

Mortality and Longevity

MIM-2021 Data Analysis Tool User Guide





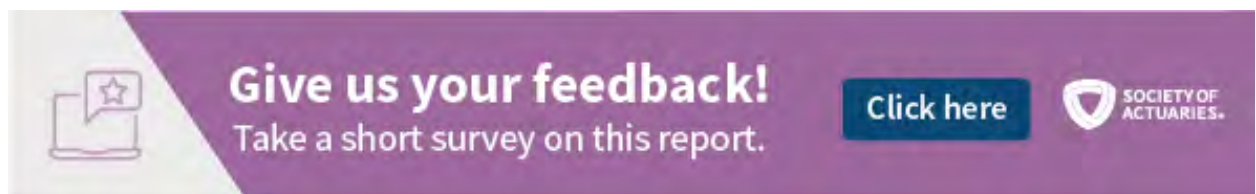
MIM-2021 Data Analysis Tool User Guide

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Introduction

As described in the MIM-2021 Report¹, the selection of an appropriately chosen historical mortality data set is an essential requirement of the MIM-2021 projection methodology. This document is a step-by-step guide for the MIM-2021 Data Analysis Tool that can help users compare and analyze the various historical mortality data sets available in the MIM-2021, as well as compare those historical rates to previously published SOA mortality tables.

It should be noted the MIM-2021 Data Analysis Tool deals only with historical mortality rates. It does not compare or analyze any of the future mortality rates developed under the MIM-2021.

Throughout this User Guide, the term “NCHS rates” without any further designation refers to all of the following historical data sets:

- Full population mortality rates developed from National Center for Health Statistics (NCHS) death counts starting in 1982 and U.S. census data going back to 1980.
- A variety of subsets of the NCHS full population data set, split into ranges (quintiles and deciles) based on estimated socioeconomic categories; (see Mortality by Socioeconomic Category in the United States). These subsets can be selected individually or blended in combination with other subsets to more closely approximate the anticipated mortality experience of the covered population to which the resulting mortality improvement rates are to be applied.
- Two additional groups of “static” NCHS decile data sets. These deciles have been based on socioeconomic categories fixed as of 1980² and 2016, respectively, as contrasted to the subsets described in the immediately preceding bullet, which reflect changes in socioeconomic deciles as they might have varied over time.

Whenever it becomes necessary to distinguish among any of these NCHS data sets, some additional description will be supplied.

Tabs 1 and 2: Historical Mortality Datasets

Tabs 1 and 2 include all of the historical SSA and NCHS mortality rates (smoothed³ and unsmoothed, respectively) required to produce the various graphs, heat maps, and tables generated in the remaining tabs of the spreadsheet. The rates are shown for every calendar year starting in 1982 through 2018.

Two-dimensional Whittaker-Henderson smoothing was performed on the unsmoothed mortality rates starting at age 15 through age 97. Therefore, Tab 1 includes smoothed gender-specific SSA and NCHS mortality rates between those two ages only, while Tab 2 includes the unsmoothed gender-specific SSA⁴ and NCHS mortality rates from ages 0 through 110.

In both Tab 1 and Tab 2, specific mortality rates can be readily identified by “filtering” on the down arrows in cells B7 through E7:

- Column B, “Data”: Choose from the desired historical SSA or NCHS data set(s) from the following options:
 - “d”: NCHS decile data sets, with deciles that vary in accordance with each county’s socioeconomic categorization over the period 1982 through 2018.
 - “d-1980”: NCHS decile data sets, with socioeconomic categories fixed as of 1980
 - “d-2016”: NCHS decile data sets, with socioeconomic categories fixed as of 2016
 - “q”: NCHS non-static quintile data sets
 - “ssa”: SSA data set
- Column C, “Decile or Quintile”: For the NCHS rates, choose from the desired decile(s), quintile(s), or “total”⁵:
 - Numeric value from 1 to 10: The value “1” represents the lowest socioeconomic scored population group for both decile and quintile data sets. The data sets representing the highest socioeconomic scored population groups are “5” for quintiles and “10” for deciles.
 - “total”: The full-population data set
- Column D, “Year”: Choose the desired calendar year(s); 1982 through 2018
- Column E, “Gender”: Choose the desired gender(s); “f” or “m”

Tabs 1 and 2 are “protected” sheets, meaning they cannot be altered. This is necessary because if the structure of the data were inadvertently modified, then various worksheet tabs that use the data could malfunction.

