SOCIETY OF ACTUARIES®

# U.S. Population Mortality Rates 2000-2016

February 2019

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# Preface: Substantive Revisions Made to this Report Subsequent to 9/28/2018 Release

## February 2019 Updates

As a result of further discussions with the Social Security Administration, the SOA has issued corrections to mortality rates for males and females aged 65 and older. The revised rates now properly account for the definition for age at death used by the Centers for Medicare and Medicaid Services (CMS). The Excel file accompanying this report reflects the corrected rates.

Due to this change, a third adjustment to the CMS data has been included in the bulleted list in Section 2: Data Sources. The tables of mortality improvement rates have also been updated with revised values for ages over 65.

A comment was received that the term “crude mortality rates” implies “central death rates”. These mortality rates are intended to be 1-year probabilities of death. References to “crude” mortality rates have been removed and a clarifying comment has been added in Section 1.

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## Section 1: Purpose of the Study

This report contains historical U.S. population mortality rates by gender and single year of age for calendar years 2000-2016. These rates represent 1-year probabilities of death. This is an update to a series of such publications; the prior iteration consisting of 2000-2015 mortality rates can be found here. The key updates from the previous publication are the finalization of 2015 mortality rates and addition of preliminary mortality rates for 2016.

## Section 2: Data Sources

These mortality rates are based on the same data sets underlying the historical probabilities of death published by the Social Security Administration (SSA). The death counts for ages 0-64 were taken from the National Center for Health Statistics via the "Multiple Cause of Death" data published in the CDC WONDER database. The corresponding population counts for years 2000-2009 are taken from the same source. The 2010-2016 population counts were taken from the Census Bureau's 2017 Vintage July 1 population estimates.

For ages 65 and up, the SOA requested counts of enrollments and deaths from the Centers for Medicare & Medicaid Services (CMS)[1]. The SOA chose to use this data set for the over-65 population because Medicare enrollment requires verification of date of birth, so age information can be more reliable in the CMS data than that for other sources, particularly for the oldest subset of the population.

Use of two different data sets required adjustments to the crude CMS data to ensure it was on the same basis as the CDC data. In order to ensure that data was being interpreted correctly, the SOA consulted the SSA regarding the adjustments made to the CMS data for their mortality calculations. The adjustments include:

- A multiplier for deaths at age 65 to reflect that CMS does not capture all age-65 deaths due to enrollment timing
- Estimating July 1 enrollment counts from tabulated January 1 enrollment counts, as the CDC population counts are as of July 1 for a given year.
- Estimating death counts by age-last-birthday at death from CMS tabulations of death counts by age at calendar year-end

It is important to remember that these historical mortality rates are unsmoothed rates. The SSA uses the same data sources and similar adjustments to compute their historical probabilities of death, but the rates that they calculate are graduated within a given calendar year per the process outlined in Actuarial Study No. 120. No such smoothing was done for this publication.

[1] The SOA relied upon the 2017 Q4 CMS data which contained final death counts for 2015 and final enrollment counts as of January 1, 2016. The 2018 Trustees Report used the 2016 Q4 CMS data which contained the preliminary version of that information. The difference in mortality rates for 2015 between these data sets is no more than 0.0003 for ages 65-68 (due to retroactive enrollments), no more than 0.0004 for ages 96-100 (due to death tabulation updates), and no more than 0.0001 at any other age. The underlying data for ages 65 and up is the same for all other years besides 2015.

Finally, it should be noted that the mortality rates calculated for 2016 should be considered preliminary. CMS trues up their most recent year of data in the following year to reflect retroactive enrollments and small data corrections. The SOA studied the pattern of historical changes between preliminary and final enrollment counts and CMS confirmed that our observations were likely to persist in future years. Therefore, the 2016 enrollment counts for ages 65-69 were increased based on the observed historical pattern in anticipation of these counts increasing when final data is made available in 2018.

## Section 3: Analysis

Mortality improvement rates can be used to analyze how mortality changes from year-to-year. Positive mortality improvement indicates a drop in mortality rates, while negative mortality improvement indicates a year-to-year increase in mortality. Below are some observations on recent mortality improvement trends.

### 3.1 Key Observations – Males

The three tables below show annual mortality improvement rates between 2013 and 2016 for males. In aggregate, mortality for males remained relatively constant from 2015 to 2016, though there were varying changes by age group. The young adult group from ages 20-44 experienced a large increase in mortality; a primary underlying cause of this change is a continuing increase in deaths from self-harm and accidents. However, retirement-aged individuals experienced a lower death rate in 2016 than 2015, with an aggregate improvement rate of 1.5% for males aged 65 and up.

