017.
4. Age groups 55-64 and higher comprised 92.7% of physiological deaths in 2017. Each of these age groups showed the pattern for all ages combined of lower annual mortality improvement in 2012-2017 than 1999-2017.

5.1.2 Income Analysis

AGE-ADJUSTED MORTALITY 1999-2017 – TOP 15%, BOTTOM 15% VS. ALL COUNTIES – PHYSIOLOGICAL CAUSES



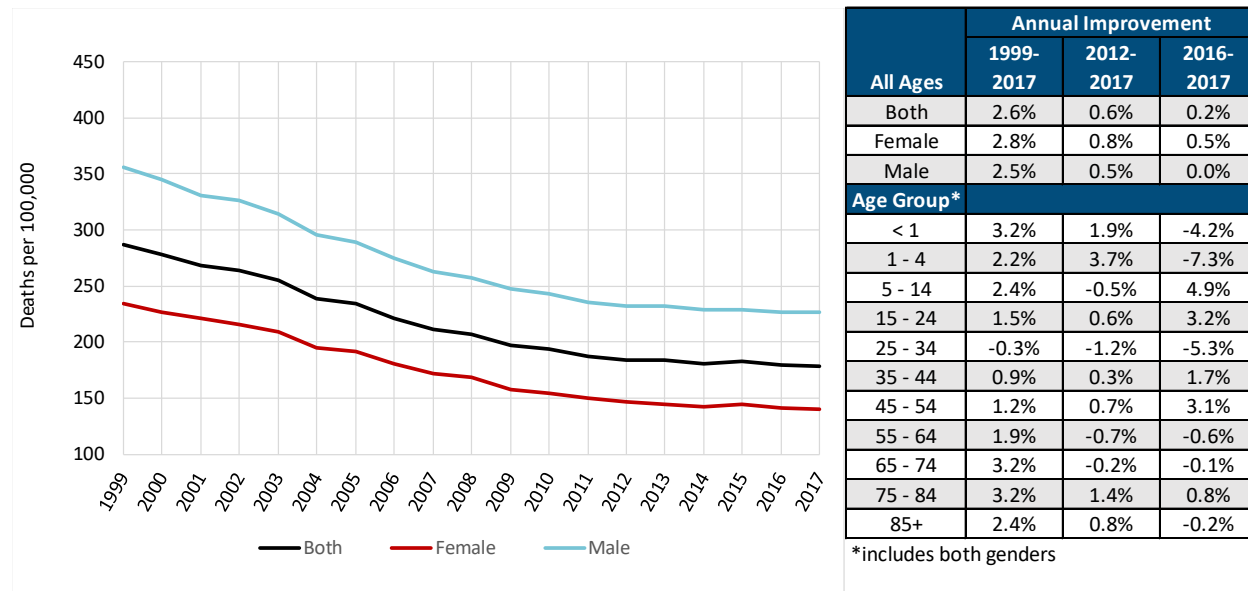
Observations:

- Over 1999-2017, the overall (both genders) Top 15% physiological causes' mortality rate decreased more than the Bottom 15% rate. The Top 15% rate decreased at a 1.9% average rate and the Bottom 15% rate decreased at a 0.9% average rate. Female and male rates also decreased more in the Top 15% than in the Bottom 15%.
- The Top 15% and Bottom 15% (both genders) diverged relative to All Counties' mortality. The Top 15% and Bottom 15% to All Counties' ratios were 90.4% and 110.0%, respectively, in 1999, and 82.5% and 120.2%, respectively, in 2017.
- Female mortality improved slightly more relative to male mortality in the Top 15% versus Bottom 15%. The female to male ratios for the Top 15% and Bottom 15% were 72.6% and 67.3% respectively, in 1999, and 77.9% and 73.2%, respectively, in 2017.

5.2 Heart

5.2.1 Total Population Analysis

AGE-ADJUSTED MORTALITY 1999-2017

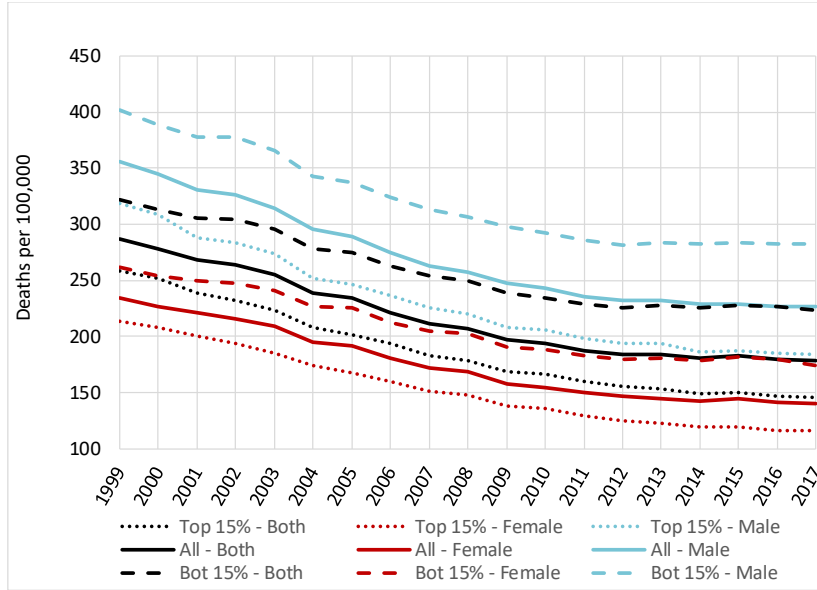


Observations:

1. The overall mortality rate (both genders) from heart disease decreased 0.2% in 2017, which followed a 1.7% decrease in 2016. Mortality experience from heart disease in 2017 continued the trend of lower mortality improvement in recent years. While annual mortality improvement was 2.6% from 1999-2017, it was 0.6% from 2012-2017.
2. Female mortality improved more than male mortality in 2017, 0.5% versus 0.0%, respectively. This aligns with experience over longer periods. Female mortality improvement exceeded male improvement annually by 0.3% over 1999-2017 and 2012-2017. The female to male mortality ratio was 65.9% in 1999, and 61.9% in 2017.
3. Age groups 55-64 and over comprised 92.5% of heart disease deaths in 2017. The decreased improvement at those ages in 2012-2017 and 2016-2017 versus 1999-2017 explains the reduced annual improvement in recent years for all ages combined.

5.2.2 Income Analysis

AGE-ADJUSTED MORTALITY 1999-2017 – TOP 15%, BOTTOM 15% VS. ALL COUNTIES – HEART



Annual Improvement 1999-2017			
All Ages	Bot 15%	All	Top 15%
Both	2.0%	2.6%	3.1%
Female	2.2%	2.8%	3.3%
Male	1.9%	2.5%	3.0%
Age Group*			
< 1	2.7%	3.2%	4.7%
1 - 4	-0.3%	2.2%	**
5 - 14	0.3%	2.4%	3.9%
15 - 24	1.2%	1.5%	1.2%
25 - 34	-0.1%	-0.3%	-0.1%
35 - 44	0.1%	0.9%	1.4%
45 - 54	0.1%	1.2%	2.2%
55 - 64	1.0%	1.9%	2.8%
65 - 74	2.4%	3.2%	4.0%
75 - 84	2.6%	3.2%	3.9%
85+	2.3%	2.4%	2.6%

*includes both genders

**Less than 10 deaths. See section 3.

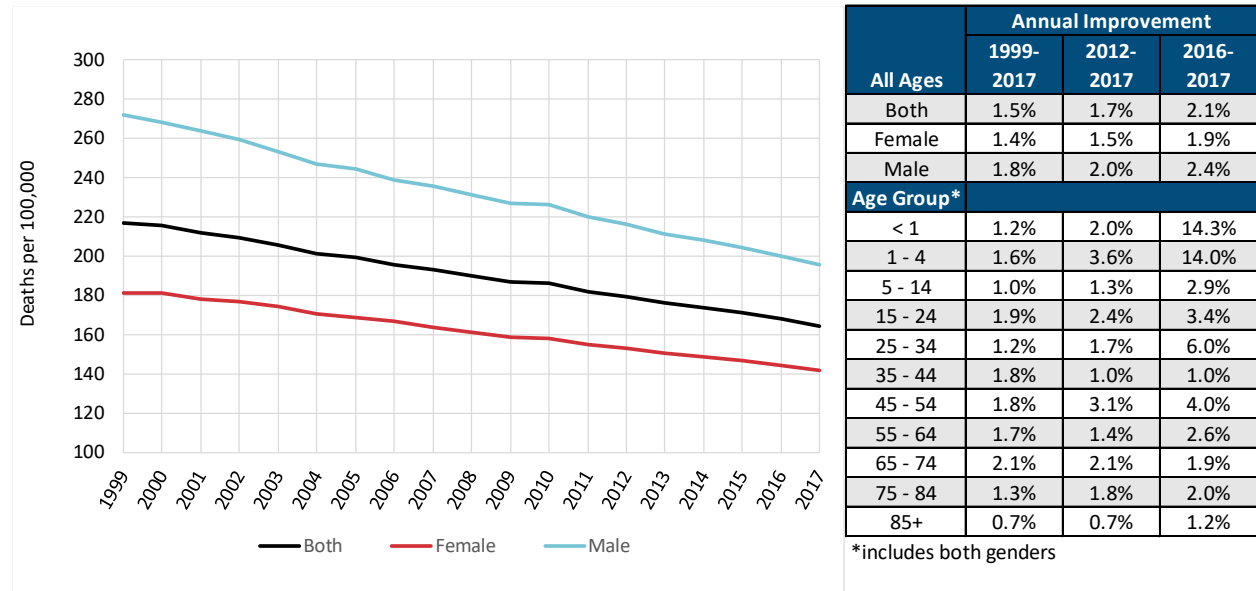
Observations:

- Over 1999-2017, the overall (both genders) Top 15% heart disease mortality rate decreased more than the Bottom 15% rate. The Top 15% rate decreased at a 3.1% average rate and the Bottom 15% rate decreased at a 2.0% average rate. Female and male rates also decreased more in the Top 15% than in the Bottom 15%.
- The Top 15% and Bottom 15% (both genders) diverged relative to All Counties' mortality. The Top 15% and Bottom 15% to All Counties' ratios were 90.0% and 112.2%, respectively, in 1999, and 81.7% and 125.0%, respectively, in 2017.
- Female mortality improved slightly more relative to male mortality in the Top 15% versus Bottom 15%. The female to male ratios for the Top 15% and Bottom 15% were 67.2% and 65.1%, respectively, in 1999, and 63.4% and 61.8%, respectively, in 2017.
- Age 85+ was an exception during 2012-2017 to the usual county rank order. Mortality improvement was higher in the Bottom 15%, 1.5%, than the Top 15%, 1.1%, during that time.

5.3 Cancer

5.3.1 Total Population Analysis

AGE-ADJUSTED MORTALITY 1999-2017

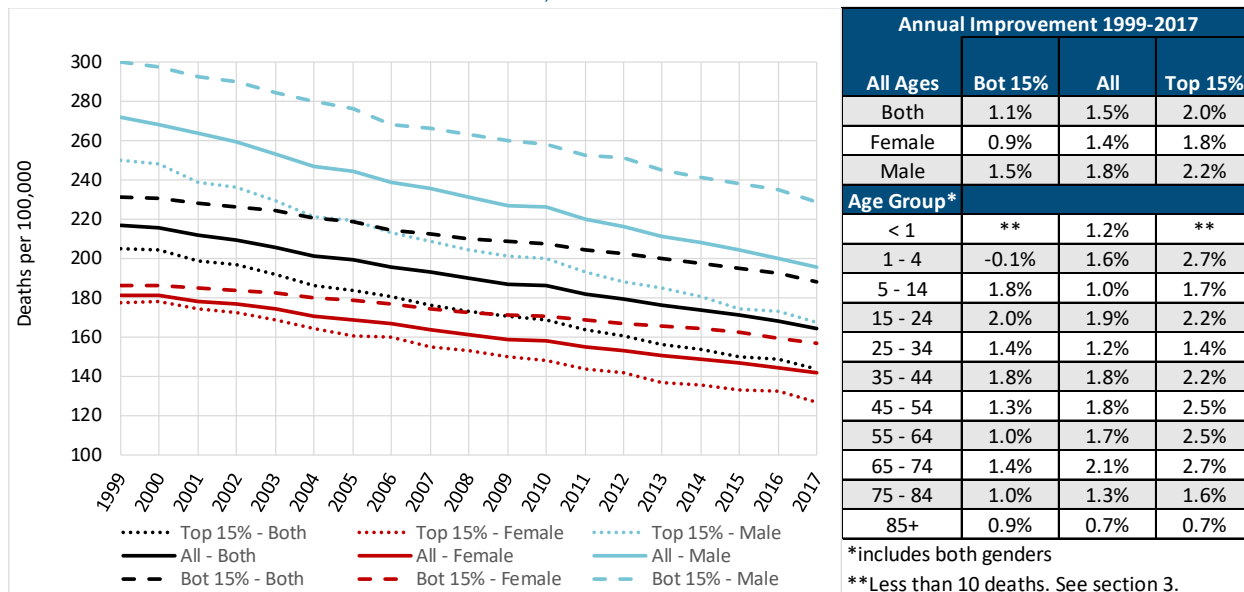


Observations:

1. The overall mortality rate (both genders) from cancer decreased 2.1% in 2017, which followed a 1.7% decrease in 2016. Mortality experience from cancer has slightly accelerated in recent years. Annual mortality improvement was 1.5% from 1999-2017, and 1.7% from 2012-2017.
2. Male mortality improved more than female mortality over all three measuring periods in the table above by about 0.5% annually. The female to male mortality ratio was 66.7% in 1999, and 72.5% in 2017.
3. Age groups 45-54 and above comprised 97.1% of cancer deaths in 2017. The greatest concentration within that range by age group was for ages 65-74 and 75-84, which had 54.1% of cancer deaths in 2017. Mortality improvement for age groups 45-54 and 75-84 accelerated, while it was flat for 65-74 and 85+ and slowed for age group 55-64 in 2012-2017 versus 1999-2017.