Tab 3: Graphical Comparison of National Level SSA and NCHS Mortality Information

As discussed in Section 3 of the MIM-2020 Report, the SSA and NCHS data sets were derived from different sources for ages 65 and over. Tab 3 allows users to visualize differences in the underlining mortality rates and assess the impact of those differences on various related metrics.

Figure 1 displays an example of the inputs for Tab 3.

Figure 1
TAB 3 INPUTS

Select Parameters

10	Metric (see list below)
m	Sex
1	Data type: 1 = smoothed, 2 = unsmoothed
1982	Earliest year
2016	Final year
20	Min age to plot
97	Max age to plot

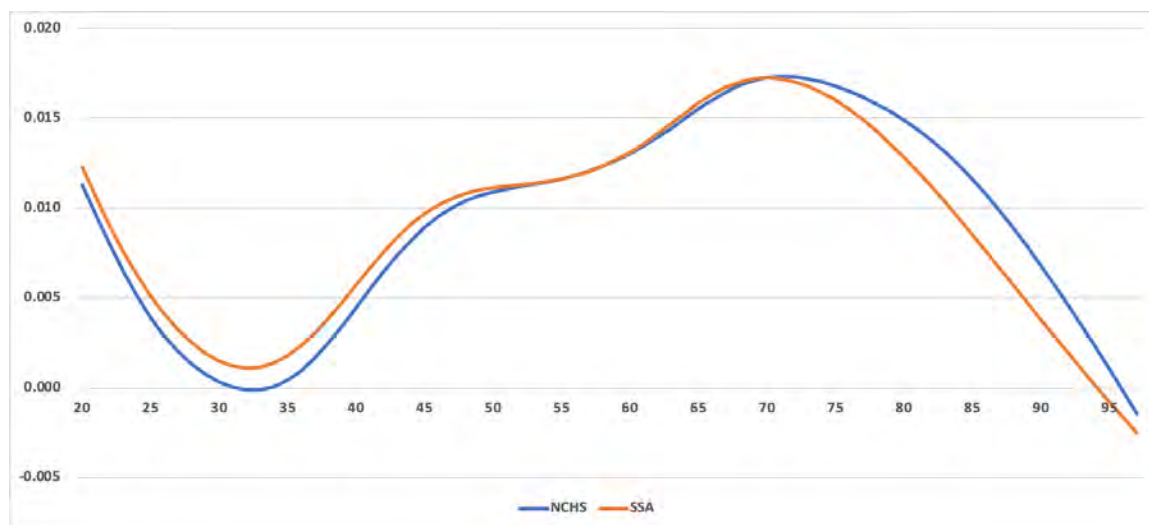
List of Metrics

1. qx in earliest year
2. qx in final year
3. log qx in earliest year
4. log qx in final year
5. qx in final year as % of qx in earliest year
6. qx in final year minus qx in earliest year
7. expected lifetime in earliest year
8. expected lifetime in final year
9. metric 8 minus metric 7
10. annualized geometric rate of improvement from earliest year to final year
11. NCHS qx as % of SSA qx: earliest year vs final year

The graph produced with this set of inputs (Figure 2) compares the annualized geometric rate of mortality improvement from 1982 through 2018 for males aged 20 through 97, based on the smoothed SSA and NCHS data sets

Figure 2
TAB 3 GRAPH SHOWING ANNUALIZED GEOMETRIC RATE OF MORTALITY IMPROVEMENT

National-Level Mortality Data: SSA versus NCHS



Tabs 4 and 5: Graphical Comparisons of NCHS Socioeconomic Quintile and Decile Mortality Information

Users can compare a range of key mortality metrics generated by each of the NCHS quintile (Tab 4) and decile (Tab 5) data sets. Figure 3 displays an example of the inputs for Tab 4.

