

# The SOA's Mortality Improvement Model (MIM): A Consistent Approach for Projecting Mortality Improvement Rates

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# Agenda

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1. The history and purpose of the SOA's Mortality Improvement Model (MIM)
2. An overview of MIM's approach for projecting mortality improvement rates
3. A quick demo of MIM
4. Questions and Answers

# Overview of the Mortality Improvement Model (MIM)

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1. In 2020, MIM was created by the SOA to provide practicing actuaries with a flexible tool for modeling U.S. mortality improvement rates. MIM is periodically updated to reflect fresh data.
2. MIM borrows its mathematical logic from the SOA's RPEC improvement scale model which was first released in 2014. (RPEC = Retirement Plans Experience Committee)
3. MIM is essentially a superset of the RPEC model. MIM can reproduce an RPEC-style projection, but also offers additional capabilities. For example, while RPEC focuses solely on national-level mortality trends, MIM can segment the population into socioeconomic deciles, calculating separate mortality improvement trends for each decile.

# URL for Downloading MIM

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The latest version of MIM is available here, and can be downloaded at no cost:

<https://www.soa.org/resources/research-reports/2021/mortality-improvement-model/>

MIM consists of two Excel files (with calculations programmed in VBA):

1. **MIM Data Analysis Tool** for examining patterns in historical mortality data
2. **MIM Application Tool** for creating scales to project mortality rates forward in time

# Mortality Improvement Rate: An Example

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Mortality rate of 70-year-old females in 2010 = 1.645%

Mortality rate of 70-year-old females in 2018 = 1.493%

Annualized geometric rate of mortality improvement across the 8-year period =

$$1 - (1.493\% / 1.645\%)^{(1/8)} = \mathbf{1.20\%}$$

# What is a Mortality Projection “Scale”?

A mortality projection scale is a set of mortality improvement rates by age, sex and, in the case of “generational” projection scales, by year.

MIM produces generational projection scales. Here is a snippet of a scale for females produced by MIM:

	<b>2018</b>	<b>2019</b>	<b>2020</b>	<b>2021</b>	<b>2022</b>	<b>2023</b>	<b>2024</b>	<b>2025</b>	<b>2026</b>	<b>2027</b>	<b>2028</b>
<b>65</b>	0.04%	-0.02%	-0.01%	0.06%	0.19%	0.36%	0.56%	0.75%	0.92%	1.05%	1.13%
<b>66</b>	0.30%	0.21%	0.17%	0.18%	0.25%	0.37%	0.52%	0.68%	0.84%	0.97%	1.07%
<b>67</b>	0.55%	0.45%	0.37%	0.34%	0.35%	0.41%	0.51%	0.63%	0.77%	0.89%	1.00%
<b>68</b>	0.77%	0.67%	0.57%	0.50%	0.46%	0.47%	0.52%	0.61%	0.71%	0.82%	0.93%
<b>69</b>	0.95%	0.86%	0.76%	0.66%	0.59%	0.56%	0.56%	0.60%	0.68%	0.77%	0.87%
<b>70</b>	1.08%	1.00%	0.91%	0.81%	0.72%	0.65%	0.62%	0.62%	0.67%	0.74%	0.83%