5.3.2 Income Analysis

AGE-ADJUSTED MORTALITY 1999-2017 – TOP 15%, BOTTOM 15% VS. ALL COUNTIES – CANCER



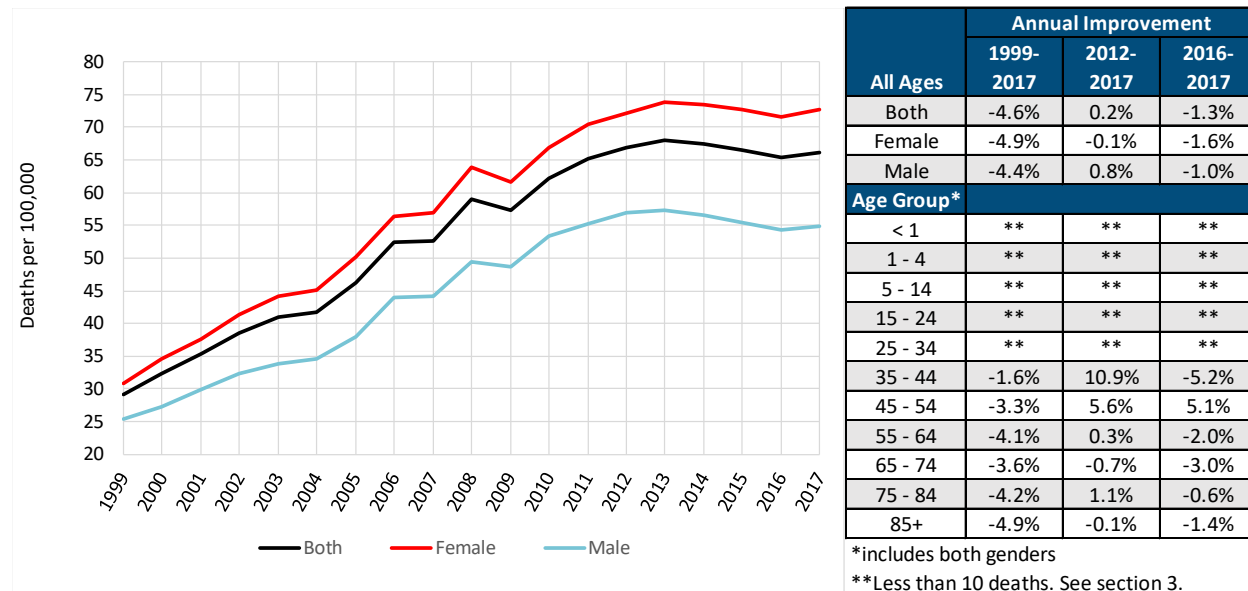
Observations:

- Over 1999-2017, the overall (both genders) Top 15% cancer mortality rate decreased more than the Bottom 15% rate. The Top 15% rate decreased at a 2.0% average rate and the Bottom 15% rate decreased at a 1.1% average rate. Female and male rates also decreased more in the Top 15% than in the Bottom 15%.
- The Top 15% and Bottom 15% (both genders) diverged relative to All Counties' mortality. The Top 15% and Bottom 15% to All Counties' ratios were 94.6% and 106.7%, respectively, in 1999, and 87.3% and 114.3%, respectively, in 2017.
- Female mortality improved less relative to male mortality in the Top 15% versus Bottom 15%. The female to male ratios for the Top 15% and Bottom 15% were 71.1% and 62.0%, respectively, in 1999, and 75.9% and 68.6%, respectively, in 2017.
- Age group 85+ was a notable exception to the usual county rank order. Mortality improvement was lower in the Top 15% than the Bottom 15% in 2012-2017 and 1999-2017. Mortality improvement for age group 85+ in the Top 15% and Bottom 15% was 0.2% and 1.4%, respectively, over 2012-2017, and 0.7% and 0.9%, respectively, over 1999-2017.

5.4 Alzheimer's/Dementia

5.4.1 Total Population Analysis

AGE-ADJUSTED MORTALITY 1999-2017

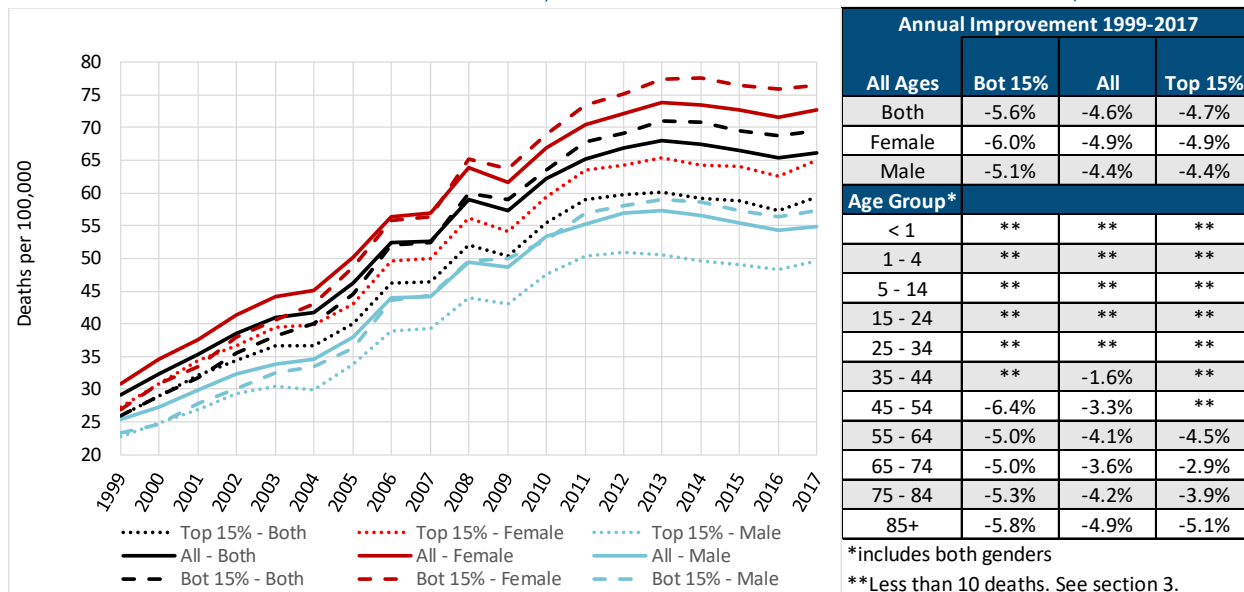


Observations:

1. The overall mortality rate (both genders) from Alzheimer's/dementia increased 1.3% in 2017. This was a reversal of a three-year trend of annual mortality improvement of 1.3% from 2013-2016. Previously, over 1999-2013, mortality increased by an average annual rate of 6.2%.
2. Female mortality increased more than male mortality in 2017, 1.6% versus 1.0%, respectively. As with the overall (both genders) rate, this reversed a three-year trend of annual mortality improvement of 1.0% and 1.8%, respectively, from 2013-2016. The female to male mortality ratio from Alzheimer's/dementia increased from 121.2% in 1999 to 132.7% in 2017.
3. The 2.0% and 3.0% increases, respectively, in 2017 for age group 55-64 and 65-74, followed increases of 4.3% and 1.5% in 2016. These were the only two age ranges that had mortality change in the same direction. All others changed in the opposite direction.
4. 99.9% of Alzheimer's/dementia deaths occurred in age groups 55-64 and above in 2017. Because of this, the impact of the 5.1% decrease for age group 45-54 had a minimal effect on the overall mortality rate change.
5. While there may be effects of an aging population and changes in the reporting of COD (see the Reliance and Limitations section found on page 48) that contributed to the recent increase in Alzheimer's/dementia deaths, this report did not attempt to comment on such matters.

5.4.2 Income Analysis

AGE-ADJUSTED MORTALITY 1999-2017 – TOP 15%, BOTTOM 15% VS. ALL COUNTIES – ALZHEIMER’S/DEMENTIA



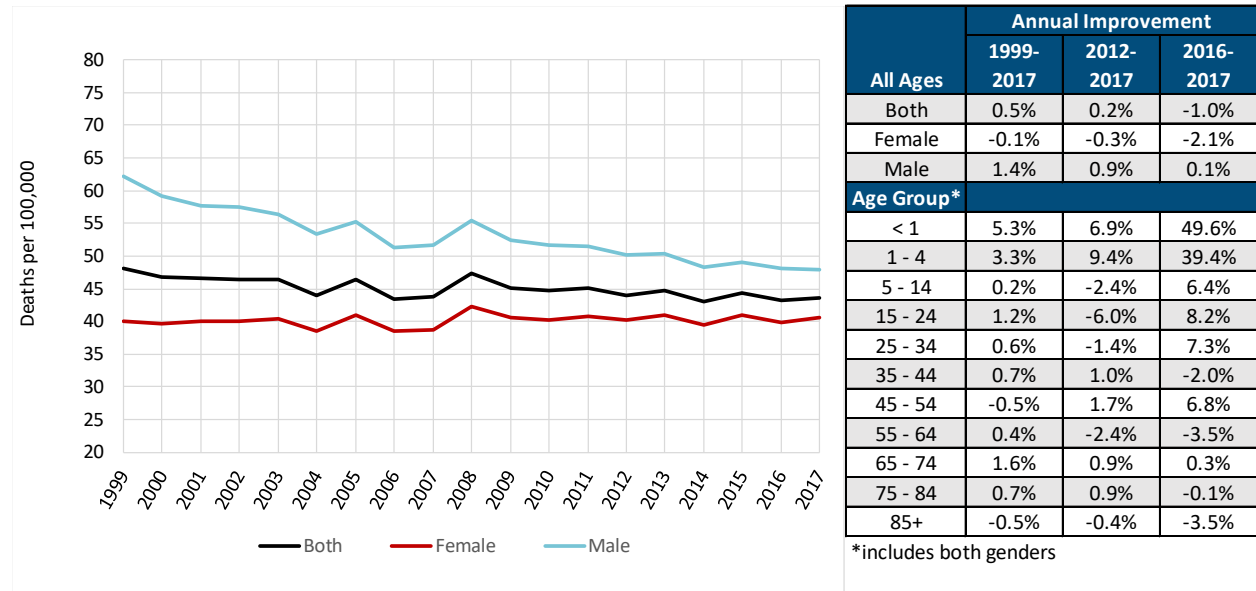
Observations:

1. The overall mortality rate (both genders) for Alzheimer’s/dementia increased by an average annual rate of 4.7% for All Counties over 1999-2017. Over that same time period, the Top 15% increased by a similar rate of 4.6%, while the Bottom 15% increased by a larger rate of 5.6%.
2. The ratio between the Bottom 15% and All Counties’ mortality rates increased gradually over time between 1999 and 2017. From 1999-2007, the ratio was less than one, going from 88.6% in 1999 to 99.7% in 2007. From 2008-2017, it was greater than one, going from 101.7% in 2008 to 105.1% in 2017. The ratio of the Top 15% to All Counties’ mortality rates remained more stable over this time period, with values between 86.8% and 89.7%.
3. For females and males, there was a similar pattern in the ratio of the Bottom 15% to All Counties’ mortality rates as in the overall ratio, 87.6% in 1999 to 105.2% in 2017 for females, and 91.6% in 1999 to 104.6% in 2017 for males. The ratio was also the closest to each other in 2007 for both, 99.2% for females and 100.7% for males.
4. There was also a similar pattern between the ratio of the Top 15% to All Counties’ mortality rates as in the overall ratio, with values between 85.9% and 91.2% for female, and 86.5% and 91.1% for males.

