Mortality and Longevity

Aging and Retirement

RPEC 2025 Mortality Improvement Update

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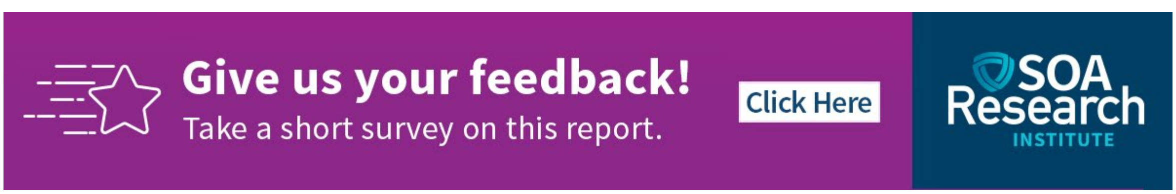

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Section 1: Executive Summary

This report presents an analysis of recent population mortality experience compiled by the Retirement Plans Experience Committee (RPEC or the Committee) of the Society of Actuaries Research Institute (SOA), with respect to the development of mortality improvement assumptions for measuring obligations of retirement programs in the United States (U.S.). Each year from 2015 through 2021, RPEC released an update to Mortality Improvement Scale MP-2014 (SOA 2014) that incorporated the latest available historical mortality data. These scales were produced by the RPEC_2014 model which, in 2021, was incorporated into the MIM-2021 model (SOA 2021). The most recent scale released by RPEC is MP-2021 (SOA 2021b), reflecting mortality data through 2019.

The MP-scale is produced using Medicare data which provides death counts and exposure counts that originate from individual beneficiary records, thereby ensuring strong internal consistency between the numerators and denominators used to compute death rates. However, the Medicare dataset has a reporting lag of over two years.

Because recent data is essential for the analysis presented in this report, RPEC used national-level data for death counts from the Centers for Disease Control and Prevention (CDC) for the purpose of reporting on recent mortality experience. In contrast to Medicare data, CDC data has a short reporting lag; however, the exposure (associated with the deaths) must be estimated, as explained in Section 3. This introduces some uncertainty into the A/E results presented in this report; consequently, the results should be viewed as best estimates as opposed to hard data.

Using CDC national-level death count data paired with estimates of U.S. population counts by sex, age, and year from the Social Security Administration (SSA), RPEC estimates that excess mortality (measured relative to 2019 mortality levels, adjusted across time using MP-2021) for the age 65+ population has fallen from more than 20% during the peak of the COVID-19 pandemic to only 1.3% for the period from July 2024 to June 2025 (the most recent 12-month period analyzed for this report). This is a 0.5% decrease in excess mortality relative to the period from July 2023 to June 2024.[1]

While the worst effects of the pandemic on mortality have subsided, there is not yet sufficient post-pandemic data upon which to develop an updated MP scale. Therefore, RPEC will not release a new scale in 2025. The next section of this report discusses the potential timing of the release of the next MP scale.

[1] While the previous report estimated excess mortality to be 2.5% for the period from July 2023 to June 2024, the updated estimate for that period is now 1.8%. The decrease is primarily due to the use of updated population estimates from the SSA. In its 2025 Trustees Report, the SSA revised its population estimates for years 2024 and earlier. Refer to section 3.3 for further details of the effects on prior period A/E estimates.

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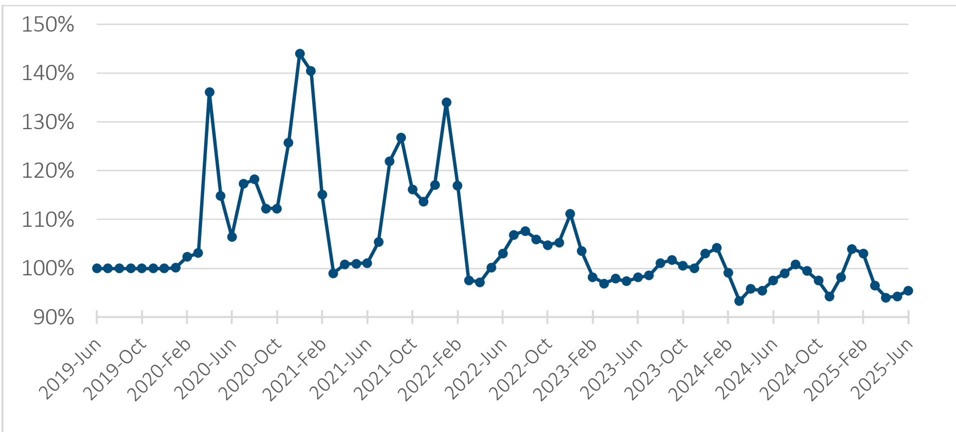
Section 2: Potential Timing of Release of an Updated MP-Scale

RPEC continues to monitor emerging mortality experience in the U.S. general population, periodically analyzing data as it becomes available from the CDC, the U.S. Census Bureau, the Centers for Medicare and Medicaid Services (CMS), and the SSA.

In the late winter / early spring of 2020, the COVID-19 pandemic began to exert a material impact on U.S. mortality experience. As shown in Figure 1, spikes in mortality persisted through early 2022 driving up the overall average excess mortality for the year; however, since that time U.S. population mortality rates have returned to levels more consistent with 2019, and have exhibited the seasonal pattern usually seen in the U.S.

Figure 1

Monthly Death Rate for the 65+ Population as % of the Corresponding Monthly Death Rate in 2019



The results in Figure 1 were produced using CDC death count data and Social Security Area Population data, as explained in Section 3.1. The results are age-standardized to remove noise caused by year-to-year changes in the population's age structure. The Appendix provides a detailed description of the age-standardization process.

RPEC continues to analyze and accumulate U.S. population experience data and believes this emerging information for the years after 2022, once collected in sufficient quantity, might reasonably be used in its traditional mortality improvement analysis. However, 2024 mortality data (the second full year since the pandemic) will not become available from CMS until 2026. As described in the MP-2021 report, the production of the MP improvement scale utilizes Order 3 Whittaker-Henderson graduation which smooths information across multiple years. To mitigate edge effects, the scale development process utilizes a two-year step back which reduces the impact of the most recent two years of data on the resulting improvement scale. These methodological choices essentially mean that the data set used in RPEC's algorithm needs to include at least five years of post-COVID experience so as not to be unduly impacted by nonrecurring pandemic-related experience. Because of these factors, RPEC would not expect to produce an updated scale in 2026 with its traditional methods using only two years of "post-pandemic" data.