# The Credibility of Mortality Improvement Rate Estimates

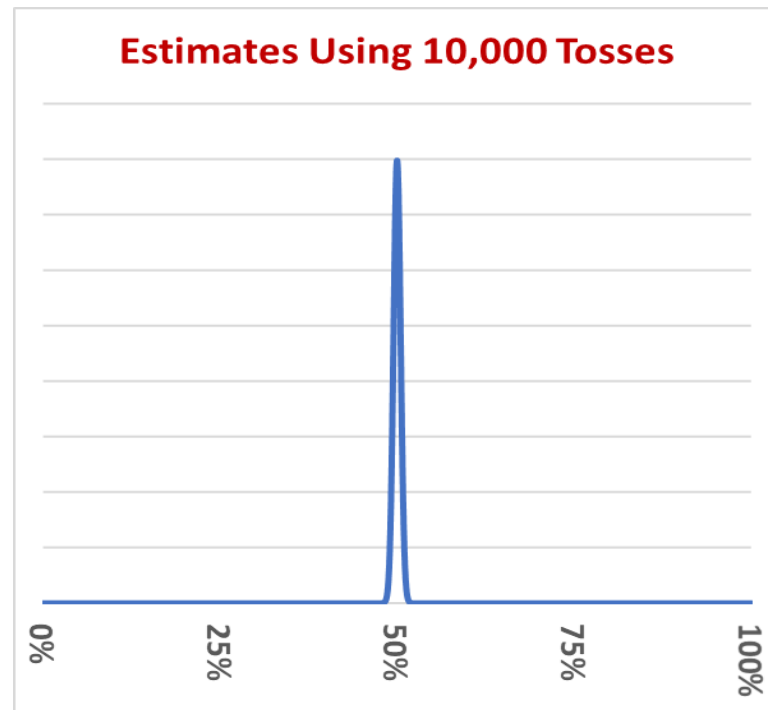
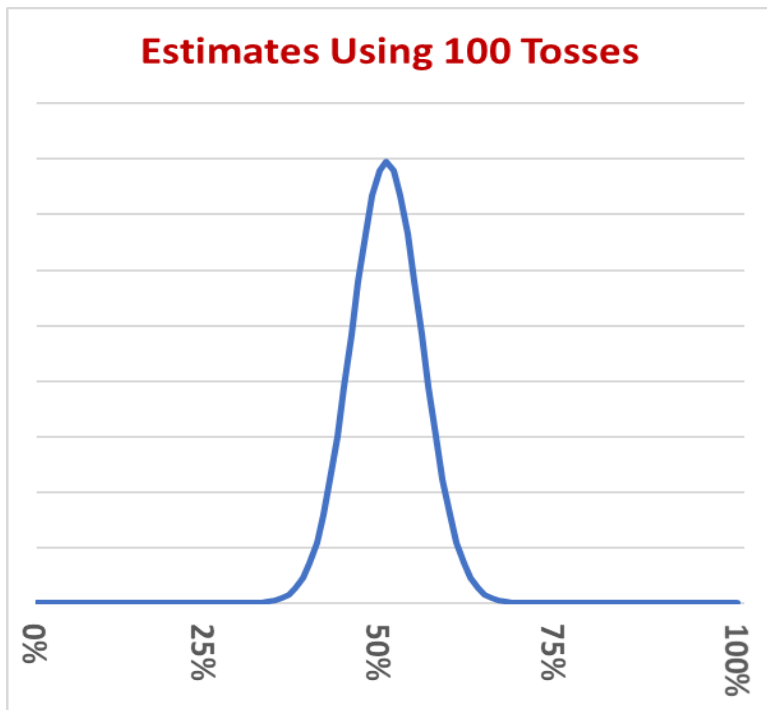
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A coin flipped  $N$  times is not likely to produce an estimate of " $p$ " (the probability of heads) equal to exactly 50%. However, the larger the value of  $N$ , the tighter the confidence interval for the estimate of  $p$ .

Similarly, the larger a pool of lives of age " $X$ ", the narrower the confidence intervals associated with the estimation of both the mortality rate ( $q_x$ ) and the rate of mortality improvement. Conversely, the smaller a pool of lives of age  $X$ , the wider the confidence intervals.

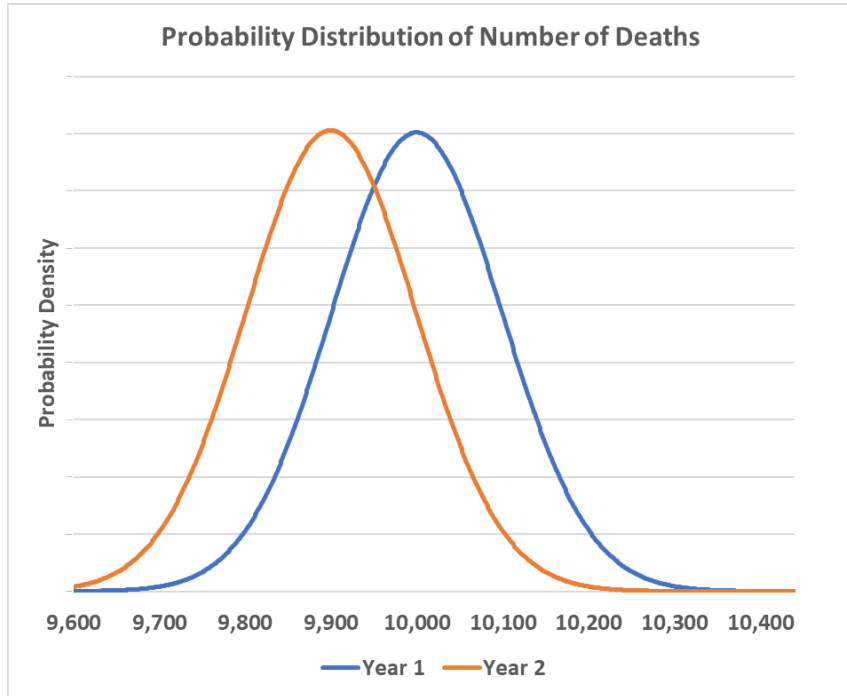
(Note that a “fair” coin is one for which the probability of heads is 50%)

## Estimates of “P” (Probability of Heads) for a Fair Coin





# Mortality Rate Improvement is More Difficult to Estimate than Mortality Rates at a Single Point in Time



This graph assumes 1 million lives, a mortality rate of 1.00% at time “1”, and a mortality rate of 0.99% at time “2”. The rate of mortality improvement is 1.00%.