5.5 Pulmonary

5.5.1 Total Population Analysis

AGE-ADJUSTED MORTALITY 1999-2017

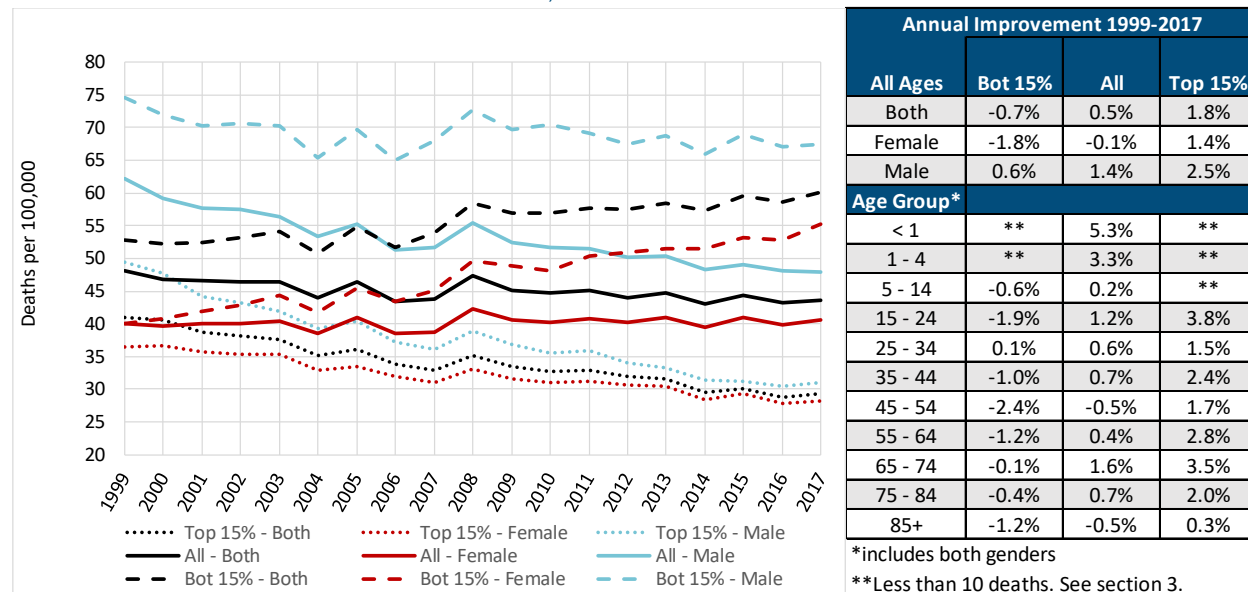


Observations:

1. The overall mortality rate (both genders) for pulmonary increased 1.0% in 2017, which was a reversal of the 2.5% decrease in 2016. Over 2006-2017, annual mortality improvement was flat, with an average annual rate of 0.0%. From 2010-2017, the rate alternated from positive to negative each year.
2. The mortality rate increased 2.1% for females, whereas males continued a positive trend with a mortality rate that decreased by 0.1% in 2017. This continued the trend of the last five years where males had an annual mortality improvement 0.9% from 2012-2017, and females had annual mortality increases of 0.3%.
3. The female to male mortality ratio from pulmonary increased from 64.3% in 1999 to 84.7% in 2017. Over 2009-2017, annual mortality improvement for females was flat, with an average annual rate of 0.0%. Over that same period, annual mortality improvement for males was 1.1%.
4. Ages groups 55-64 and above comprised 96.6% of pulmonary deaths in 2017. Of these, only age group 65-74 had a decrease in mortality in 2017.

5.5.2 Income Analysis

AGE-ADJUSTED MORTALITY 1999-2017 – TOP 15%, BOTTOM 15% VS. ALL COUNTIES – PULMONARY



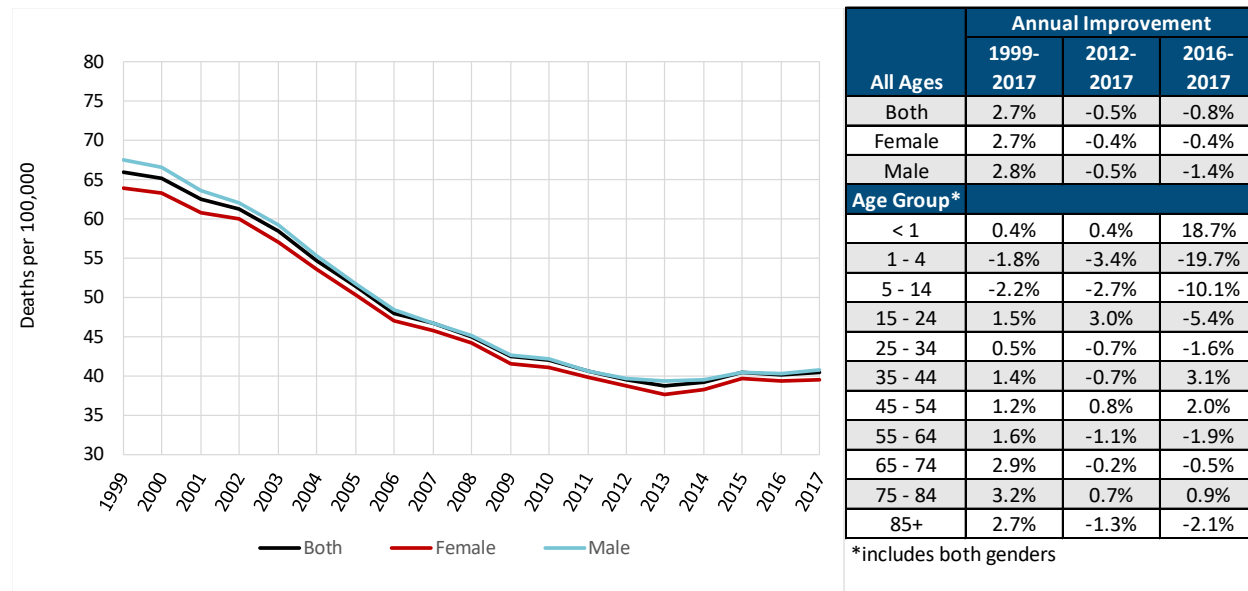
Observations:

1. The overall mortality rate (both genders) for pulmonary decreased by an average annual rate of 0.5% for All Counties over 1999-2017. Over that same time period, the Top 15% decreased by a larger rate of 1.8%, while the Bottom 15% showed an increase of 0.7%.
2. The ratio of the Top 15% to All Counties' mortality rates generally decreased over time between 1999 and 2017 and went from 85.1% in 1999 to 67.2% in 2017. The ratio between the Bottom 15% and All Counties' mortality rates generally increased over time, between 1999 and 2017, and went from 109.8% in 1999 to 137.7% in 2017.
3. For females and males, there was a similar pattern in the ratio of the Top 15% to All Counties' mortality rates as in the overall ratio, 91.3% in 1999 and 69.4% in 2017 for females, and 79.3% in 1999 and 64.8% in 2017 for males. There was also a similar pattern between the ratio of the Bottom 15% to All Counties' mortality rates as in the overall ratio, 100.2% in 1999 to 135.8% in 2017 for females, and 119.8% in 1999 to 140.4% in 2017 for males.

5.6 Stroke

5.6.1 Total Population Analysis

AGE-ADJUSTED MORTALITY 1999-2017

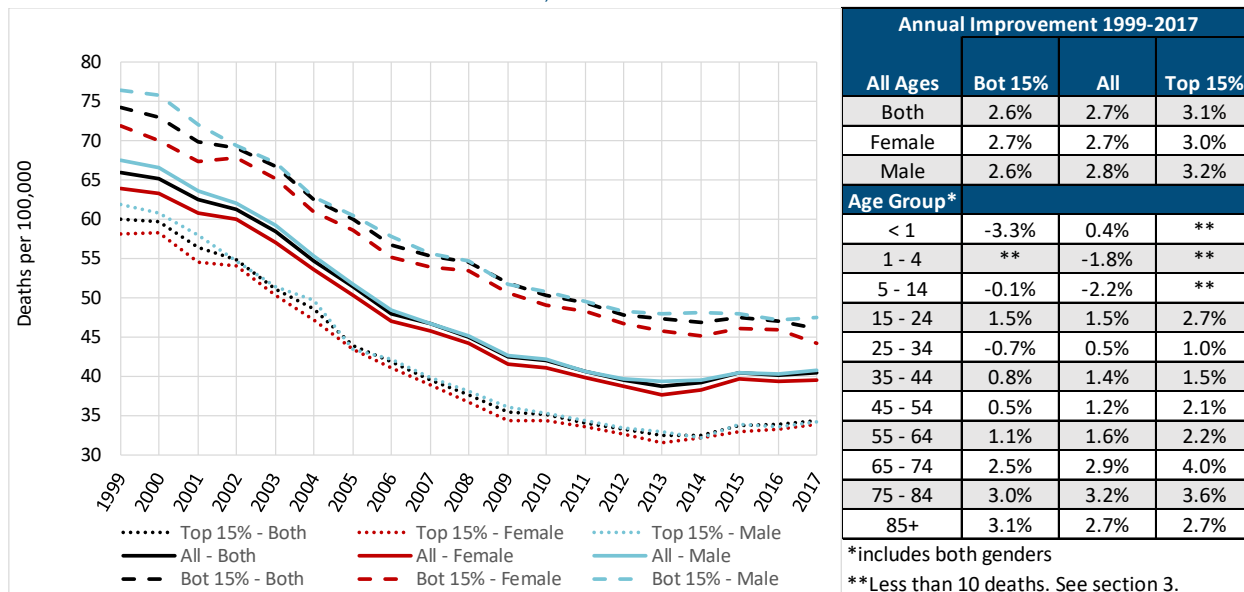


Observations:

1. The overall mortality rate (both genders) for stroke increased 0.8% in 2017, which was a reversal of the 0.7% decrease in 2016. Since 2015, there has been a small annual mortality improvement of 0.1%. Previously, over 1999-2013, annual mortality improvement was 3.7%.
2. Male mortality increased more than female mortality in 2017, 1.4% versus 0.4%, respectively. As with overall, the male and female increases were a reversal of decreases of 0.6% and 0.8% in 2016, respectively. The female mortality rate was very similar to the male rate over 1999-2017. The female to male mortality ratio from stroke increased from 94.8% in 1999 to a high of 98.2% in 2011. In 2017, the ratio was 96.7%.
3. Stroke primarily affects the middle and older age groups. Over 1999-2017, 97.8% of the total deaths were in age groups 45-54 and above. The middle age made up 4.1%. Although the mortality rate decreased in 2017 for age groups 45-54 and 75-84, since age group 85+ accounted for the greatest concentration of 2017 deaths at 43.9%, it's 2.1% increase had the most influence on the overall number.