Some practitioners have noted that while post-pandemic data accumulates, due to the passage of time the current year is close to the end of the horizontal convergence period over which the MP-2021 model algorithm assumes mortality improvement rates converge to their ultimate assumed level. Some have suggested that RPEC extend the convergence period in the scale to extend the period to which the ultimate mortality improvement rates apply. While individual practitioners can make such an adjustment through the MIM-2021 model and develop alternate projected mortality rates, RPEC does not believe the mortality rates developed from such modified assumptions are inherently better predictors of future mortality rates compared to using the MP-2021 Scale as published.

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RPEC will continue to evaluate the emerging data as it becomes available and will consider whether alternative methods[2] could generate a meaningful update to the MP-2021 scale in 2026. Nonetheless, it is possible that RPEC could determine the best course would be to wait for three to five years of post-pandemic data prior to issuing an updated improvement scale. At the long end of that range, the data for 2027 would not be available from CMS until 2029, with the likely result being an updated MP scale reflecting our traditional methods in the fall of that year.

Section 3: Recent U.S. Mortality Trends

This section of the report provides RPEC's analysis of recent U.S. mortality experience, with a focus on excess mortality and how it has abated over time. The data sources and methodology used to produce the results remain unchanged relative to last year's report, although the results shown for historical periods have changed slightly relative to last year's report largely due to updated historical population counts from the SSA.

3.1 DATA SOURCES

The Medicare dataset used to produce the MP-scale provides both death counts and exposure counts tied together via a system of individual-level beneficiary records. The tight relationship between the death and exposure data is a key reason that RPEC uses Medicare data to produce the MP-scale. However, the Medicare dataset has a reporting lag of over two years.

Because timely data is essential for the analysis presented in this report, RPEC used death count data from the Centers for Disease Control and Prevention (CDC) for this purpose. CDC data has a relatively short reporting lag and captures deaths across the entire U.S. resident population. However, unlike the Medicare dataset, exposure associated with CDC death data must be estimated. Possible sources for exposure data include (1) estimates of the U.S. resident population produced by the Census Bureau and (2) the Social Security Administration's (SSA) estimates of the Social Security Area population (which is a slightly broader population definition compared to that used by the Census Bureau). For reasons elaborated in Section 6.2 of the Appendix, RPEC selected the SSA's population estimates to facilitate the analysis presented in this report.

To compute death rates for this analysis, CDC-reported death counts (by sex, single-age, and year) were divided by the SSA's population estimates (by sex, single-age, and year), and the results were then averaged across broad age groups. The estimated death rates for broad age groups were age-standardized to remove noise caused by gradual shifts in the age/sex structure of the population. As explained in Section 6.3 of the Appendix, the results were age-standardized using 2019 population counts (by age and sex) as the weights.

[2] Such alternative methods might include assigning zero weight to the pandemic years of data and applying the current graduation processes. Another possibility might be to fill the years 2020 through 2022, inclusive, with expected mortality data based on the MP-2021 analysis and then perform the graduation while including data for 2023, as well as data for 2024 when it becomes available in the spring of 2026.

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3.2 ANNUAL REFINEMENTS OF HISTORICAL U.S. POPULATION ESTIMATES

The U.S. population is large and dynamic; consequently, it is challenging to develop estimates of population counts with a short reporting lag. On an annual basis, the SSA refines and updates its estimates (both historical and projected) of the Social Security Area population (SSAP) and releases the results as a component of its annual OASDI Trustees Report. It is not uncommon for previously reported SSAP estimates for recent years to shift slightly from one Trustees Report to the next.

For RPEC's 2024 report (SOA 2024), SSAP data was obtained from the 2024 OASDI Trustees Report (SSA 2024); for the current RPEC report, SSAP data was obtained from the 2025 Trustees Report (SSA 2025). Across the two Trustees reports, some small shifts occurred to SSAP estimates for the 65+ population. For the period from 2019 through 2022, the estimated 65+ population decreased slightly, while for 2023 and 2024 it increased slightly, as can be seen in Table 1.

Table 1

Estimated Social Security Area Population Age 65+ (Millions) from 2019 to 2024

	2019	2020	2021	2022	2023	2024
2024 Trustees Report	54.31	55.98	57.51	59.17	60.88	62.63
2025 Trustees Report	54.24	55.89	57.40	59.12	60.97	62.84
2025 / 2024 Report	99.87%	99.84%	99.81%	99.92%	100.15%	100.34%

These adjustments to population estimates led to a modest downward shift in RPEC's estimates of A/E ratios for 2023 and 2024—that is, relative to RPEC's report from last year, estimated A/E ratios for 2023 and 2024 are now slightly lower, as discussed in the next section of the report and depicted in Figure 4. Similarly, these adjustments led to a modest upward shift in RPEC's estimates of A/E ratios for 2020-2022.

3.3 RESULTS FOR THE 65+ POPULATION

Using death count data from the CDC and population estimates extracted from the 2025 OASDI Trustees Report, RPEC analyzed recent mortality experience for the 65+ population, producing the A/E death ratios shown in Figures 2 and 3. Each value in these figures reflects the trailing 12 months of data, compared against the corresponding data from 2019. For example, the result for June 2025 reflects data from July 2024 through June 2025, compared against January-to-December data from 2019. Results are age-standardized (using the 2019 population counts, by age and sex, as weights) to eliminate noise related to shifts in the population age structure.

Two sets of historical A/E values are presented in Figures 2 and 3. The red dashed line shows values using 2019 data to compute expected deaths, without any adjustment for expected mortality improvement. In contrast, for the solid blue line, expected deaths were adjusted from 2019 levels to reflect mortality improvement anticipated by the MP-2021 projection scale. To compute expected deaths in 2024, for example, 2019 data was adjusted using MP-2021 to reflect expected improvement from 2019 through 2024.