Figure 3
TAB 4 INPUTS

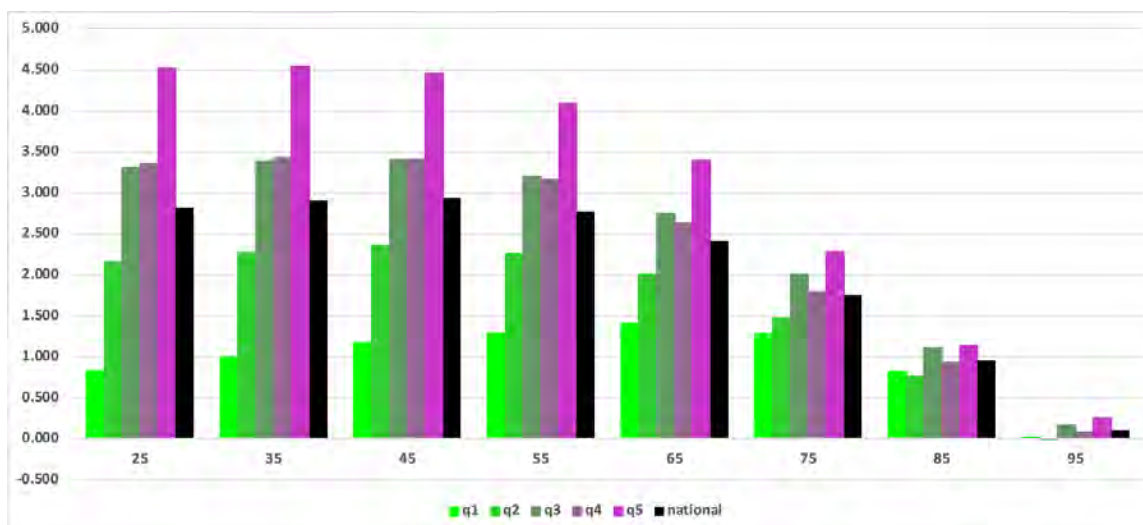
Select Parameters	
14	Metric (see list below)
f	Sex
1	Data type: 1 = smoothed, 2 = unsmoothed
Yes	Graph national-level data, in addition to quintiles?
1982	Earliest year
2018	Final year

List of Metrics

1. annualized geometric rate of improvement from earliest year to final year
2. like metric 1, but expressed relative to the national average rate of improvement
3. qx in final year as % of qx in earliest year
4. qx in final year minus qx in earliest year
5. qx in earliest year
6. qx in final year
7. log qx in earliest year
8. log qx in final year
9. qx in earliest year as % of national-level value (quintile qx / national level qx)
10. qx in final year as % of national-level value (quintile qx / national level qx)
11. metric 10 minus metric 9
12. expected lifetime in earliest year
13. expected lifetime in final year
14. metric 13 minus metric 12

The bar graph produced with this set of inputs (Figure 4) shows for each NCHS quintile (and for the national-level NCHS data set) a comparison of the change in period life expectancies between 1982 and 2018 for females at eight ages, based on smoothed mortality data.

Figure 4
TAB 4 BAR GRAPH COMPARING THE CHANGE IN PERIOD LIFE EXPECTANCIES



Except for an additional option to select one of the “static” decile data sets (d-1982 or d-2016) for the comparisons, the inputs and analysis in Tab 5 are the identical to those in Tab 4.

Tabs 6 and 7: Graphs of Mortality Rates Across Years and Ages

Tabs 6 and 7 provide the user with an opportunity to compare graphs of mortality rates across a range of years and ages. Users first select in cell C7 of both Tabs the type of output desired:

- Mortality rates
- Natural logarithm of mortality rates
- The ratio of the selected mortality rate to the corresponding mortality rate in 1982.