5.6.2 Income Analysis

AGE-ADJUSTED MORTALITY 1999-2017 – TOP 15%, BOTTOM 15% VS. ALL COUNTIES – STROKE



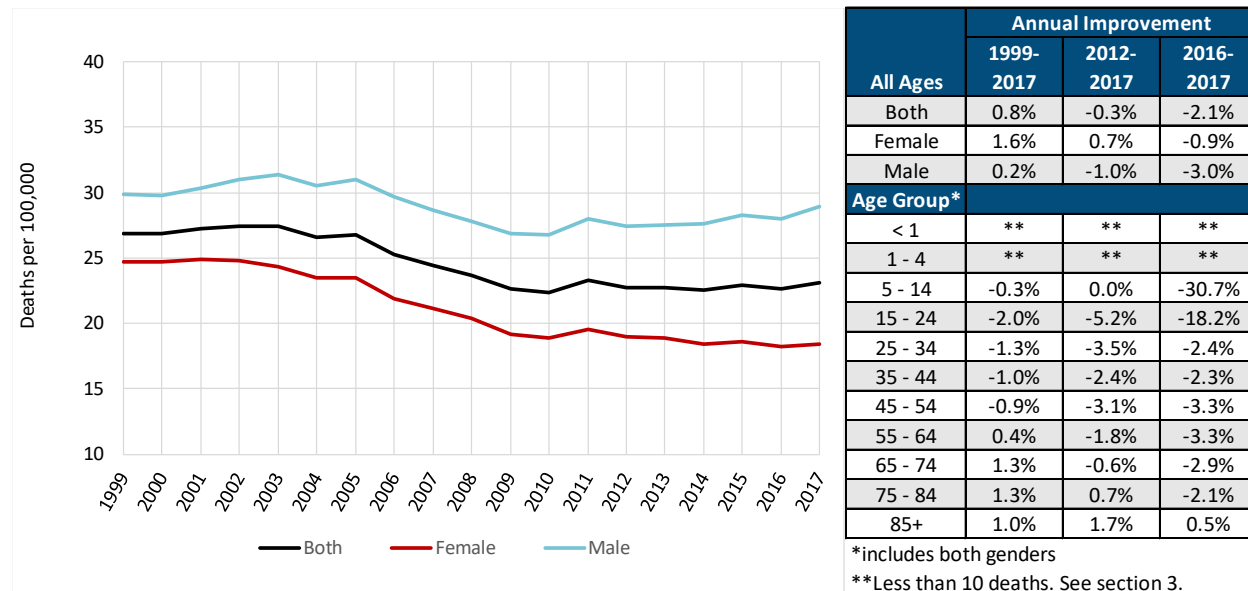
Observations:

1. The overall mortality rate (both genders) for stroke decreased by an average annual rate of 2.7% for All Counties over 1999-2017. Over that same time period, the Bottom 15% decreased by a similar rate of 2.6%, while the Top 15% decreased by a lower rate of 3.1%.
2. The ratio of the Top 15% to All Counties' mortality rates generally decreased and went from 91.1% in 1999 to 84.8% in 2017. The ratio between the Bottom 15% and All Counties' mortality rates varied between 1999 to 2017, 112.6% in 1999 to 114.0% in 2017, and hit a maximum of 122.1% in 2009.
3. For females and males, there was a similar pattern between the ratio of the Top 15% to All Counties' mortality rates as in the overall ratio, 90.8% in 1999 to 85.6% in 2017 for females, and 91.5% in 1999 to 83.9% in 2017 for males. There was also a similar pattern between the ratio of the Bottom 15% to All Counties' mortality rates as in the overall ratio, 112.3% in 1999 to 112.2% in 2017 and hit a maximum of 122.0% in 2009 for females, 113.2% in 1999 to 116.3% in 2017 and hit a maximum of 122.1% in 2013 for males.

5.7 Diabetes

5.7.1 Total Population Analysis

AGE-ADJUSTED MORTALITY 1999-2017

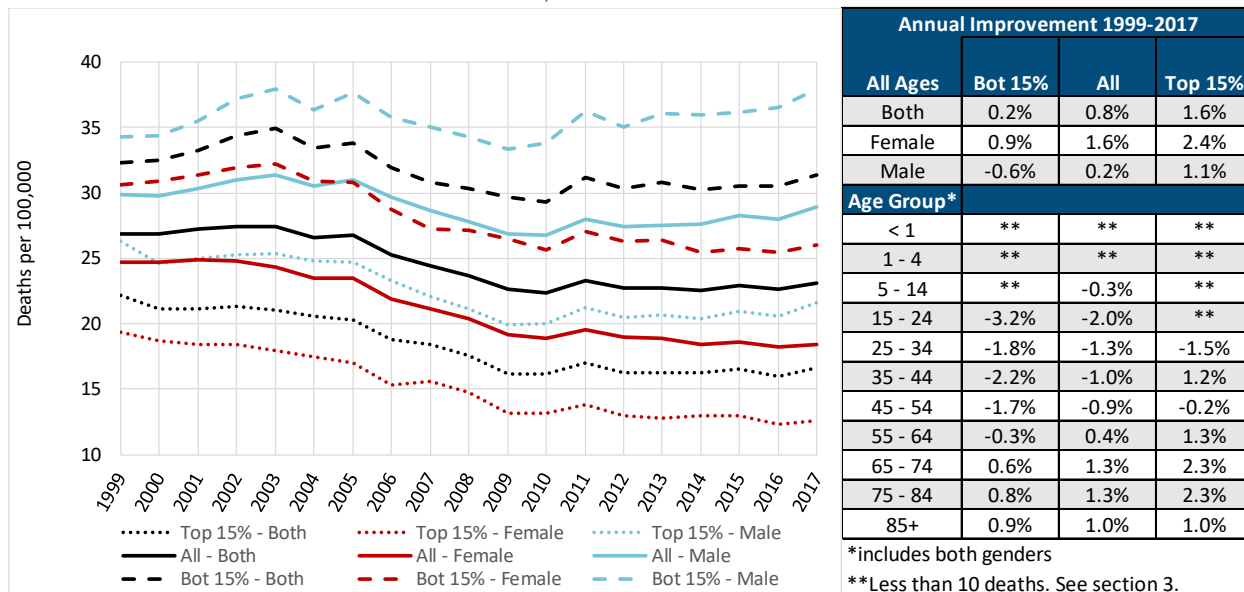


Observations:

1. The overall mortality rate (both genders) for diabetes increased 2.1% in 2017, which was a reversal of the 1.2% decrease in 2016. Over 2011-2016, annual mortality improvement was 0.6%. Between 2005 and 2010, this rate saw a significant decrease, with an annual mortality improvement of 3.5%.
2. Male mortality increased more than female mortality in 2017, 3.0% versus 0.9%, respectively. Both were reversals of the 0.7% and 2.1% decreases, respectively, in 2016.
3. For males, this returned to a three-year trend of annual increases in mortality. From 2012-2015, the overall mortality rate increased by an average annual rate of 1.0%. For females, over the same period, the overall mortality rate decreased by an average annual rate of 0.8%.
4. The female to male mortality ratio from diabetes decreased from 82.8% in 1999 to 63.6% in 2017.
5. Diabetes primarily affects the middle to older age groups. Over 1999-2017, 98.8% of the total deaths were in age groups 35-44 and above. All age ranges, besides 85+, showed a mortality rate increase in 2017. For the age groups between 35 and 84, the mortality rate increase ranged from 2.1% - 3.3%. Of those, only ages groups 35-44 and 45- 54 also increased in 2016.

5.7.2 Income Analysis

AGE-ADJUSTED MORTALITY 1999-2017 – TOP 15%, BOTTOM 15% VS. ALL COUNTIES – DIABETES



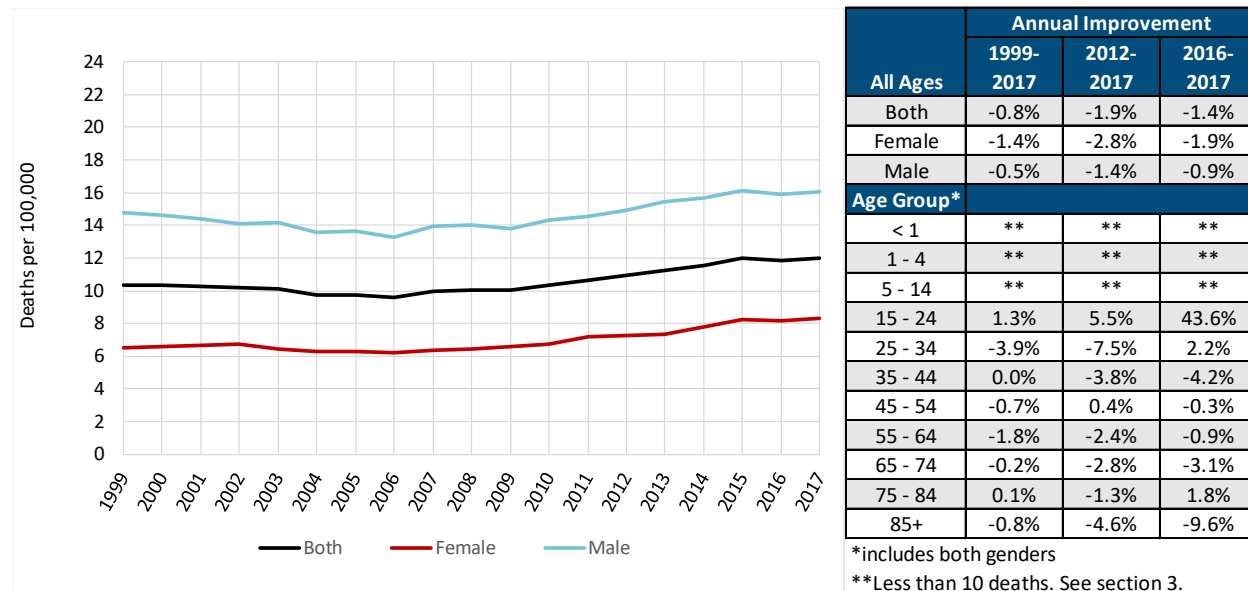
Observations:

1. The overall mortality rate (both genders) for diabetes decreased by an average annual rate of 0.8% for All Counties over 1999-2017. Over that same time period, the Top 15% decreased twice as much with a rate of 1.6%, while the Bottom 15% showed a much smaller decrease at a rate of 0.2%.
2. The ratio of the Top 15% to All Counties’ mortality rates generally decreased and went from 82.6% in 1999 to 71.9% in 2017. The ratio between the Bottom 15% and All Counties’ mortality rates generally increased over time between 1999 to 2017 and went from 120.2% in 1999 to 136.0% in 2017.
3. For females and males, there was a similar pattern between the ratio of the Top 15% to All Counties’ mortality rates as in the overall ratio, 78.6% in 1999 to 68.6% in 2017 for females, and 88.2% in 1999 to 74.9% in 2017 for males. There was also a similar pattern in the ratio of the Bottom 15% to All Counties’ mortality rates as in the overall ratio, 123.9% in 1999 to 141.5% in 2017 for females, and 115.0% in 1999 to 131.3% in 2017 for males.

5.8 Liver

5.8.1 Total Population Analysis

AGE-ADJUSTED MORTALITY 1999-2017

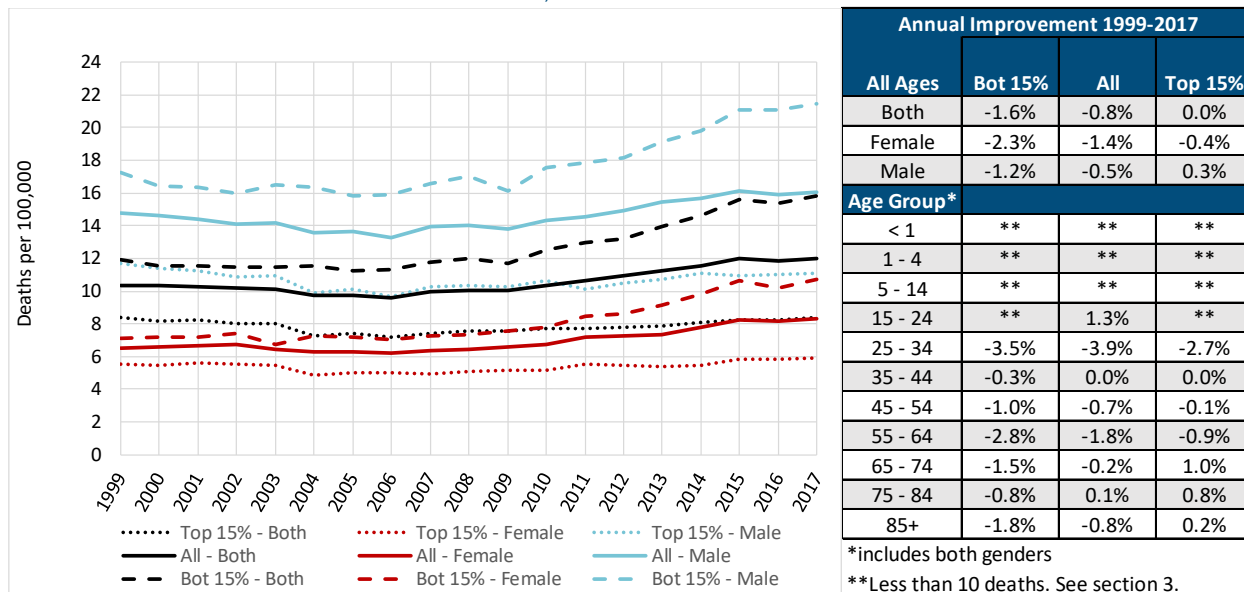


Observations:

1. The overall mortality rate (both genders) for liver increased 1.4% in 2017, which was a reversal of a 1.1% decrease in 2016. This returned to the increasing trend of mortality, which occurred from 2006-2015, at a rate of 2.5%. Previously, over 1999-2006, annual mortality improvement was 1.1%.
2. Female mortality increased more than male mortality in 2017, 1.9% versus 0.9%, respectively. As with overall, this was a reversal of decreases of 0.9% and 1.1%, respectively, in 2016. The female to male mortality ratio for liver increased from 44.3% in 1999 to a high of 51.8% in 2017.
3. Liver primarily affects the middle to older age groups. Over 1999-2017, 98.3% of the total deaths were in age groups 35-44 and above. Of these age groups, 75-84 had annual mortality improvement, while all others had decreasing annual mortality.

