SOCIETY OF ACTUARIES®

U.S. Population Mortality Rates 2000-2015

July 2017

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Section 1: Purpose of the Study

This report contains historical U.S. population crude mortality rates by gender and single year of age for calendar years 2000-2015. This is an update to the November, 2016 publication, which can be found here. The key updates from the previous publication are the finalization of 2014 mortality rates and addition of preliminary mortality rates for 2015.

Section 2: Data Sources

These crude 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 population counts for years 2000-2009 are taken from the same source. The 2010-2015 population counts were taken from the Census Bureau's 2016 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. Because the SSA works closely with these two sources of data, 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.

It is important to remember that these historical mortality rates are crude 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.

Finally, it should be noted that the mortality rates calculated for 2015 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.

[1] The SOA relied upon the 2016 Q4 CMS data which contained final death counts for 2014 and final enrollment counts as of January 1, 2015. The 2017 Trustees Report used the 2015 Q4 CMS data which contained the preliminary version of that information. The difference in crude mortality rates for 2014 between these data sets is no more than 0.00040 for ages 65-68 (due to retroactive enrollments), no more than .00050 for ages 98-100 (due to death tabulation updates), and no more than 0.0001 at any other age. The underlying data is the same for all other years besides 2014.

Therefore, the 2015 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 2012 and 2015 for males. In aggregate, mortality for males increased from 2014 to 2015. The young adult group from ages 20-44 experienced the greatest rise in mortality; a primary underlying cause of this increase is a significant rise in deaths from self-harm and accidents. Aggregate mortality improvement from 2014 to 2015 was negative for the first time since 1999 for retirement-age individuals (65 and Over) and for the first time since 1993 for the population as a whole.

Male Mortality Improvement - Five-Year Age Groups			
Age Band	2012 -> 2013	2013 -> 2014	2014 -> 2015
20-to-25	2.1%	-1.3%	-6.8%
26-to-30	-0.5%	-1.1%	-7.8%
31-to-35	-1.9%	-3.6%	-7.8%
36-to-40	0.2%	-2.9%	-6.0%
41-to-45	-0.4%	-0.2%	-2.5%
46-to-50	0.3%	1.6%	0.5%
51-to-55	0.5%	0.0%	-0.1%
56-to-60	-0.7%	-0.5%	-0.1%
61-to-65	0.3%	-2.0%	-1.7%
66-to-70	0.4%	1.9%	-0.8%
71-to-75	-0.6%	0.5%	0.6%
76-to-80	0.1%	0.4%	0.4%
81-to-85	0.3%	1.7%	-1.0%
86-to-90	-0.8%	2.1%	-0.3%
91-to-95	0.8%	1.7%	-1.6%
96-to-100	0.4%	0.6%	-1.3%
All Ages	**0.0%**	**0.6%**	**-0.9%**

Male Mortality Improvement - Broad Age Groups			
Age Band	2012 -> 2013	2013 -> 2014	2014 -> 2015
20-to-44	-0.1%	-1.7%	-6.3%
45-to-64	-0.4%	-0.3%	-0.4%
65-to-84	0.3%	0.8%	-0.1%
85-to-100	0.1%	1.8%	-1.1%
All Ages	**0.0%**	**0.6%**	**-0.9%**

Male Mortality Improvement - Under/Over 65			
Age Band	2012 -> 2013	2013 -> 2014	2014 -> 2015
Under 65	-0.4%	-0.6%	-1.7%
65 and Over	0.2%	1.2%	-0.5%
All Ages	**0.0%**	**0.6%**	**-0.9%**

3.2 Key Observations – Females

The three tables below show annual mortality improvement rates between 2012 and 2015 for females. The female population exhibited many of the same patterns as the male population. Like with males, female retirement-age mortality improvement was generally positive prior to the deterioration from 2014-2015. There was a significant rise in female mortality in the young adult age band, though this was not as severe as the corresponding increase for males. The -2.2% mortality improvement for females aged 85-100 is the largest single-year deterioration this century for that age group.

Female Mortality Improvement - Five-Year Age Groups			
Age Band	2012 -> 2013	2013 -> 2014	2014 -> 2015
20-to-25	1.1%	-1.1%	-6.0%
26-to-30	1.6%	-1.5%	-6.1%
31-to-35	-3.2%	-2.5%	-6.1%
36-to-40	-1.8%	-2.7%	-2.4%
41-to-45	0.2%	-2.5%	-0.2%
46-to-50	0.8%	0.1%	-0.3%
51-to-55	-1.2%	-1.7%	0.7%
56-to-60	-0.7%	-2.0%	-1.1%
61-to-65	1.0%	-0.7%	-0.8%
66-to-70	0.5%	2.3%	-0.1%
71-to-75	-0.3%	0.5%	-0.1%
76-to-80	0.4%	0.8%	0.0%
81-to-85	0.2%	1.1%	-1.6%
86-to-90	-0.1%	2.8%	-1.7%
91-to-95	0.7%	1.9%	-2.6%
96-to-100	-0.8%	2.1%	-2.3%
All Ages	**0.1%**	**1.0%**	**-1.3%**

Female Mortality Improvement - Broad Age Groups			
Age Band	2012 -> 2013	2013 -> 2014	2014 -> 2015
20-to-44	-0.6%	-2.5%	-3.4%
45-to-64	-0.4%	-1.3%	-0.5%
65-to-84	0.4%	1.0%	-0.4%
85-to-100	0.1%	2.3%	-2.2%
All Ages	**0.1%**	**1.0%**	**-1.3%**

Female Mortality Improvement - Under/Over 65			
Age Band	2012 -> 2013	2013 -> 2014	2014 -> 2015
Under 65	-0.5%	-1.5%	-1.0%
65 and Over	0.2%	1.7%	-1.3%
All Ages	**0.1%**	**1.0%**	**-1.3%**

Section 4: Mortality Improvement Calculation Methodology

The SOA computed the above crude 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 because it is the earliest pertinent year in the three-year improvement trend tables shown above; it is intended that future iterations of this publication will continue to use 2012 as a reference population to keep figures consistent. 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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