On Tab 6, users can select up to ten combinations of data set, age and gender. Running the “Redraw Graph” macro produces a graph of the corresponding mortality rates across all years from 1982 through 2018.

Similarly, on Tab 7, after selecting up to ten combinations of data set, calendar year and gender, a graph comparing mortality rates across all ages 20 through 90 is produced.

Tabs 8 and 9: Inputs for Heat Maps

Tabs 8 and 9 offer the user the ability to select mortality data sets to plot on a heat map(s). After selecting the desired data set(s) and pressing RUN, a user is transported to Tab 10 which displays the requested heat maps.

Tabs 8 and 9 are similar in nature, but they each serve a slightly different purpose. Tab 8 is used to select a series of heat maps to produce in sequence, with each heat map reflecting a single mortality data set. For example, one could produce heat maps for each of the five socioeconomic quintiles. Tab 9, in contrast, produces just one pair of heat maps (female and male), but permits a user to blend data sets by entering

weights across quintiles or deciles. For example, a user could produce female and male heat maps that reflect a 50%/50% blend of deciles 9 and 10.

Both Tabs 8 and 9 permit a user to specify both the age range (cells B9 and B10) and the year range (cells B10 and B11) to display on the heat maps. Either smoothed or unsmoothed data can be selected (cell B14). Any of three output types can be selected with cell B15: (1) mortality improvement rates, (2) mortality rates and (3) mortality rates divided by the corresponding rate in a user-specified year (cell B16).

On Tab 8, after choosing the age/year range and the type of output, range B19:B98 is used to select data sets. Figure 5 illustrates a request to produce heat maps for six data sets: a “total” data set includes all quintiles, and then each of the five separate quintiles. The numbering in the example below – 1 through 6 – indicates the order in which the heat maps will output on Tab 10. Simply leave a cell blank if the user does not wish to output a heat map for that data set.

Figure 5
TAB 8 EXAMPLE OF DATA SET SELECTION FOR HEAT MAPS

	SSA-F
	SSA-M
1	q-total-F
	q-total-M
2	q-1-F
	q-1-M
3	q-2-F
	q-2-M
4	q-3-F
	q-3-M
5	q-4-F
	q-4-M
6	q-5-F

Using input range B19:B98, the user may select as many (or as few) data sets as the user wishes, i.e., there is no maximum or minimum limit on the number of selected data sets.

Cell B101 contains an optional input enabling the selected data to be expressed relative to the user-specified data set in cell B101. For example, suppose a user enters “q-total-F” in cell B101, and suppose, with cell B15, a user selects mortality improvement rates as the desired output. In this case, the heat maps will show mortality improvement rates expressed relative to those from data set “q-total-F” (the national-level data). Continuing this example, suppose the improvement rate for females aged 55 in 2010 is 1% using national level data, and 1.5% using data for the upper quintile. Then relative improvement rate for the upper quintile is 1.5% minus 1.0%, or 0.5%, and this result would be plotted on the heat map.

Like Tab 8, Tab 9 has inputs for selecting the age and year range to plot on the heat maps. Beginning in row 19, however, the inputs on Tab 9 differ from those on Tab 8. Use cell B19 to select one of 6 data sets to plot. Data sets 1 and 2 are national-level data sets, while data sets 3 through 6 involve quintiles or deciles. For these data sets, the user must enter quintile/decile weightings on row 29. The weights must sum to 100%.

After setting the parameters, press RUN on Tab 8 or 9 to produce the heat maps.

Tabs 10 and 11: Heat Maps

Tab 10 presents the heat map(s) requested on Tab 8 or Tab 9. The default color legend appears in range C6:R6. Alternatively, a user can enter their own set of colors in range C11:R11, and then set cell I13 to “User-Specified”. To enter a set of colors on row 11, simply format each cell’s background color to match the desired color.

Rows 7 through 10 contains the numerical values corresponding with each color. A user may change any of these values, taking care the sequence of values increases monotonically from left to right.