5.8.2 Income Analysis

AGE-ADJUSTED MORTALITY 1999-2017 – TOP 15%, BOTTOM 15% VS. ALL COUNTIES – LIVER



Observations:

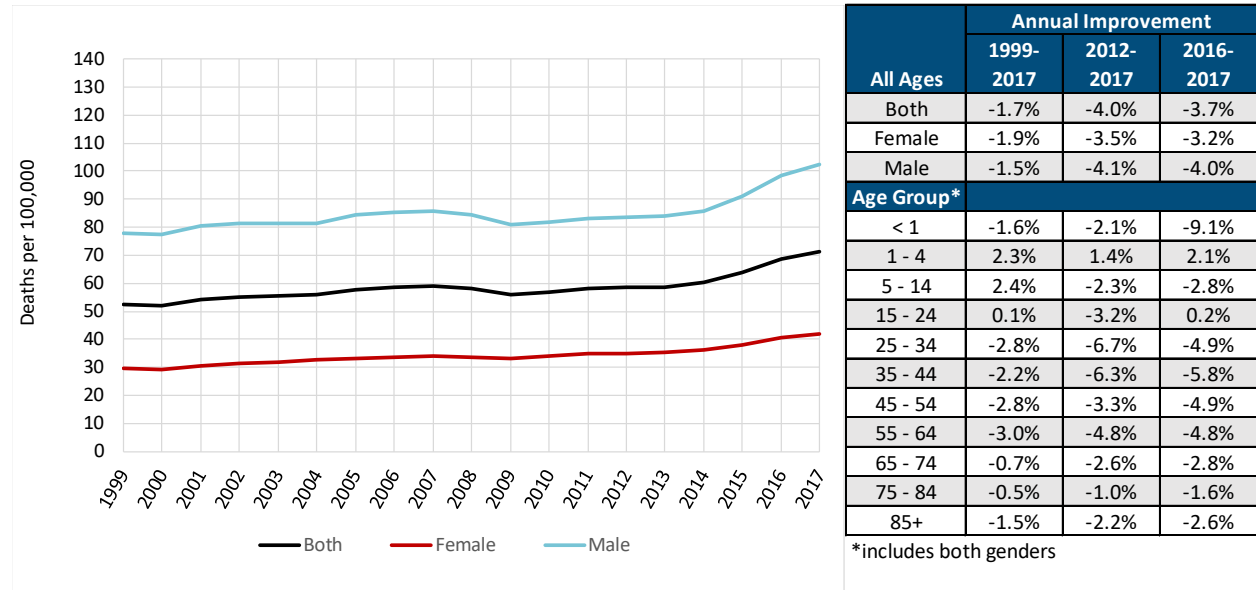
1. The overall mortality rate (both genders) for liver increased by an average annual rate of 0.8% for All Counties over 1999-2017. Over that same time period, the Bottom 15% increased by a rate double that of 1.6%, while the Bottom 15% showed no change.
2. The ratio of the Top 15% to All Counties' mortality rates generally decreased and went from 80.9% in 1999 to 69.6% in 2017. The ratio between the Bottom 15% and All Counties' mortality rates generally increased and went from 114.7% in 1999 to 132.0% in 2017 and hit a minimum of 111.4% in 2000.
3. For females and males, there was a similar pattern between the ratio of the Top 15% to All Counties' mortality rates as in the overall ratio, 84.5% in 1999 to 71.1% in 2017 for females, and 79.2% in 1999 to 69.1% in 2017 for males. There was also a similar pattern in the ratio of the Bottom 15% to All Counties' mortality rates as in the overall ratio, 108.3% in 1999 to 128.6% in 2017 for females, and 117.0% in 1999 to 133.5% in 2017 for males.

Section 6: External Causes

6.1 Total External Causes

6.1.1 Total Population Analysis

AGE-ADJUSTED MORTALITY 1999-2017

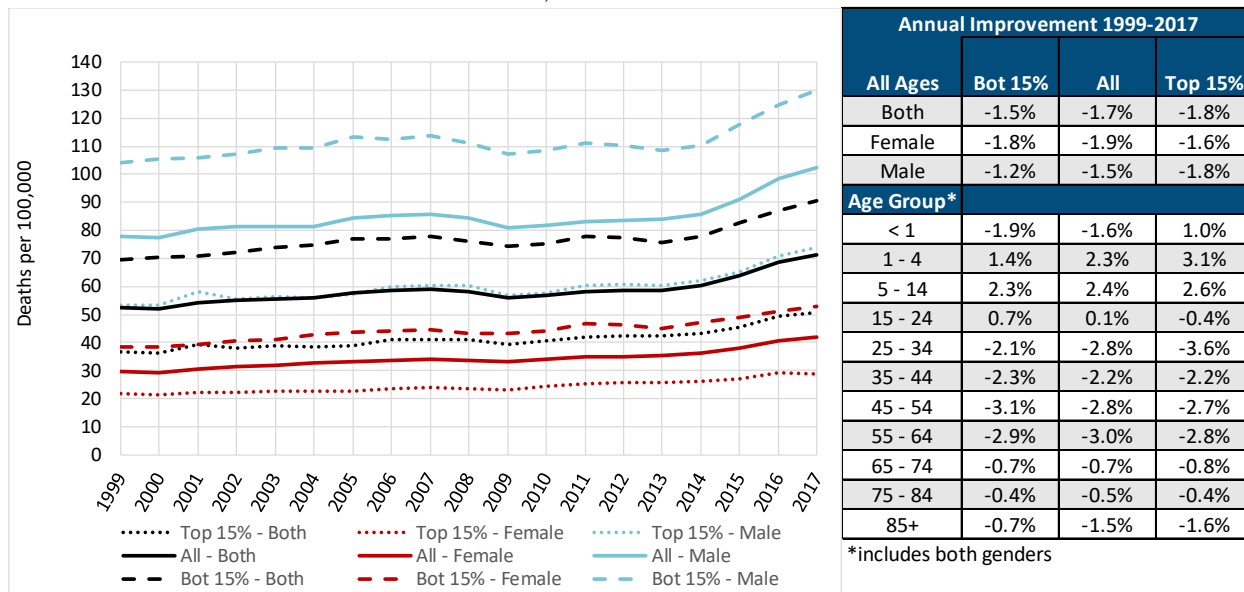


Observations:

1. External causes of death included three CODs analyzed separately in this report. They are, by descending number of 2017 deaths, accidents, suicide, and assault. The shapes of the lines in the above External COD graph resemble the lines in the Accidents graph in section 6.2.1 because a majority, 71% in 2017, of the External deaths were due to Accidents.
2. The overall (both gender) mortality rate increased 3.7% in 2017, which was about half the 2016 increase of 7.5%. The mortality rate increases were 4.0% for males and 3.2% for females and were also about half the 2016 increases of 8.0% and 6.0%, respectively. The ratio of female mortality rates to male rates ranged between 38% and 42% from 1999-2017.
3. The total number of External deaths in 2013-2017 was 1,053,330. The 25-34, 35-44, 45-54, and 55-64 age groups accounted for 15%, 14%, 16%, and 14%, respectively, of these deaths.
4. Each age group between 15-44 saw a lower increase in mortality in 2017 relative to their average increase over 2012-2017.

6.1.2 Income Analysis

AGE-ADJUSTED MORTALITY 1999-2017 – TOP 15%, BOTTOM 15% VS. ALL COUNTIES – EXTERNAL CAUSES



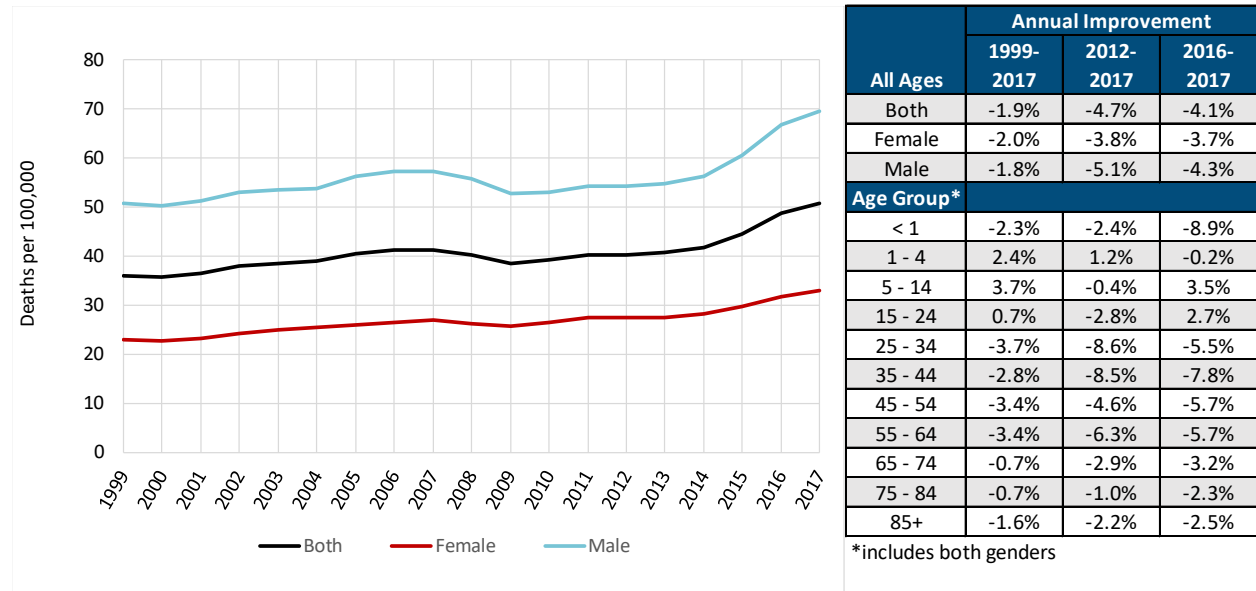
Observations:

- Over 1999-2017, the overall (both genders) Top 15% mortality rate increased more than the Bottom 15% rate. The Top 15% rate increased at a 1.8% average rate, and the Bottom 15% rate increased at a 1.5% average rate. The male rate also increased more in the Top 15% than the Bottom 15%, but the female rate increased less in the Top 15% than in the Bottom 15%.
- Over 1999-2017, mortality rates were lower for the Top 15% than the Bottom 15% for the overall (both gender) male and female groupings. This was also true for all the age groups.
- The ratio of the Bottom 15% to All Counties' mortality rates decreased from 132.1% in 1999 to 127.3% in 2017. The ratio of the Top 15% to All Counties' mortality rates increased slightly from 69.9% in 1999 to 71.3% in 2017.