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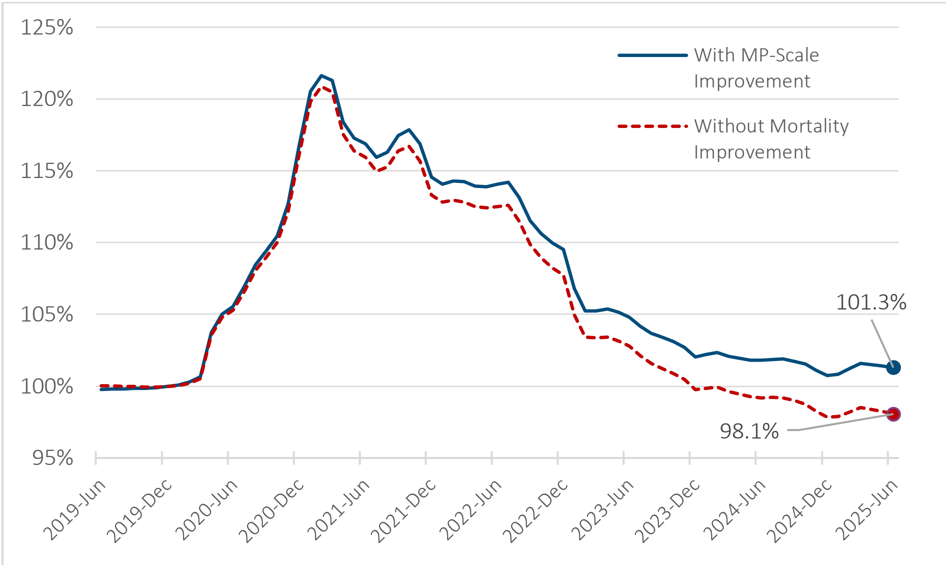
Figure 2

Ratio of Actual to Expected Deaths for Trailing 12-Month Periods for the 65+ Population



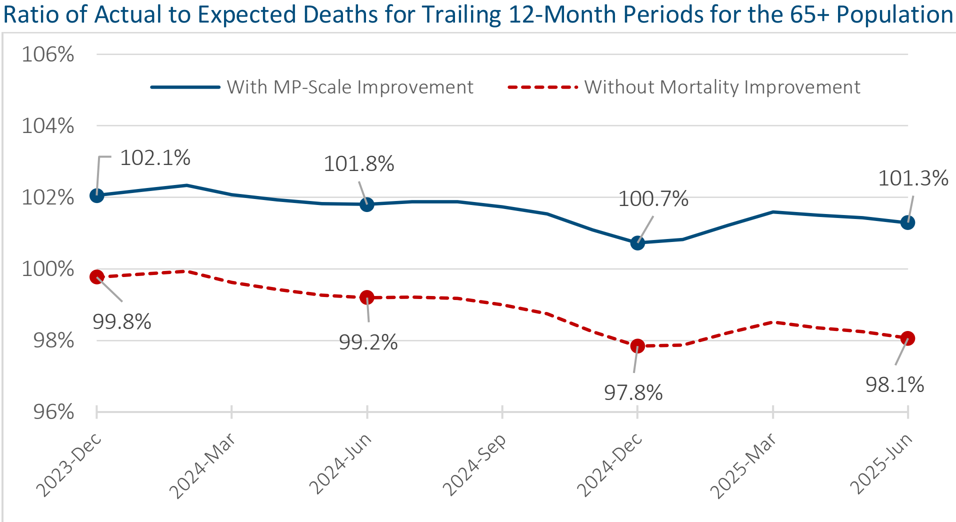
Actual deaths for the 65+ population have fallen to slightly below the level expected using 2019 mortality rates but remain 1.3% above the level expected using 2019 mortality rates projected forward with MP-2021.

The final data point in this figure captures the 12-month period from July 2024 to June 2025.

The dashed red line uses expected values computed directly from 2019 data, without adjustment based on the MP-2021 scale. The solid blue line also uses 2019 data to compute expected deaths but adjusts the deaths to reflect mortality improvement implied by the MP-2021 scale.

Figure 3

Ratio of Actual to Expected Deaths for Trailing 12-Month Periods for the 65+ Population



This is the same data that appears in Figure 2 but includes only the period from Dec 2023 onwards.

Figure 3 reflects the same data as Figure 2 but includes only the period from Dec 2023 onwards. The dashed red line uses expected values computed directly from 2019 data, without adjustment based on the MP-2021 scale. The solid blue line also uses 2019 data to compute expected deaths but adjusts the deaths to reflect mortality improvement implied by the MP-2021 scale.

A comparison of the results in Figures 2 and 3 (and in subsequent exhibits) against corresponding results presented in last year's RPEC report reveal differences for years 2023 and 2024. For these two years, refinements to exposure estimates (see Table 1) led to modest shifts in estimated A/E ratios, as depicted in Figure 4.

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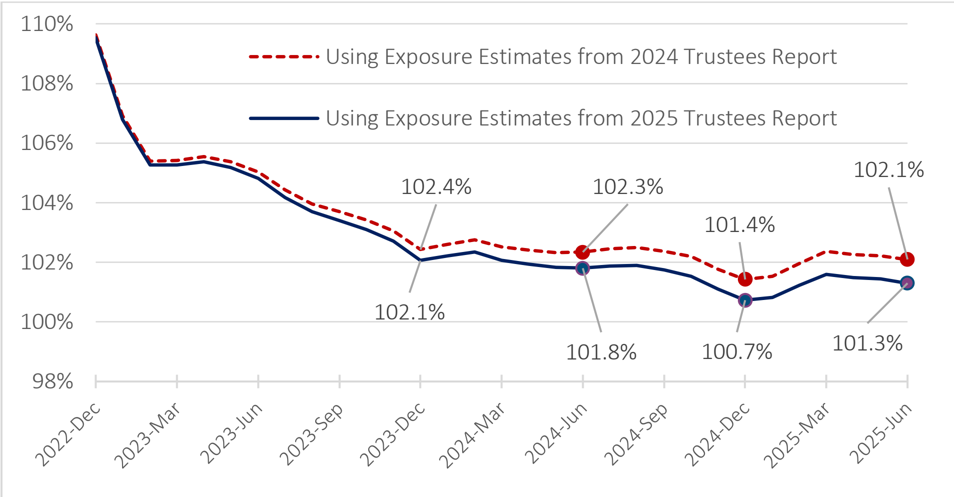
Figure 4
Ratio of Actual to Expected Deaths (with MP-2021 scale) for Trailing 12-Month Periods for the 65+ Population



Both lines in this graph use the MP-scale to compute expected deaths. The lines are differentiated by their associated exposure data: the red dashed line is based on exposure data from the 2024 Trustees Report, while the blue line is based on exposure data from the 2025 Trustees Report.