Note the extensive overlap between the two distributions of the number of deaths. This overlap complicates efforts to measure mortality improvement.

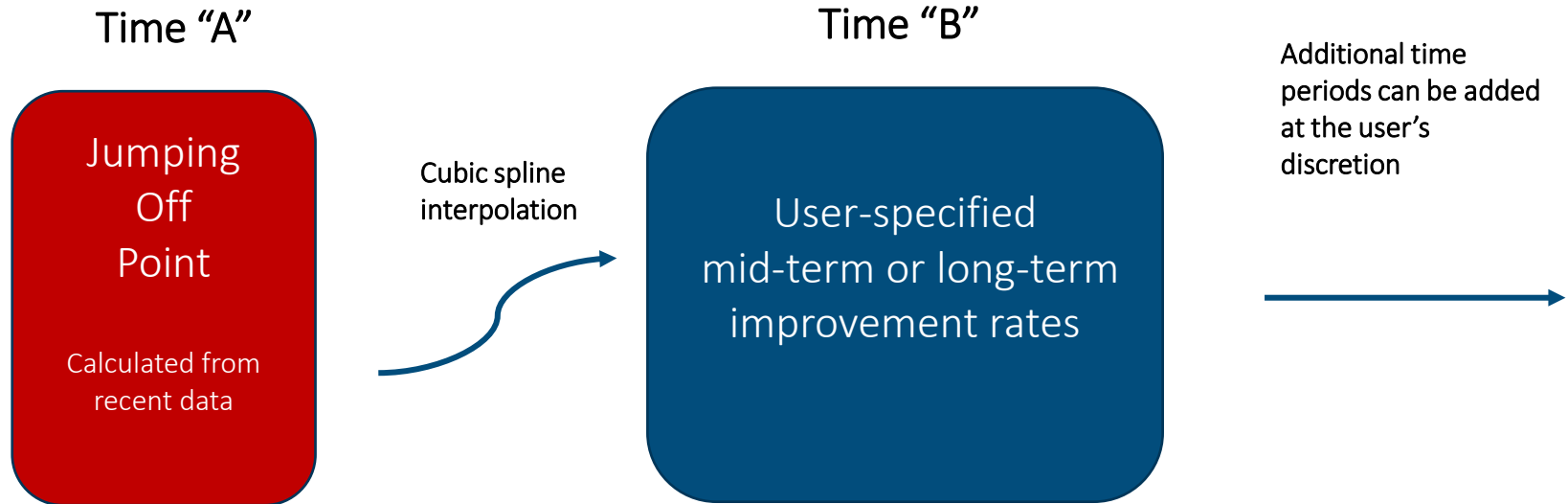
# MIM's Approach for Producing Improvement Rate Scales

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- To achieve robust improvement rate estimates, MIM uses large datasets that cover hundreds of millions of lives: (1) Social Security Administration (SSA) data and (2) National Center for Health Statistics (NCHS) and Census data, segmented into socioeconomic quintiles or deciles.
- MIM uses many years of historical data, but with an emphasis placed upon data for recent years.
- Separately by sex, MIM smooths historical mortality rates by age and year (simultaneously), and computes improvement rates by comparing consecutive years of smoothed data.
- The improvement rates from a recent year serve as the “jumping-off” point for projecting forward in time.
- To create a projection scale, MIM interpolates between the jumping-off point and assumed long-term rates. The long-term rates can be set either by expert judgement, or by equating future long-term rates with historical long-term rates tabulated from data by MIM.