6.2 Accidents

6.2.1 Total Population Analysis

AGE-ADJUSTED MORTALITY 1999-2017

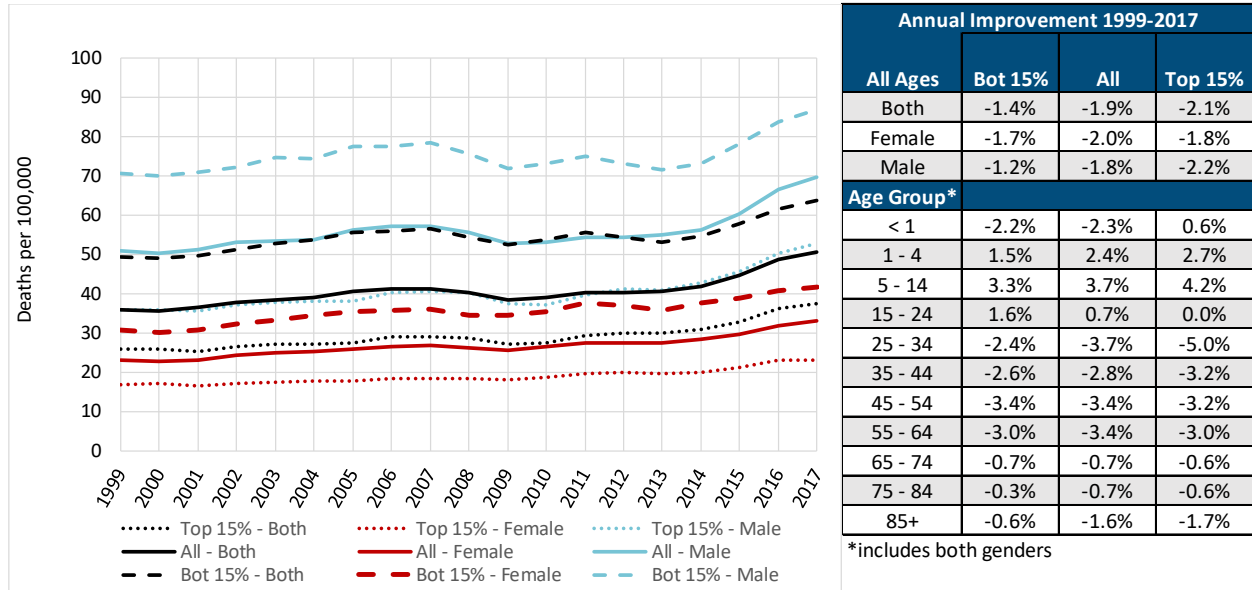


Observations:

1. The large increases in accident mortality rates between 2014 and 2016 slowed in 2017. The overall (both gender) mortality rate increased 4.1% in 2017. This was less than half of the 2016 increase of 9.3%. The 2017 mortality rate increases were 4.3% for males and 3.7% for females, significantly lower than the 2016 increases of 10.4% and 6.8%, respectively.
2. The total number of accident deaths in 2013-2017 was 744,366. The 25-34, 35-44, 45-54, 55-64, and 85+ age groups accounted for 14%, 12%, 15%, 13%, and 15%, respectively, of these deaths.
3. Only two age groups had mortality improvement in 2017. The 5-14 age group saw a 3.5% decrease following a 7.8% increase in mortality in 2016. The 15-24 age group had a 2.7% decrease following an 11.9% increase in mortality in 2016.
4. Each age group between 5-44 and the 55-64 group saw a lower increase in mortality in 2017 relative to their average increase over 2012-2017.
5. The ratio of female mortality rates to male rates ranged between 45% and 51% from 1999-2017.

6.2.2 Income Analysis

AGE-ADJUSTED MORTALITY 1999-2017 – TOP 15%, BOTTOM 15% VS. ALL COUNTIES – ACCIDENTS



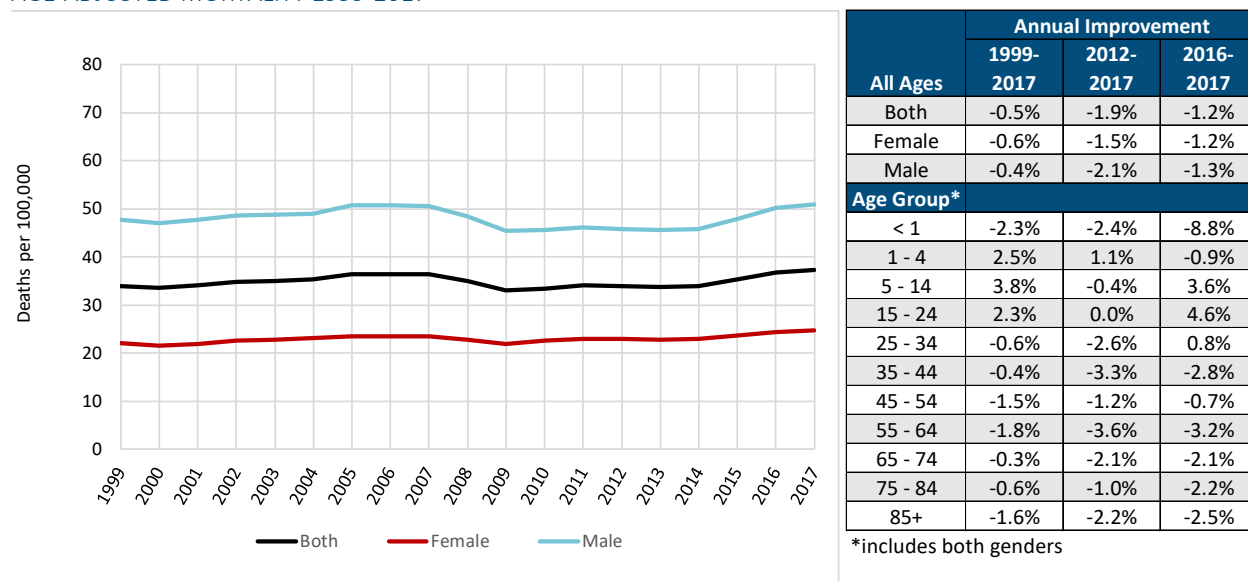
Observations:

- Over 1999-2017, the overall (both genders) Top 15% accident mortality rate increased more than the Bottom 15% rate. The Top 15% rate increased at a 2.1% average rate and the Bottom 15% rate increased at a 1.4% average rate. Male and female rates also increased more in the Top 15% than in the Bottom 15%.
- Over 1999-2017, accident mortality rates were lower for the Top 15% than the Bottom 15% for the overall (both gender) male and female groupings. This was also true for all the age groups.
- The ratio of the Bottom 15% to All Counties' mortality rates decreased from 136.8% in 1999 to 125.6% in 2017. The ratio of the Top 15% to All Counties' mortality rates increased slightly from 71.7% in 1999 to 73.9% in 2017.

6.2.3 Analysis of Deaths Due to Accidents Excluding Opioid Deaths

This analysis removes deaths due to opioid usage from the accident COD analysis in section 6.2.1.

AGE-ADJUSTED MORTALITY 1999-2017



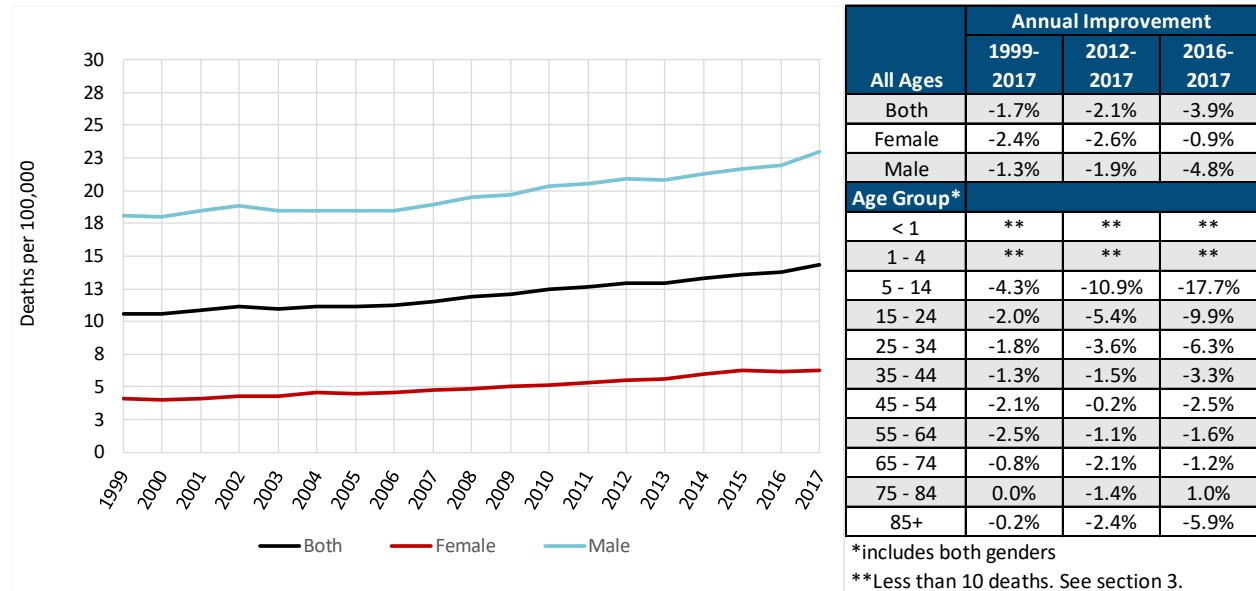
Observations:

1. Removing opioid deaths from the accident analysis flattens the lines in the above graph relative to the lines in the graph in section 6.2.1 because accidental deaths from opioid usage have increased from 1999-2017.
2. The overall mortality rate (both genders) increased 1.2% in 2017 but was less than one-third of the 4.4% increase in 2016. The male and female mortality rates increased 1.3% and 1.2%, respectively, in 2017. These 2017 male and female increases were also much lower than their respective 2016 increases of 4.8% and 3.3%.
3. The total number of accident deaths, excluding opioids in 2013-2017, was 587,364. The 25-34, 35-44, and 65-74 age groups each accounted for 10% of these deaths; the 45-54, 55-64, and 75-84 age groups each accounted for 13%; and the 85+ accounted for 19%.
4. Only three age groups had mortality improvement in 2017. The improvement here followed increases in mortality in 2016. The 5-14 age group saw a 3.6% decrease following an 8.0% increase in mortality in 2016. The 15-24 age group had a 4.6% decrease following a 6.1% increase in mortality in 2016. And the 25-34 age group had a 0.8% decrease following a 10.7% increase in 2016.
5. The ratio of female mortality rates to male rates ranged between 46% and 50% from 1999-2017.

6.3 Suicide

6.3.1 Total Population Analysis

AGE-ADJUSTED MORTALITY 1999-2017

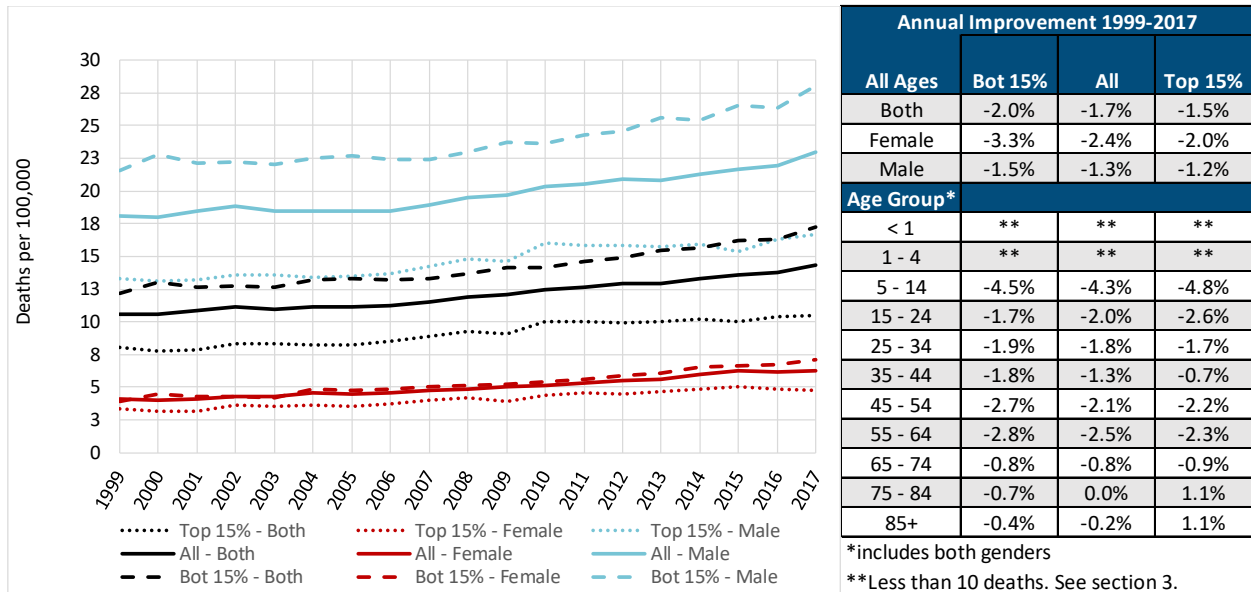


Observations:

1. The increase in the suicide mortality rate was 3.9% in 2017, more than double the 1.2% increase in 2016. The mortality rate has increased each year since 2005, with the rate of increase varying from year to year.
2. Male deaths from suicides increased 4.8% in 2017. This was more than double the 1.3% increase in 2016. Even though female rates increased more from 1999-2017 on a percentage basis than male rates, the absolute change in the female death rates was less than the absolute change in male death rates.
3. The total number of suicide deaths in 2013-2017 was 220,306. The 15-24, 25-34, 35-44, 45-54, and 55-64 age groups accounted for 12%, 16%, 16%, 20%, and 17%, respectively, of these deaths.
4. Each age group except 65-74 and 75-84 saw a higher increase in mortality in 2017 relative to their average increase over 2012-2017.
5. The ratio of female mortality rates to male rates has been relatively low and ranged between 22% and 29% from 1999-2017.