The final data point in Figure 4 covers the 12-month period from July 2024 to June 2025. For this data point, the A/E ratio is 102.1% when calculated with exposures from the 2024 Trustees Report, and 101.3% when calculated using exposures from the 2025 Trustees Report. RPEC updated its analyses presented throughout this report to reflect the 2025 SSAP data because it is assumed that the 2025 data reflects SSA's updated best estimate given the additional data and analysis they have conducted over the past year.

3.4 RESULTS BY GENDER AND 10-YEAR AGE GROUP

The results in Figures 2, 3, and 4 reflect the aggregate mortality experience of all cohorts aged 65 and above for males and females combined. To provide greater detail, Tables 2 and 3 below decompose the data into female versus male and into 10-year age groups. In addition, data for the working-age population is presented. Like the results in Figures 2 through 4, the results in Tables 2 and 3 are age-standardized to eliminate noise associated with shifts in age composition. The results do not precisely match the corresponding results presented in RPEC's 2024 report (SOA 2024) due to revisions in exposure estimates (as explained in Sections 3.2 and 3.3).

Table 2 uses 2019 data for expected deaths, identical to the approach used for the dashed red lines in Figures 2 and 3. Table 3 also uses 2019 data as the basis for computing expectations, but adjusts the data to reflect the mortality trends implied by the MP-2021 scale, identical to the approach used for the solid blue lines in Figures 2 and 3.

Roughly speaking, across the period from 2019 to 2025, the MP-2021 scale has negative rates of improvement for ages below 50, and positive rates of improvement for ages above 50. This relationship causes the values in Table 3 to be greater than the corresponding values in Table 2 for ages 55+ and has the opposite effect for lower ages. For example, the 2024 A/E value for males in the 35-to-44 age group is 111.1% in Table 2, but just 98.9% in Table 3. Conversely, the 2024 A/E value for males in the 75-to-84 age group is only 96.1% in Table 2, versus 100.0% in Table 3.

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Table 2

Ratios of Actual to Expected Deaths Using 2019 Data (without improvement) to Compute Expectations

	Females				Males			
Age	2022	2023	2024	July 2024 to June 2025	2022	2023	2024	July 2024 to June 2025
15-24	118.5%	110.3%	96.6%	92.2%	116.7%	110.7%	97.0%	93.2%
25-34	121.3%	107.7%	93.4%	88.8%	126.2%	114.0%	96.1%	90.1%
35-44	123.4%	112.8%	104.1%	101.7%	132.0%	123.1%	111.1%	106.8%
45-54	113.4%	102.0%	97.1%	96.4%	119.0%	108.4%	101.9%	100.4%
55-64	111.4%	100.8%	97.1%	96.7%	111.9%	101.7%	96.7%	96.4%
65-74	109.4%	100.8%	99.1%	99.4%	109.9%	101.2%	99.1%	99.8%
75-84	107.3%	99.4%	97.5%	98.1%	107.5%	98.2%	96.1%	96.0%
85+	107.0%	100.5%	98.9%	98.8%	106.3%	98.6%	96.4%	96.4%
20 to 64	114.0%	103.0%	97.5%	96.5%	117.4%	107.2%	99.4%	97.6%
55+	108.1%	100.3%	98.3%	98.5%	108.6%	99.7%	97.1%	97.2%
65+	107.6%	100.2%	98.5%	98.7%	107.8%	99.3%	97.2%	97.3%

Table 3

Ratios of Actual to Expected Deaths Using 2019 Data and the MP-2021 Scale to Compute Expectations

	Females				Males			
Age	2022	2023	2024	July 2024 to June 2025	2022	2023	2024	July 2024 to June 2025
15-24	115.2%	106.9%	93.6%	89.4%	114.2%	108.1%	94.8%	91.3%
25-34	114.4%	100.7%	87.0%	82.7%	118.9%	106.5%	89.5%	83.9%
35-44	117.2%	106.0%	97.0%	94.7%	121.1%	110.9%	98.9%	94.7%
45-54	115.9%	105.0%	100.5%	100.0%	118.4%	107.7%	101.0%	99.5%
55-64	112.3%	102.3%	99.5%	99.6%	113.0%	103.3%	99.0%	99.1%
65-74	111.8%	103.7%	102.6%	103.3%	110.9%	102.6%	101.0%	102.0%
75-84	110.0%	102.9%	101.9%	102.9%	110.1%	101.4%	100.0%	100.3%
85+	108.1%	101.9%	100.7%	100.9%	107.8%	100.5%	98.8%	99.1%
20 to 64	113.9%	103.3%	98.3%	97.5%	115.8%	105.6%	98.1%	96.6%
55+	109.8%	102.6%	101.2%	101.8%	110.2%	101.8%	99.8%	100.2%
65+	109.5%	102.6%	101.5%	102.1%	109.6%	101.5%	99.9%	100.5%

Section 4: Potential Mortality Loads for Improvement Scale Development

RPEC is aware that some actuaries and plan sponsors would like somehow to reflect the potential lingering effects of the COVID-19 pandemic in an adjusted mortality assumption. It continues to be RPEC's opinion that it would not be appropriate to publish an MP scale reflecting a COVID adjustment given the uncertainty regarding the effects of the pandemic on future mortality levels. However, RPEC also continues to believe that an actuary could reasonably use the information in this report and other sources to develop their own "COVID-adjusted" mortality improvement scale reflecting their opinion and their clients' opinions on the potential future effects. Section 4.1 of the 2023 mortality improvement report (SOA 2023) listed some of those other sources of information.

As reported in Sections 3.3 and 3.4, the A/E ratios for the 65+ population have decreased over the years since the onset of the pandemic and were around 100.7% for 2024 and 101.3% for the 12-month period ending in June of 2025. Some actuaries may be of the opinion that the excess mortality from the pandemic in the U.S. has reached its ultimate level. That is to say, the current excess mortality of roughly 1.3% is

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expected to persist in the long term, indicating a permanent shift in mortality levels compared to projections based on 2019 mortality using MP-2021.

To implement such an assumption through an adjusted MP-2021 scale, an actuary could make this adjustment using the MIM model by adding a 1.3% load for ages 65 and older for males and females in the 2025+ columns in Tab 1, Step 5 of the model. Alternatively, the actuary could enter the sex-distinct excess mortality amounts of 0.5% male and 2.1% female.