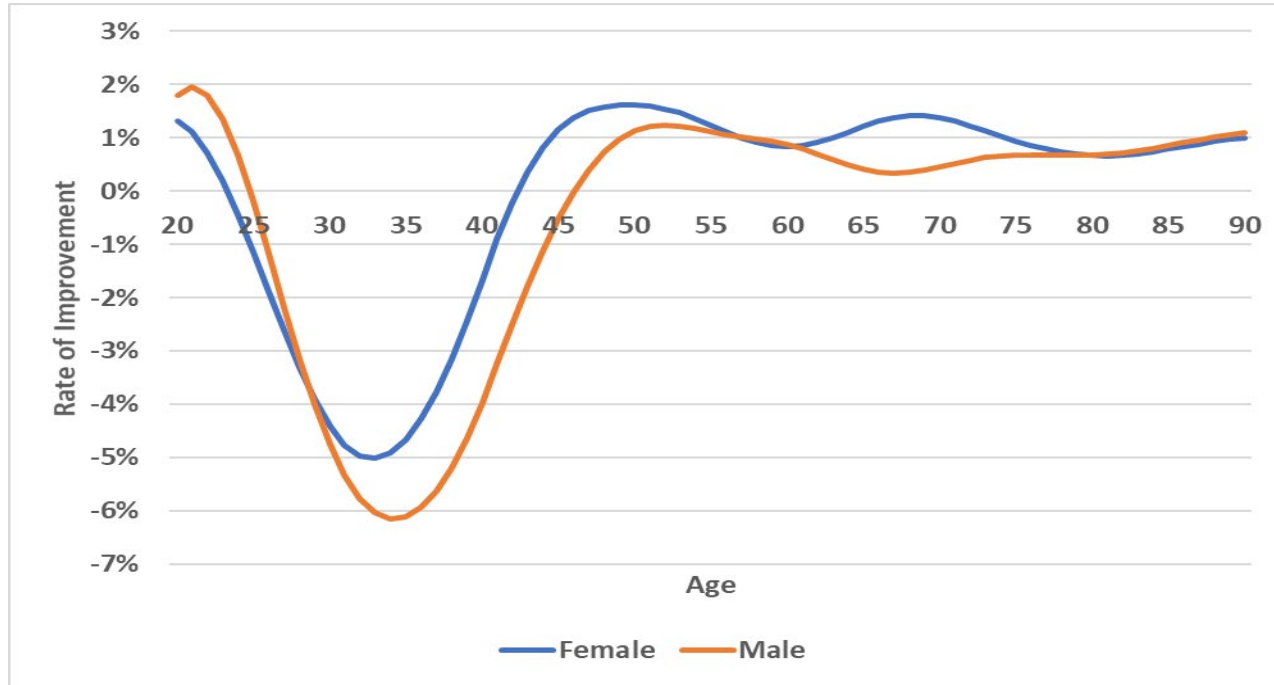
# Creating a Projection Scale with MIM

MIM creates a projection scale by using cubic splines to interpolate from the jumping-off point to a set of assumed improvement rates at time point “B”. These rates can be determined either by expert judgement or with help from MIM. Also, the user is free to change time point “B”.

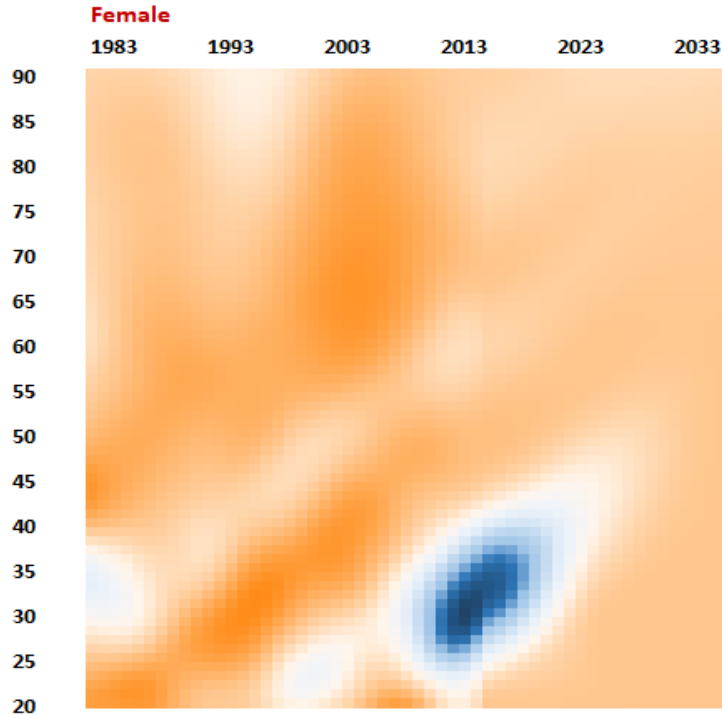


# Example of MP-2021's “Jumping-Off” Improvement Rates

(Jumping-off year = 2017; data for this example = highest socioeconomic decile)



# Heat Map of a Mortality Improvement Scale Produced by MIM



MIM produces mortality improvement scales in tabular form and provides various options for visualizing the results, including heat maps such as the one presented on this slide. Dark blue indicates periods of mortality deterioration, while orange and red indicate periods of improvement.

# Quick Demo of MIM

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A full demo of MIM would take about an hour, but we have only a few minutes remaining, so I'll run a couple of quick examples to illustrate MIM's basic operation.