6.3.2 Income Analysis

AGE-ADJUSTED MORTALITY 1999-2017 – TOP 15%, BOTTOM 15% VS. ALL COUNTIES – SUICIDE



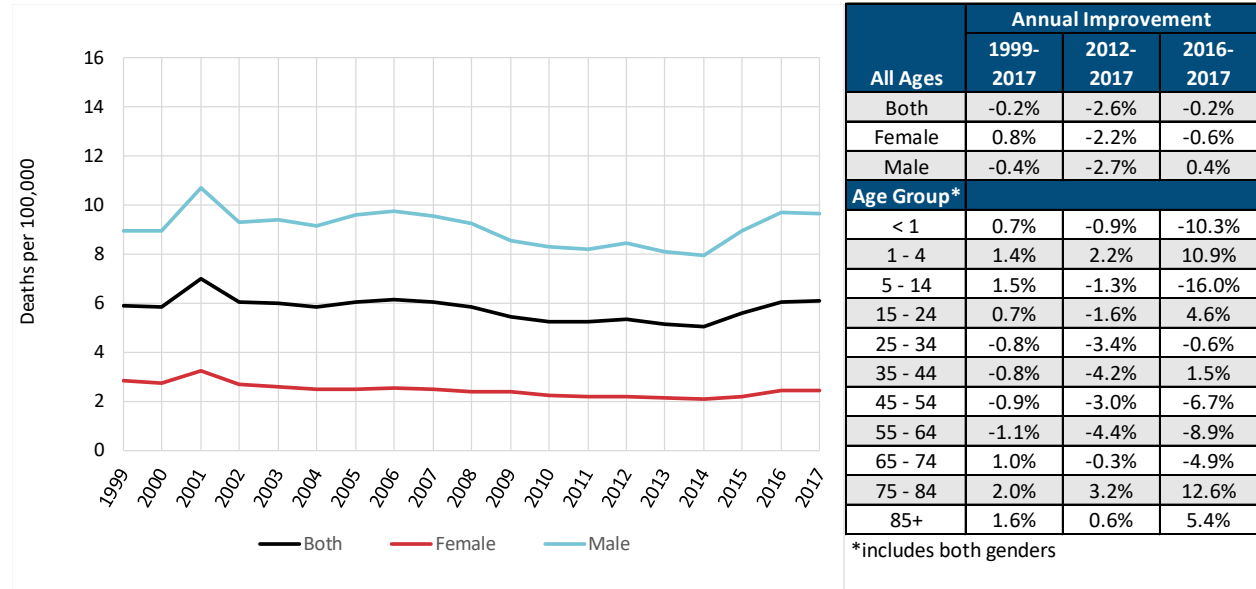
Observations:

- Over 1999-2017, the overall (both genders) Bottom 15% suicide mortality rate increased more than the Top 15% rate. The Bottom 15% rate increased at a 2.0% average rate and the Top 15% rate increased at a 1.5% average rate. Male and female rates also increased more in the Bottom 15% than in the Top 15%.
- Over 1999-2017, suicide mortality rates were lower for the Top 15% than the Bottom 15% for the overall (both gender) male and female groupings. This was also true for all the age groups.
- The ratio of the Bottom 15% to All Counties' mortality rates increased from 114.8% in 1999 to 120.6% in 2017. The ratio of the Top 15% to All Counties' mortality rates decreased slightly from 75.4% in 1999 to 73.4% in 2017.

6.4 Assault

6.4.1 Total Population Analysis

AGE-ADJUSTED MORTALITY 1999-2017

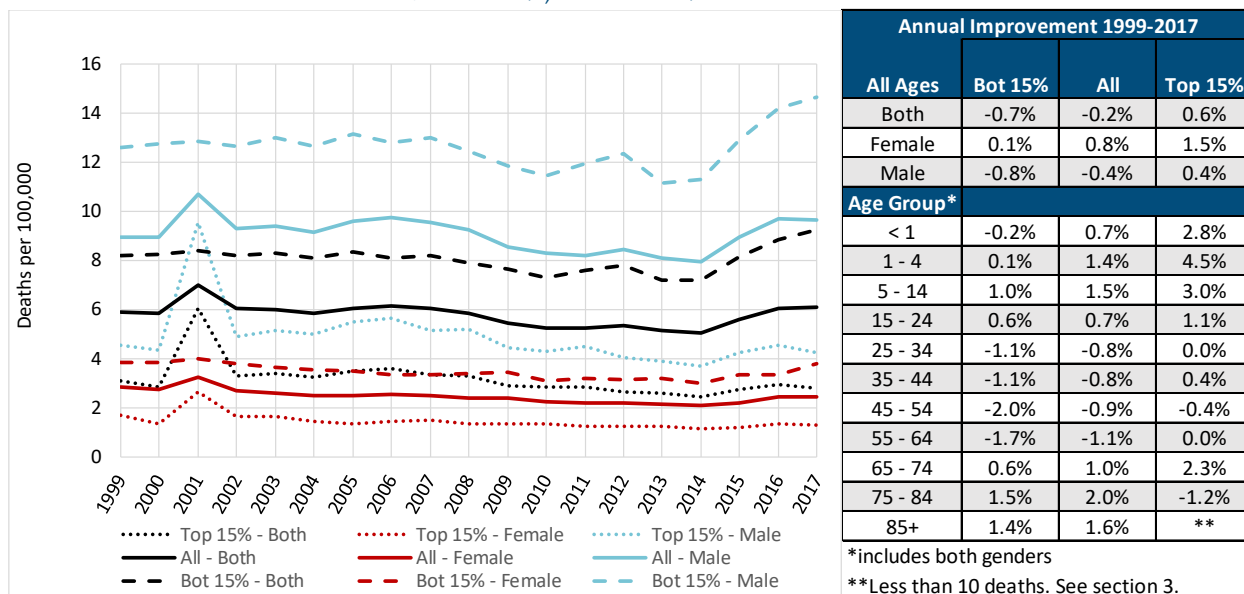


Observations:

1. The overall (both genders) mortality rate due to assault increased 0.2% after two years of much larger increases in 2015 and 2016.
2. The percentage changes in 2017 mortality rates were mixed by age group. The mortality rate for the 1-4, 15-24, 35-44, 75-84, and 85+ age groups decreased in 2017, while the other age groups increased.
3. The total number of assault deaths in 2013-2017 was 88,658. The age groups between 15-34 accounted for 54% of these deaths, and the age groups between 35-54 made up 28%.
4. The ratio of female mortality rates to male rates has been relatively low and ranged between 24% and 32% from 1999-2017.
5. The 9/11 terrorist attack appeared as a noticeable spike in 2001 and impacted males more than females.

6.4.2 Income Analysis

AGE-ADJUSTED MORTALITY 1999-2017 – TOP 15%, BOTTOM 15% VS. ALL COUNTIES – ASSAULT



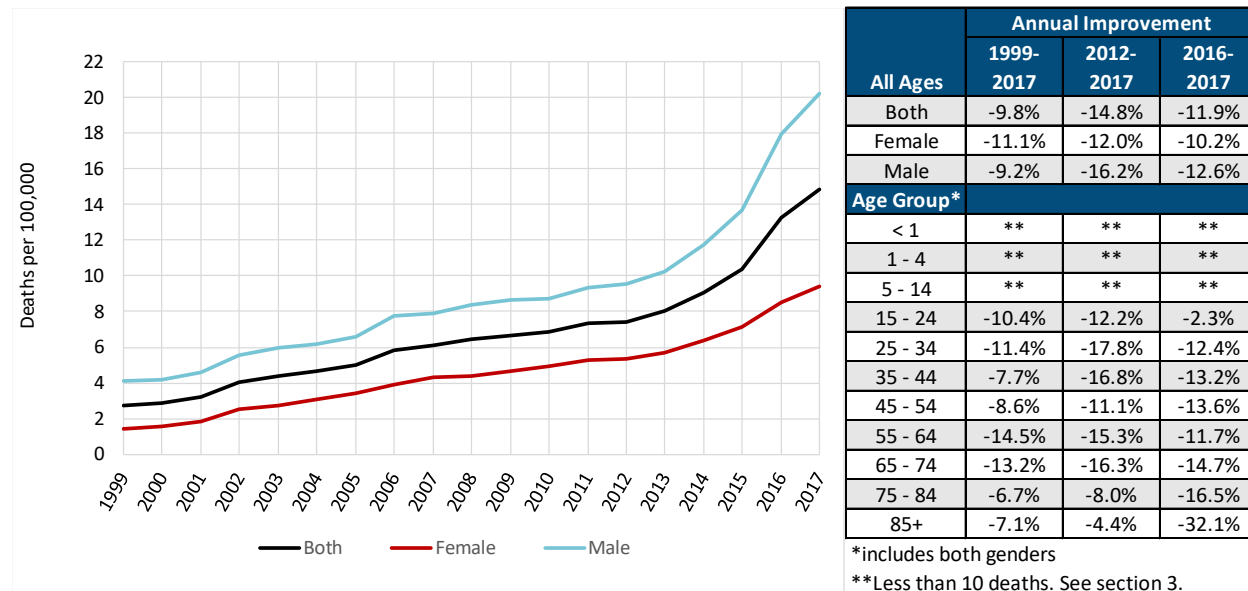
Observations:

- Over 1999-2017, the overall (both genders) Bottom 15% assault mortality rate increased more than the Top 15% rate. The Bottom 15% rate increased at a 0.7% average rate, while the Top 15% rate decreased at a 0.6% average rate. Male and female rates also increased more (or decreased less) in the Bottom 15% than in the Top 15%.
- Over 1999-2017, assault mortality rates were lower for the Top 15% than the Bottom 15% for the overall (both gender) male and female groupings. This was also true for all age groups except 45-54 and 55-64 in 2011 which were impacted by the 9/11 terrorist attack.
- The ratio of the Bottom 15% to All Counties' mortality rates increased from 139.1% in 1999 to 152.4% in 2017. The ratio of the Top 15% to All Counties' mortality rates decreased slightly from 52.5% in 1999 to 45.5% in 2017.
- The impact of 9/11 was greater on males than females and had a greater impact on the Top 15% versus the Bottom 15%, due to the number of deaths in the New York metro area.

6.5 Opioids

6.5.1 Total Population Analysis

AGE-ADJUSTED MORTALITY 1999-2017



Observations:

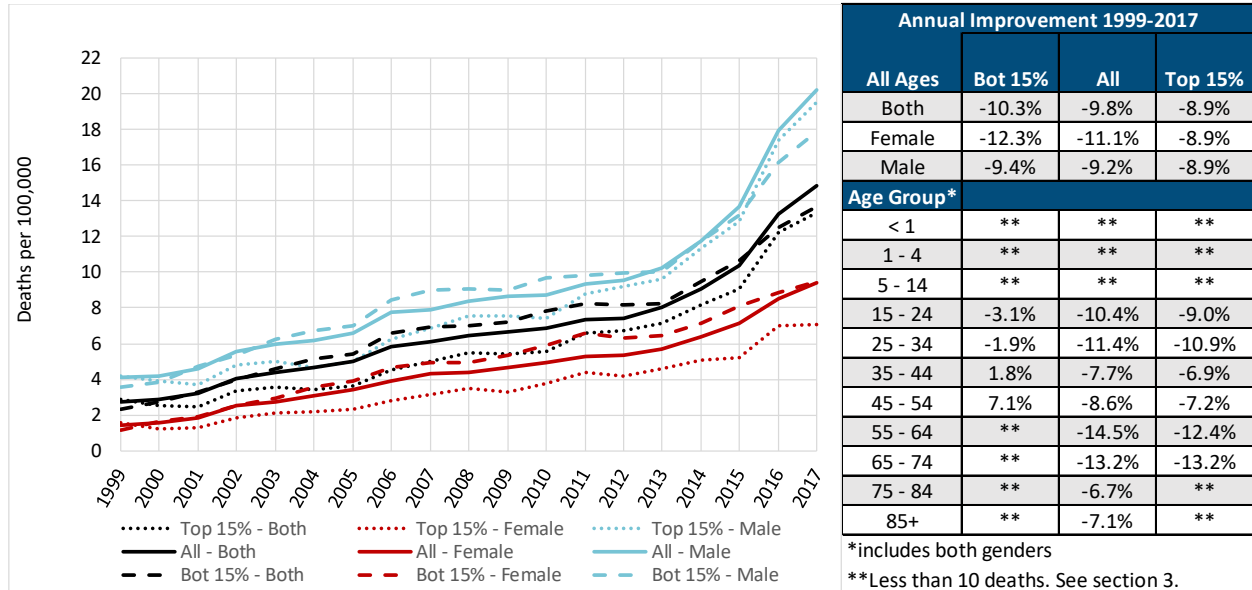
1. The overall (both genders) mortality rate due to opioid usage increased 11.9% in 2017, more than any other COD included in this report. The next highest increases occurred in the accident and suicide CODs, which each included opioid deaths, and increased 4.1% and 3.9%, respectively.
2. In 2017, the 11.9% overall (both genders) increase and the 12.6% male mortality increase were much lower than their respective 2016 increases of 27.4% and 31.1%.
3. The number of deaths due to opioids first exceeded the number of motor vehicle accidents¹¹ and firearm¹² deaths in 2016 and continued to exceed them in 2017. In 2017, there were 47,600 opioid deaths, while motor vehicle accidents and firearms deaths were 40,231 and 39,220, respectively. The age groups between 25-54 accounted for 73% of the 2017 opioid deaths.
4. Deaths due to opioid usage increased across all age groups in 2017, and the older age groups exhibited the largest increases. Each age group except 45-54, 75-84, and 85+ saw a lower increase in mortality in 2017 relative to their average increase over 2012-2017.
5. The ratio of female mortality rates to male rates ranged between 34% and 57% from 1999-2017. It peaked in 2010 at 56.8% and, since then, dropped to 46.6% in 2017.