| Male Mortality Improvement - Five-Year Age Groups | | | |
|---|---|---|---|
| Age Band | 2013 -> 2014 | 2014 -> 2015 | 2015 -> 2016 |
| 20-to-24 | -0.6% | -7.1% | -8.6% |
| 25-to-29 | -1.9% | -7.6% | -11.1% |
| 30-to-34 | -2.5% | -8.2% | -10.5% |
| 35-to-39 | -3.8% | -7.0% | -10.3% |
| 40-to-44 | 0.0% | -3.1% | -6.1% |
| 45-to-49 | 1.2% | 0.5% | -1.9% |
| 50-to-54 | 0.5% | -0.5% | 0.4% |
| 55-to-59 | -0.6% | 0.2% | -0.4% |
| 60-to-64 | -1.2% | -1.1% | -0.3% |
| 65-to-69 | 0.9% | -0.7% | -0.6% |
| 70-to-74 | 0.6% | 0.3% | 1.5% |
| 75-to-79 | 1.0% | 0.0% | 1.3% |
| 80-to-84 | 1.3% | -0.4% | 2.4% |
| 85-to-89 | 1.8% | -0.6% | 2.1% |
| 90-to-94 | 1.6% | -1.4% | 1.7% |
| 95-to-100 | 0.8% | -2.4% | 2.7% |
| **All Ages** | **0.6%** | **-0.9%** | **0.2%** |

| Male Mortality Improvement - Broad Age Groups | | | |
|---|---|---|---|
| Age Band | 2013 -> 2014 | 2014 -> 2015 | 2015 -> 2016 |
| 20-to-44 | -1.6% | -6.2% | -9.0% |
| 45-to-64 | -0.3% | -0.4% | -0.4% |
| 65-to-84 | 1.0% | -0.2% | 1.3% |
| 85-to-100 | 1.6% | -1.1% | 2.0% |
| **All Ages** | **0.6%** | **-0.9%** | **0.2%** |

| Male Mortality Improvement - Under/Over 65 | | | |
|---|---|---|---|
| Age Band | 2013 -> 2014 | 2014 -> 2015 | 2015 -> 2016 |
| Under 65 | -0.6% | -1.7% | -2.4% |
| 65 and Over | 1.2% | -0.5% | 1.5% |
| **All Ages** | **0.6%** | **-0.9%** | **0.2%** |

### 3.2 Key Observations – Females

The three tables below show annual mortality improvement rates between 2013 and 2016 for females. Females increased greater aggregate mortality improvement than males from 2015 to 2016, primarily due to a less severe increase in mortality for the 20-44 age group. Directionally, mortality improvement patterns from 2015 to 2016 were similar for males and females in that five-year age groups below age 65 generally showed an increase in mortality and all five-year age groups above age 65 showed a decrease in mortality.

| Female Mortality Improvement - Five-Year Age Groups | | | |
|---|---|---|---|
| Age Band | 2013 -> 2014 | 2014 -> 2015 | 2015 -> 2016 |
| 20-to-24 | -0.2% | -5.8% | -7.3% |
| 25-to-29 | -2.8% | -5.2% | -9.2% |
| 30-to-34 | -1.6% | -9.5% | -8.4% |
| 35-to-39 | -3.8% | -1.6% | -8.9% |
| 40-to-44 | -2.8% | -0.5% | -2.0% |
| 45-to-49 | 0.1% | -0.1% | -0.4% |
| 50-to-54 | -1.0% | -0.1% | -0.2% |
| 55-to-59 | -2.3% | -0.8% | -0.7% |
| 60-to-64 | -1.2% | -0.5% | -1.2% |
| 65-to-69 | 1.8% | 0.4% | 0.8% |
| 70-to-74 | 0.6% | -0.3% | 1.9% |
| 75-to-79 | 1.7% | -0.5% | 1.6% |
| 80-to-84 | 0.9% | -0.9% | 1.8% |
| 85-to-89 | 2.5% | -2.1% | 2.1% |
| 90-to-94 | 1.7% | -2.3% | 2.6% |
| 95-to-100 | 2.4% | -3.1% | 2.4% |
| **All Ages** | **1.0%** | **-1.3%** | **1.2%** |

| Female Mortality Improvement - Broad Age Groups | | | |
|---|---|---|---|
| Age Band | 2013 -> 2014 | 2014 -> 2015 | 2015 -> 2016 |
| 20-to-44 | -2.5% | -3.5% | -6.2% |
| 45-to-64 | -1.3% | -0.4% | -0.7% |
| 65-to-84 | 1.2% | -0.5% | 1.6% |
| 85-to-100 | 2.2% | -2.3% | 2.3% |
| **All Ages** | **1.0%** | **-1.3%** | **1.2%** |

| Female Mortality Improvement - Under/Over 65 | | | |
|---|---|---|---|
| Age Band | 2013 -> 2014 | 2014 -> 2015 | 2015 -> 2016 |
| Under 65 | -1.5% | -1.0% | -1.8% |
| 65 and Over | 1.7% | -1.4% | 2.0% |
| **All Ages** | **1.0%** | **-1.3%** | **1.2%** |

## Section 4: Mortality Improvement Calculation Methodology

The SOA computed the above mortality improvement rates by calculating the age-adjusted death rates (ADRs) for each age group within each year. This methodology is described in the following paper published by the Centers for Disease Control and Prevention and written by Lester R. Curtin, Ph.D. and Richard J. Klein, M.P.H.: https://www.cdc.gov/nchs/data/statnt/statnt06rv.pdf

The SOA applied the direct standardization method described on pages 2-3 of the paper using 2012 population counts (as described above under "Data Sources") as the reference population. 2012 was selected to ensure consistency with previous iterations of this study. The unrounded mortality rates for each age band were weighted by 2012 population counts. For each age band 'x' and calendar year 'y', the mortality improvement rate $f_{(x,y)}$ was calculated from the weighted mortality rates $q_{(x,y)}$:

$$f_{(x,y)} = 1 - \frac{q_{(x,y)}}{q_{(x,y-1)}}$$

## Section 5: Questions

If you have any questions on these historical U.S. population mortality rates, please contact Patrick Nolan at (847) 273-8860 or pnolan@soa.org.

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