In deciding whether to make this or other COVID-related adjustments to a mortality improvement scale, actuaries should consider the following:

- The data used by RPEC in its analysis is for the broader U.S. population. There may be regional differences in excess mortality in recent years like there were in 2020 and 2021, but RPEC did not perform an analysis to study these differences. That being said, the regional variances observed throughout 2020 and 2021 in the U.S. may have dissipated over time as fewer people are maintaining their vaccinations and more people have developed some sort of resistance arising from previous COVID infections.

- Excess mortality for a specific pension population may be somewhat different than it is for the broader U.S. population. Anecdotally, members of RPEC have observed that excess mortality levels vary significantly from one pension population to another and generally have not been as severe as for the general U.S. population.

- The A/E results reported in Sections 3.3 and 3.4 reflect a base mortality table set in 2019, with similar results for earlier base tables. If an experience study has been performed for a specific pension plan to set a base mortality table in a year other than 2019, the A/E results may not be applicable. Accordingly, Table 4 (below) presents A/E ratios for various base years similar to the results provided in Table 3 of Section 3.4. For example, a pension valuation that utilizes an adjusted base mortality assumption from an experience study of 2017 data and projects mortality using MP-2021 could use a 99.2% adjustment for males and 100.5% for females as indicated in Table 4.

Table 4

Actual Deaths for Ages 65+ Using Data from July 2024 to June 2025,
Divided by Expected Deaths Computed Using January-to-December Data from Different Base Years

Base Year	Females	Males	Total
2010	103.8%	102.2%	103.0%
2011	102.4%	101.6%	102.1%
2012	102.5%	101.6%	102.0%
2013	101.7%	100.4%	101.1%
2014	102.6%	100.7%	101.7%
2015	100.4%	99.3%	99.9%
2016	101.8%	100.3%	101.1%
2017	100.4%	99.2%	99.9%
2018	100.9%	99.5%	100.2%
2019	**102.1%**	**100.5%**	**101.3%**

Because 2019 is used as the base year for computing expected deaths in all other exhibits in this report, the corresponding row is bolded in this table. Expected deaths are adjusted to reflect mortality improvement implied by the MP-2021 scale.

If a pension valuation currently reflects the standard Pri-2012 base mortality tables with MP-2021 improvements, the central year of the base mortality table is 2012. Furthering the point in the third bullet above, an actuary for such a plan who intends to implement a COVID load based on the information in this report should arguably consider the A/E ratios reflecting the 2012 base year rather than 2019. According to

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Table 4, these A/E ratios are 101.6% for males and 102.5% for females (based on data for the latest 12-month period considered in this report, from July 2024 to June 2025).

Section 5: Other Sources of Information

5.1 SOCIAL SECURITY ADMINISTRATION APPROACH TO REFLECTING PANDEMIC MORTALITY

The 2025 Trustees Report (SSA 2025) contains information regarding the mortality impact of COVID-19 and the projection of future effects used by the SSA in its modeling for the system. Note that this material is focused on the broader U.S. population, and post-65 is specifically reflective of people enrolled in the Social Security system as recorded by CMS.

A high-level description of the COVID-19-related mortality impact reflected in the 2025 Trustees Report states:

> Also for the 2025 Trustees Report, the Trustees assume that the COVID-19 pandemic, which began having a net effect on death rates in 2020, will continue to affect death rates through 2025. While, in general, the pandemic has caused an increase in death rates, final and provisional total death data through July 2024 show that there are notable differences by age group. Therefore, the Trustees assume a set of factors for the 2025 report (representing the multiplicative factors that are applied to the death probabilities that we now estimate would have occurred in the absence of the pandemic, i.e., applied to the current "baseline") that vary by broad age group. Death rates for all age groups are assumed to return to baseline levels for 2026 and thereafter. (SSA 2025b: *The Long-Range Demographic Assumptions for the 2025 Trustees Report, Section 2.1*).

Additionally, from the same report, "The following table shows the factors used for the 2024 and 2025 Trustees Reports" (SSA 2025b, Section 2.1).

Table 5
SSA MULTIPLICATIVE FACTORS APPLIED TO BASELINE DEATH PROBABILITIES

	2024 Trustees Report					2025 Trustees Report				
Year	Age 0	Ages 1-14	Ages 15-64	Ages 65-84	Ages 85+	Age 0	Ages 1-14	Ages 15-64	Ages 65-84	Ages 85+
2020	0.99	1.01	1.19	1.16	1.14	0.98	1.03	1.18	1.16	1.14
2021	1.03	1.11	1.32	1.18	1.07	1.01	1.13	1.32	1.17	1.07
2022	1.03	1.18	1.16	1.10	1.07	1.05	1.22	1.16	1.10	1.07
2023	1.01	1.22	1.08	1.06	1.04	1.05	1.20	1.07	1.03	1.01
2024	1.00	1.06	1.02	1.02	1.01	1.01	1.17	0.99	1.02	0.98
2025	1.00	1.00	1.00	1.00	1.00	1.00	1.09	1.00	1.00	1.00

Baseline death probabilities are the death probabilities that were estimated to have occurred in the absence of the pandemic, at the time the assumptions were developed for each Trustees Report. For the 2024 Trustees Report, the multiplicative factors reflect actual data through 2022 and estimates for 2023-2025. For the 2025 Trustees Report, the factors reflect actual data through 2023 and estimates for 2024-2025.

The report also notes the following:

> For the 2025 Trustees Report, the factors for 2024 were estimated based on partial, provisional data through July 2024 and assumptions about the remainder of the year. Note that in the table above, the factors are lower than 1.00 for age groups 15-64 and 85 and older in 2024. This suggests that death probabilities for these age groups

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> in 2024 were lower than they would have been if the pandemic had not occurred. This is consistent with the assumption that increased deaths in the acute phase of the pandemic were primarily an acceleration of deaths that would have occurred in later years. (SSA 2025b: *The Long-Range Demographic Assumptions for the 2025 Trustees Report, Section 2.1*)

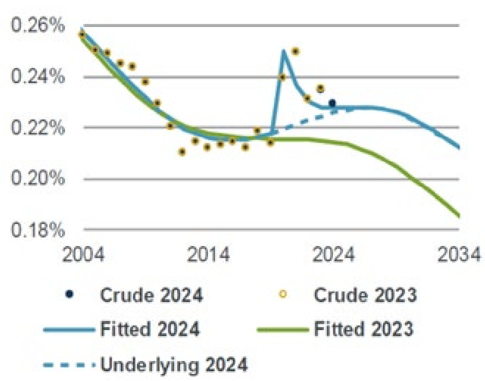
Consistent with prior Trustees reports issued after the pandemic, the SSA does not assume any long-term residual mortality effects due to the pandemic.