Tab 11 shows the data plotted on the heat maps on Tab 10. To see all the data, set cell B5 and B6 to “1”, and then re-run Tab 8 or Tab 9. For a compact presentation of the data, use cells B5 and B6 to show only every “Nth” calendar year and every “Nth” age. After setting cells B5 and B6, re-run Tab 8 or 9 to produce the desired output.

Tabs 12 and 13: Comparison of SSA and NCHS Mortality Rates to Other Mortality Tables

Tab 12 facilitates a comparison of the SSA and NCHS mortality rates against commonly used mortality tables. Use cells B8, B9 and C19:L19 to select a SSA or NCHS data set. This data set can be compared against any of the data sets shown on rows 33 through 226. Select any (or all) of these data sets by entering a “1” in the appropriate cell in range J33:J226. If the user wishes to exclude a data set, simply leave the corresponding row blank in column J.

Cell B23 provides two options for comparing the SSA or NCHS data against the comparison mortality table. Under option 1, the outputs will be SSA/NCHS mortality rates minus the corresponding rates for the comparison table(s). Under option 2, the outputs will be SSA/NCHS mortality rates divided by the comparison table(s).

After setting the various parameters, press “Fetch and Compare the Selected Mortality Tables”. The outputs will appear in columns P through AA. Each row shows the results for one comparison table. Consider the following example:

Figure 6
TAB 12 EXAMPLE

Table Name	Year	Sex	National-Level NCHS Mortality Rates Divided by the Corresponding Mortality Rate of the Comparison Table							
			20	30	40	50	60	70	80	90
RP2006_WhiteCol_HealthyAnnuit	2006	Female				150%	158%	133%	126%	116%

This example compares NCHS national-level female mortality rates against the RP-2006 female white-collar employee mortality table. No results appear for ages 20, 30 and 40 because the RP-2006 table begins at age 50. Consider the “133%” value at age 70. This indicates the NCHS mortality rate at age 70 is 33% greater than the corresponding mortality rate from the RP-2006 table.

Note Tab 13 contains the comparison mortality tables. Keep in mind some of these tables do not cover the entire age. For example, many of the annuitant tables begin at age 50.

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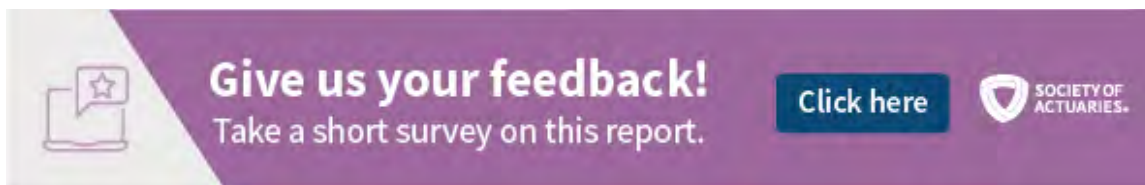
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

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Endnotes

¹ Society of Actuaries. 2021. “Developing A Consistent Framework For Mortality Improvement”. <https://www.soa.org/resources/research-reports/2021/developing-consistency-framework/>.

² Although the NCHS mortality data begins in 1982, the decennial census as of 1980 was used to establish socioeconomic categories for this group of static NCHS data sets. Given the decennial census occurs only once every 10 years (e.g. 1970, 1980, 1990, etc.), the 1980 census is positioned closest in time to the first year of the NCHS mortality data (1982).

³ See Appendix A of the MIM-2021 Report for a description of the methodology used to smooth historical mortality rates. Society of Actuaries. 2021. “Developing A Consistent Framework For Mortality Improvement”. <https://www.soa.org/resources/research-reports/2021/developing-consistency-framework/>.

⁴ The SSA mortality rates included in Tab 2 are those that were published in connection with the annual Trustees’ Reports, and subsequently reflect the SSA’s standard practice of smoothing their mortality rates within calendar years, but not between calendar years.

⁵ For the SSA data set, “total” is the only available option in column C.

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