¹¹ ICD-10 113 Cause List: Motor vehicle accidents - (V02-V04,V09.0,V09.2,V12-V14,V19.0-V19.2,V19.4-V19.6,V20-V79,V80.3-V80.5,V81.0-V81.1,V82.0-V82.1,V83-V86,V87.0-V87.8,V88.0-V88.8, V89.0,V89.2)

¹² ICD-10 113 Cause List: Accidental discharge of firearms - (W32-W34), Intentional self-harm (suicide) by discharge of firearms (X72-X74), Assault (homicide) by discharge of firearms (*U01.4, X93-X95), Discharge of firearms, undetermined intent (Y22-Y24)

6.5.2 Income Analysis

AGE-ADJUSTED MORTALITY 1999-2017 – TOP 15%, BOTTOM 15% VS. ALL COUNTIES – OPIOIDS

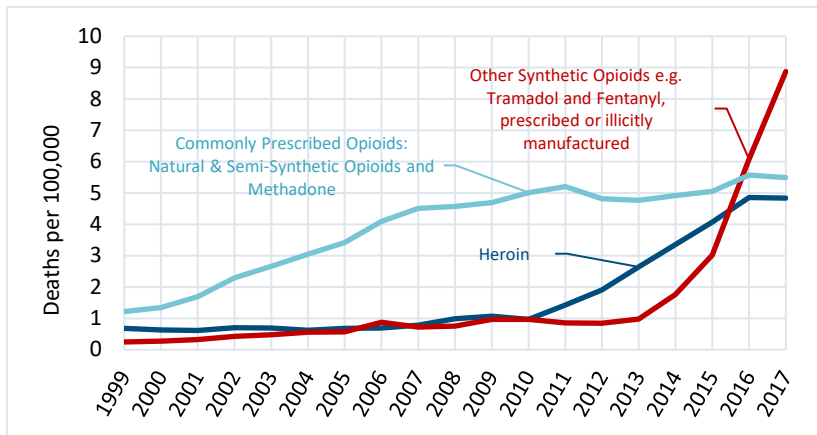


Observations:

- Over 1999-2017, the overall (both genders) Bottom 15% opioid mortality rate increased more than the Top 15% rate. The Bottom 15% rate increased at a 10.3% average rate, while the Top 15% rate increased at an 8.9% average rate. Male and female rates also increased more in the Bottom 15% than in the Top 15%.
- From 1999-2017, the Top 15%, the Bottom 15%, and the All Counties' opioid mortality rates were relatively close in each of the overall (both genders), female, and male groups. The greatest absolute difference in mortality rates was only 2.4 deaths, which occurred in 2017, for females. Here, the Bottom 15% mortality rate was 9.5 and the Top 15% rate was 7.1.
- From 1999-2017, the Top 15%, the Bottom 15%, and the All Counties' mortality rates were relatively close in each of the age groups. The greatest absolute difference in mortality rates was 21.2, which occurred in 2017 for the 45-54 age group. Here, the Bottom 15% rate was 2.8 and the All Counties' rate was 24.1.

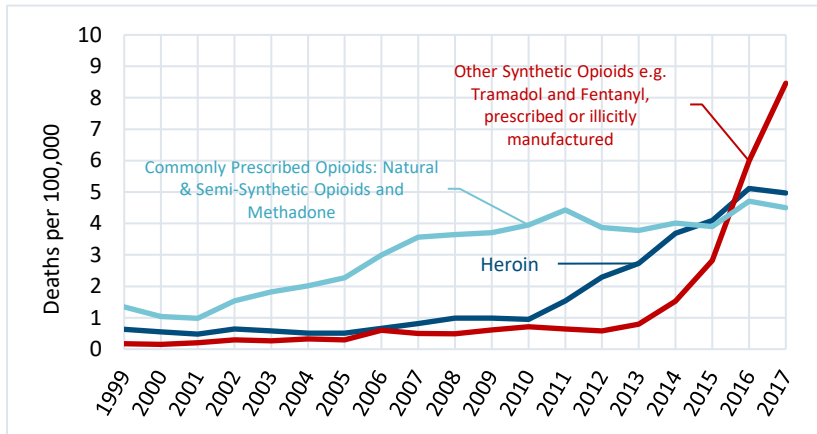
6.5.3 Opioid by Income and Type Analysis

ALL COUNTIES – AGE-ADJUSTED MORTALITY 1999-2017



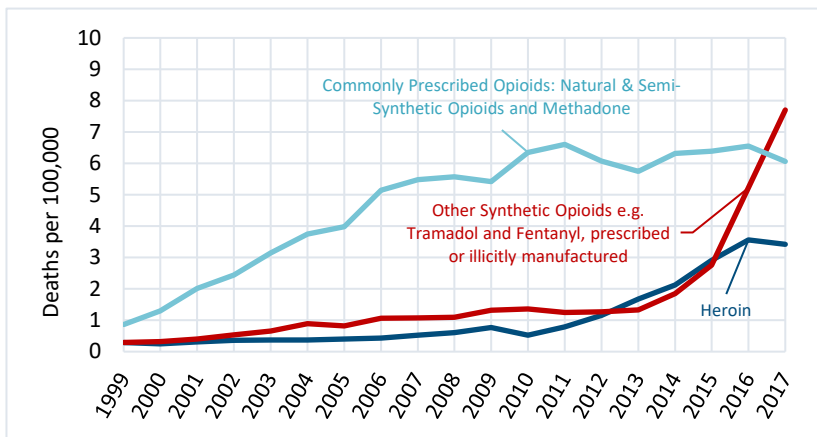
- In All Counties, the sharp rise in other synthetic opioid deaths since 2013 continued in 2017.
- Overdoses from commonly prescribed opioids and heroin leveled off in 2017.

TOP 15 COUNTIES – AGE-ADJUSTED MORTALITY 1999-2017



- In the Top 15%, similar to All Counties, the sharp rise in other synthetic opioid deaths since 2013 continued in 2017.
- Overdoses from commonly prescribed opioids and heroin were down slightly in 2017 in the Top 15%.

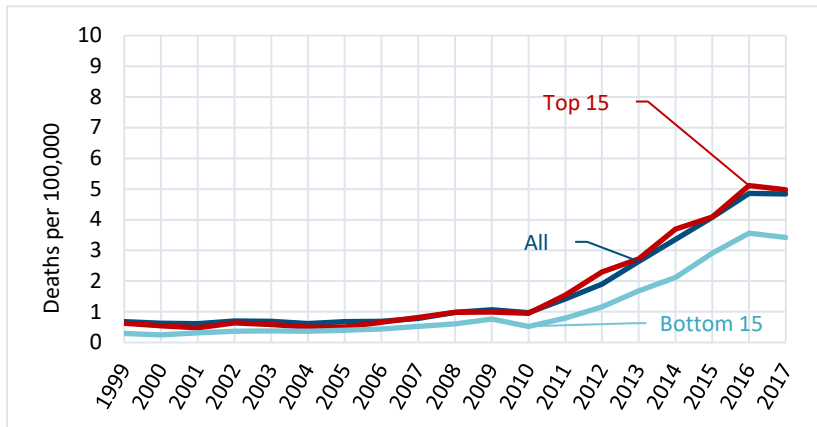
BOTTOM 15 – AGE-ADJUSTED MORTALITY 1999-2017



- The Bottom 15%, similar to All Counties, also saw a steep increase since 2013 in other synthetic opioid deaths continue in 2017.
- Other synthetic opioid deaths surpassed overdoses from commonly prescribed opioids in 2017 and became the top killer in all three county groups in 2017.

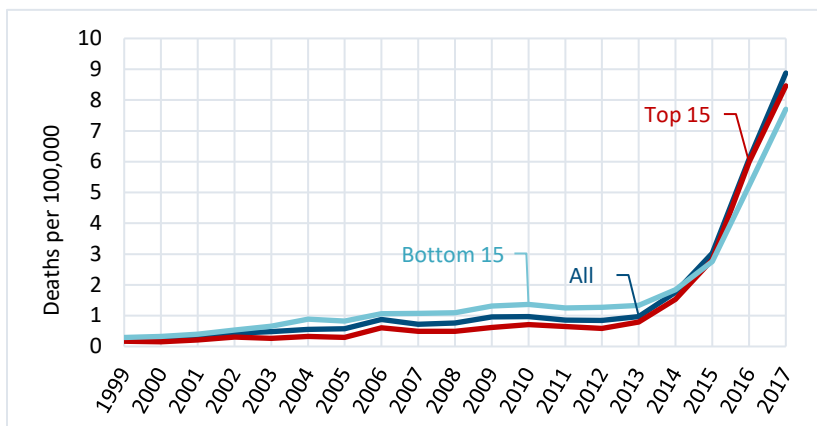
6.5.4 Opioid by Type and Income Analysis

HEROIN – AGE-ADJUSTED MORTALITY 1999-2017



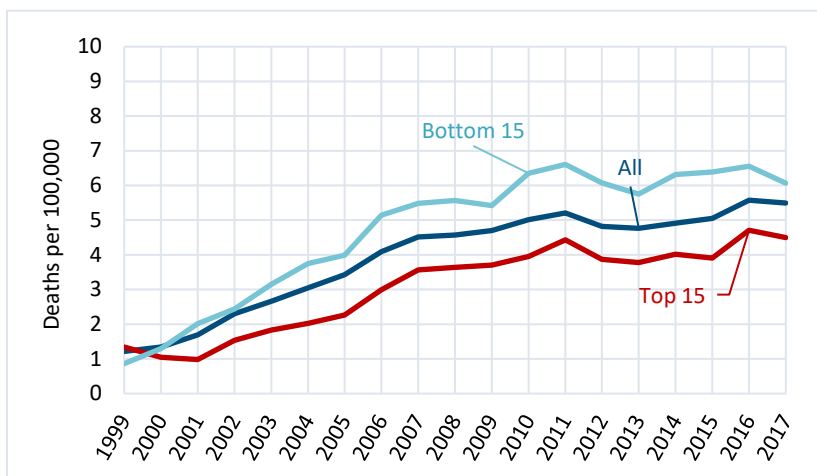
- Heroin mortality rates for the Top 15% and All Counties were higher than the Bottom 15% and the difference has increased since 2009.

OTHER SYNTHETIC OPIOIDS e.g. TRAMADOL AND FENTANYL, PRESCRIBED OR ILLICITLY MANUFACTURED – AGE-ADJUSTED MORTALITY 1999-2017



- Other synthetic opioid mortality rates did not vary much by income.

COMMONLY PRESCRIBED OPIOIDS: NATURAL & SEMI-SYNTHETIC OPIOIDS AND METHADONE – AGE-ADJUSTED MORTALITY 1999-2017



- For commonly prescribed opioids, the Bottom 15% had higher mortality rates than the Top 15%, although the difference narrowed in 2017.

Section 7: 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 some limited instances where the mortality rates, associated mortality improvement, or comparative results between the Top 15%, 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, analyzed in section 6.5, 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 analysis shown in section 6.2.3. 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 causes 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 and 2017 in section 6.2.3, 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.

The Top and Bottom 15% were determined by ranking counties based on their average county-level median household income. It should be noted that some counties, especially the large ones, will contain households with a wide range of income levels and the average median income for those counties may be quite different than the income level in each individual household in those counties.

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