5.2 APPROACHES IN OTHER COUNTRIES TO REFLECTING PANDEMIC MORTALITY

United Kingdom (U.K.)

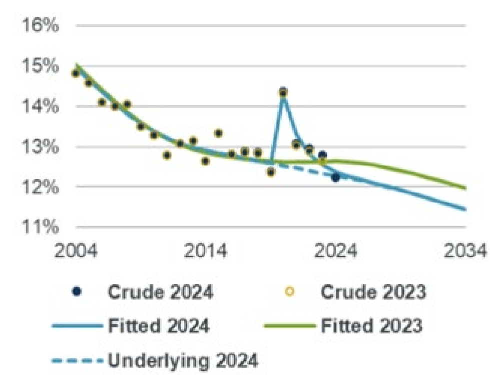
Mortality levels in the U.K. have continued to recover from the pandemic. Overall, mortality levels in 2024 for England and Wales were the lowest on record and slightly lower than 2019 levels, although there was significant variance among different age groups. The following two charts, obtained from the Continuous Mortality Improvement (CMI) Working Paper 201, show that age-standardized mortality rates (ASMRs) for males aged 20-59 in 2024 remained significantly higher than pre-pandemic levels, whereas those for males aged 80-100 were slightly lower than pre-pandemic levels.

Figure 5A
Crude, Fitted, and Projected Age-Standardized Mortality Rates, Male, 20 to 59



Source: Chart 4I in CMI Working Paper 201.

Figure 5B
Crude, Fitted, and Projected Age-Standardized Mortality Rates, Male, 80 to 100



Source: Chart 4M in CMI Working Paper 201.

The CMI has historically modeled COVID effects in their Mortality Projections Model by assigning lower weights to the experience in the early onset of the pandemic. In the Core settings of last year's model, CMI_2023, 0% weight was given to 2020 and 2021 mortality experience, and 15% weight was given to 2022 and 2023 experience. However, CMI had noticed that the model was producing some counterintuitive results when incorporating updated experience, and over the past year investigated some alternative approaches for incorporating post-pandemic experience.

With input from the actuarial community in the U.K., the CMI changed their methodology in the final version of their model, CMI-2024, which was released in June 2025. The revised methodology reflects a "fitted overlay" approach, under which the model separates the experience into "underlying" and "overlay" mortality, with the "overlay" mortality decaying based on an assumed half-life parameter H. The default parameter under the Core model is H=1, meaning excess mortality decreases by 50% for each year since 2020. This default parameter was supported by a large majority of respondents surveyed by the CMI.

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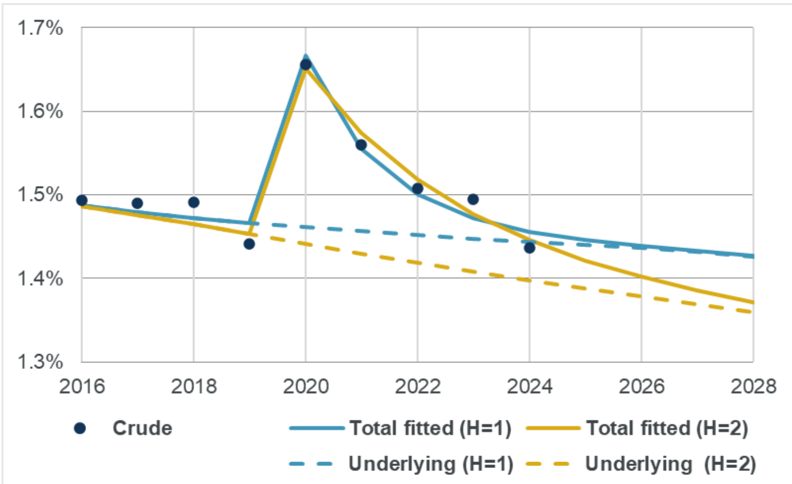
The “underlying” mortality is fitted by giving full weight to all years but allowing for the assumed “overlay” in 2020 and beyond. Higher half-life parameters imply greater remaining excess mortality inferred from the post-pandemic experience and therefore lower “underlying” mortality, resulting in higher cohort life expectancies under the model. This is illustrated in the chart below, which was also obtained from the CMI’s Working Paper 201:

Figure 6
Male ASMRs from CMI_2024 with a Half-Life of 1 or 2 years



Source: Chart A3A in CMI Working Paper 201

To better reflect the varying “underlying” post-pandemic mortality levels among the different age groups, CMI also updated the model to reflect five different age terms. The effects of reflecting different age terms can be seen in the first two charts in this section, comparing the “Fitted 2023” green lines to the “Fitted 2024” blue lines.

Overall, the Core CMI-2024 model produces a 1.25%-2.5% increase (relative to the CMI-2023 model) in cohort life expectancies for males aged 65 and older, and a 0.15%-1.5% increase for females age 65 and older, depending upon their age group.

Canada

The Canadian Institute of Actuaries (CIA) commissioned a research project on mortality improvements in Canada, which was carried out by Ad Res Advanced Reinsurance Services GmbH in collaboration with Koblenz University of Applied Sciences. The findings of the research project were published by the CIA on April 11, 2024 in a report *Mortality Improvements Research: Report to the Canadian Institute of Actuaries’ Project Oversight Group* (CIA 2024), along with a new mortality improvement scale. The name of the improvement scale is not clear, so in this report it is referred to as “CanMI-2024,” a name adopted by Club Vita.

The scale was developed using mortality data from 1989 to 2019 from the Human Mortality Database and tested against mortality experience from the Canada Pension Plan, Quebec Pension Plan, and Old Age Security. The executive summary of the report (CIA 2024) describes the development of the scale as follows:

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> We have based our recommendation for a set of best-estimate improvement rates for future mortality on an adapted version of the so-called CMI Method, which is used by the UK's Institute and Faculty of Actuaries' Continuous Mortality Investigation. The CMI Method decomposes historically observed mortality improvement rates into age, period and cohort components to describe the short-term behaviour of future mortality improvements and relies upon expert input regarding their long-term behaviour. The expert provides a long-term improvement rate assumption for each component, as well as the expected time for the short-term improvement rates to converge to the long-term rate assumption. *(April 2024; Mortality Improvements Research: Report to the Canadian Institute of Actuaries' Project Oversight Group)*

The long-term mortality improvement rate recommended in the report is 1.3% attained around 2059, an increase from the 0.8% starting in 2030 from the previous CPM-B scale and the 1.0% starting in 2033 from the previous MI-2017 scale. The long-term improvement rate was developed from a stochastic analysis using the Age-Period-Cohort model (APC model) and the integrated Age-Period-Cohort model (APCI model), which were chosen among 14 different models under consideration.

It is notable that the CanMI-2024 improvement scale was based upon pre-pandemic mortality experience, and it does not include any assumed lingering effects of the pandemic. Adoption of the new improvement scale is not yet widespread, as many pension actuaries are waiting for an updated base mortality table expected to be published in the coming months by the CIA.

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Section 6: Appendix

6.1 DATA SOURCE FOR DEATH COUNTS

As explained in Section 3.1, the analysis presented in this report uses CDC death count data. This data is available with a short reporting lag, thereby facilitating an examination of recent mortality trends. The CDC data used in this analysis was downloaded on October 5, 2025. CDC data for recent months is only partially complete. Therefore, this analysis excludes the most recent four months of data (July, August, September, and October of 2025). Data for June 2025 and earlier was adjusted upwards using completion factors to produce estimates of final death counts. RPEC developed the completion factors by comparing CDC datasets downloaded at different points in 2024 and 2025, which yielded an understanding of the rate at which the data matures. For the age 65+ population, the completion factors are 99.7%, 99.8%, and 99.9% for deaths that occurred in June 2025, May 2025, and April 2025, respectively. For all prior months, completion factors exceed 99.90%.

6.2 DATA SOURCE FOR EXPOSURE

To compute crude death rates for the analysis presented in this report, CDC death counts were divided by "Social Security Area population" (SSAP) estimates produced by the SSA for its 2025 Trustees Report (SSA 2025).

An asymmetry exists between the geographical area covered by CDC death data and the area covered by the SSAP counts. The CDC data captures U.S. residents of the 50 states and the District of Columbia (DC), while the SSAP data has broader coverage. In addition to the 50 states and DC, the SSAP data captures the following population segments: civilian residents of Puerto Rico, the Virgin Islands, Guam, American Samoa, and the Northern Mariana Islands; Federal civilian employees and persons in the U.S. Armed Forces abroad and their dependents; non-citizens living abroad who are insured for Social Security benefits; and all other U.S. citizens abroad. As a result of this broader definition, SSAP is about 2% larger than the U.S. resident population. This asymmetry is material with respect to computing mortality rates, but the objective of this report is to examine mortality trends rather than to quantify mortality rates. Trends are unlikely to be affected by the asymmetry.

Before selecting the SSAP data to serve as the exposure dataset for this analysis, RPEC considered using the Census Bureau's estimates of the U.S. resident population. However, the Census Bureau has not yet updated its age-sex specific population estimates for 2011 to 2019 to reflect information gathered in the 2020 Decennial Census. Consequently, discontinuities may exist between pre-2020 and post-2020 data that could interfere in the analysis of mortality trends. In contrast, RPEC found no evidence of discontinuities in the SSAP data—that is, the data appears to flow smoothly from one year to the next, exhibiting strong consistency with the CDC death count data.

6.3 AGE STANDARDIZATION

The A/E results presented in Section 3 are calculated across broad age groups. For example, the results in Figures 1 through 4 reflect data for ages 65 and above. Shifts in a population's age structure can influence the aggregate death rate computed across an age group. In general, if the average age shifts upwards (downwards) across time, this will tend to increase (decrease) the aggregate death rate, even if age-specific mortality rates remain unchanged. This makes it difficult to interpret trends in unstandardized death rates.

For a hypothetical data set, suppose that the unstandardized death rate for females of age 60-to-64 is 1.00% in year one of a mortality study, and 0.98% in year five. Without more information, it cannot be

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determined if the 2% decrease in the aggregate death rate is due to (1) a downward shift in age-specific mortality rates, (2) a downward shift in the age distribution, or (3) a combination of these two effects. This issue is illustrated using fictional data in Tables 6 and 7. In Table 6, age-specific mortality rates decrease by 2%, leading to a 2% decline in the aggregate mortality rate. In Table 7, age-specific mortality rates are constant across time, but shifts in the population's age structure lead to that same 2% decline in the aggregate mortality rate as in Table 6.

Table 6

Downward Shift in Age-Specific Death Rates Leads to 2% Decrease in Aggregate Death Rate

	1	2	3	4	5	6	6 / 3
Age	Year 1 Exposure	Year 1 Deaths	Year 1 D / E	Year 5 Exposure	Year 5 Deaths	Year 5 D / E	Mort Ratio
60	100,000	789	0.789%	100,000	773	0.773%	98.0%
61	99,000	875	0.884%	99,000	857	0.866%	98.0%
62	98,010	970	0.990%	98,010	951	0.970%	98.0%
63	97,030	1,076	1.108%	97,030	1,054	1.086%	98.0%
64	96,060	1,193	1.242%	96,060	1,169	1.217%	98.0%
Total	490,100	4,902	1.000%	490,100	4,804	0.980%	**98.0%**

Table 7

Shift in Age Composition Leads to a 2% Decrease in the Aggregate Death Rate

	1	2	3	4	5	6	6 / 3
Age	Year 1 Exposure	Year 1 Deaths	Year 1 D / E	Year 5 Exposure	Year 5 Deaths	Year 5 D / E	Mort Ratio
60	100,000	789	0.789%	140,000	1,105	0.789%	100.0%
61	99,000	875	0.884%	126,700	1,120	0.884%	100.0%
62	98,010	970	0.990%	114,664	1,135	0.990%	100.0%
63	97,030	1,076	1.108%	103,770	1,150	1.108%	100.0%
64	96,060	1,193	1.242%	93,912	1,166	1.242%	100.0%
Total	490,100	4,902	1.000%	579,046	5,675	0.980%	**98.0%**

To neutralize the effects of changes in the population's age structure, the results presented in this report are age standardized. Age-standardized results are easy to interpret because the effects of changes in age structure are eliminated. If a standardized death rate increases (decreases) across time, this implies that age-specific death rates also increased (decreased).

For this report, age standardization was accomplished using 2019 population counts as weights. In effect, this "freezes" the population's age structure at 2019 levels. Aggregate death rates are computed as the weighted average of age-specific death rates, using weights derived from 2019 population counts. For example, to compute the age-standardized death rate in 2023 for ages 60 to 69, the following calculation is performed:

$$\left(\sum_{x=60}^{69} \frac{\text{Deaths}(x)_{2023}}{\text{Population}(x)_{2023}} * \text{Population}(x)_{2019}\right) \div \sum_{x=60}^{69} \text{Population}(x)_{2019}$$

Revisiting the situation depicted above in Table 7, this methodology of age standardization would use the year one exposure counts by age in computing the weighted-average death rate for the 60-64 age band in year five. Since the year five death rates are the same as year one death rates for each age, the resulting age-standardized, weighted-average death rate for the 60-64 age band would be the same 1.000% as in year one, and therefore the mortality ratio in the rightmost column would be 100%. This illustrates how

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age standardization resolves the skewing of death rates when there are shifts in the age composition of a group over time.

For presentational simplicity, the prior equation shows death and population data in annual time units. The SSAP data consists of annual (mid-year) estimates, RPEC uses linear interpolation to translate the annual population counts into monthly estimates. The monthly data facilitates calculations for rolling 12-month periods that straddle adjacent calendar years – for example, the period from July 2024 to June 2025.

6.4 EXPECTED DEATH RATES

The A/E values presented in Sections 3.3 and 3.4 are determined as the ratio of two age-standardized death rates. The numerator (the actual death rate) is calculated as described in Section 6.3. The denominator (the expected death rate) is calculated using 2019 death count data because 2019 was chosen as the base year for RPEC's A/E analysis. Because 2019 data is also used for age standardization, the expected death rate calculation in any given year reduces to the following, as illustrated for the age group running from 60 to 69:

$$\sum_{x=60}^{69} \mathrm{Deaths(x)}_{2019} \div \sum_{x=60}^{69} \mathrm{Population(x)}_{2019}$$

The fact that the resulting expected death rate for any given year is the same as in 2019 makes sense, since without a mortality improvement assumption the expected mortality is constant. To determine expected death rates that include mortality improvement implied by the MP-2021 scale, the calculation of the expected mortality rate in year *y* is modified as follows:

$$\sum_{x=60}^{69} \mathrm{Mort\ Improve\ Factor(x,y)} * \mathrm{Deaths(x)}_{2019} \div \sum_{x=60}^{69} \mathrm{Population(x)}_{2019}$$

The mortality improvement factor varies by age and target year, reflecting cumulative MP-2021 improvement from 2019 to the target year *y* that is captured in the numerator of the A/E calculation. For example, if the actual period is calendar 2023, then the mortality improvement factor will reflect cumulative MP-scale improvement across the 2019-to-2023 period. A factor of 95% indicates cumulative mortality improvement of 5%, or a 5% reduction in the mortality rate.

To calculate the expected death rate for a period that straddles adjacent calendar years, the calculation is similar, except the summation in the numerator is broken into separate months, and the appropriate mortality improvement factor is applied to each month's data. For example, suppose the base period for computing the expected death rate is 2019, and the target period to be compared against the base period runs from February 2024 to January 2025; thus, eleven months of the target period fall in 2024, and one month (January) falls in 2025. In this case, expected deaths would reflect (1) data from February to December of 2019, projected forward to 2024 and (2) data from January of 2019, projected forward to 2025. Notice that each calendar month in the target period is always paired with the same calendar month in the base period, ensuring that the numerator and denominator share the same seasonality. In this example, February 2024 is matched with February 2019, and the projection period is five years (2024 minus 2019). Similarly, January 2025 is matched with January 2019, and the projection period is six years (2025 minus 2019).

To generate sex-specific results, the calculations described in Sections 6.3 and 6.4 are performed separately for males and females. To generate combined results for males and females, the calculations are aggregated across both sexes.

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6.5 EXCESS MORTALITY ESTIMATED USING MEDICARE DATA FROM 2020 THROUGH 2023

The excess mortality estimates presented in this report were generated using CDC data for death counts and SSAP data for exposure counts. This approach was used because CDC data is available with a relatively short time lag, thereby facilitating an analysis of recent mortality experience.

In contrast, the MP-scale is produced using Medicare data. This data has a lengthy reporting lag, but provides both exposure counts and death counts, tied together via a database of individual beneficiary records. The tight relationship between the death and exposure data is a key reason that RPEC uses Medicare data to produce the MP-scale.

At the time of publication of this report, Medicare data was available only through 2023. Using this data, RPEC computed excess mortality for the 65+ population separately for each year from 2020 to 2023 and compared the results against those produced using CDC and SSAP data:

Table 8

Ratios of Actual to Expected Deaths for the 65+ Population

Data Source(s)	2019	2020	2021	2022	2023
CDC and SSAP	100.00%	116.71%	114.56%	109.53%	102.06%
Medicare	100.00%	116.09%	114.17%	109.32%	101.95%
Medicare minus CDC/SSAP	0.00%	- 0.62%	- 0.39%	- 0.21%	- 0.10%

Expected deaths were computed by projecting 2019 mortality rates forward in time using MP-2021.

In the preceding table, the A/E results calculated using Medicare data are quite close to those calculated using CDC and SSAP data. For 2023 data, the gap between the A/E results is 0.10%. While there is a difference in A/E ratios between the two datasets that has persisted through 2023, the rate of decline in excess mortality (equal to A/E minus 1.0) since 2020 is very similar, as illustrated in Table 9 below.

Table 9

Excess Mortality as % of Excess Mortality in 2020 for the 65+ Population

Data Source(s)	2020	2021	2022	2023
Excess (year) / Excess (2020): CDC and SSAP	100.0%	87.1%	57.0%	12.3%
Excess (year) / Excess (2020): Medicare	100.0%	88.1%	57.9%	12.1%

Expected deaths were computed by projecting 2019 mortality rates forward in time using MP-2021.

The 65+ populations covered by the Medicare data and the CDC data are similar but not identical. The CDC death count data covers the entire U.S. resident population, while the Medicare data captures about 94% of the 65+ population (this percentage was estimated by RPEC). The slight difference in covered populations is one potential source of the gap between the A/E results in Table 8. Another potential source is the uncertainty in the SSA's population count estimates.

Section 7: Reliance and Limitations

The information in this report has been developed from data from other sources and has been presented for the purpose of valuing U.S. pension and other post-employment benefit obligations. No assessment has been made concerning the applicability of the information to other purposes.

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Section 8: Acknowledgments

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