Session 5A, SOA Mortality and Longevity Research

Moderator:
R. Dale Hall, FSA, CERA, MAAA

Presenters:
Cynthia MacDonald, FSA, MAAA
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SOA Mortality and Longevity Research

SESSION 5A
9:15 – 10:15 AM
FRIDAY JANUARY 6 2017

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Quoting the Actuarial Profession on Mortality

• “Each of us is merely a small instrument; all of us, after accomplishing our mission, will disappear.”
  
  *Mother Teresa*

• “Never use abstract nouns when concrete ones will do. If you mean “More people died” don’t say “Mortality rose.”
  
  *C.S. Lewis*

• “To understand the future, we have to go back in time.”
  
  *Pitbull*
History of Mortality Analysis at the SOA

• 1889: Reason for Being Statement

• Life
  • 1920’s Build and Blood Pressure studies
  • First establishment of body mass indexes as a mortality indicator

• Annuitant / Pensioner:
  • McClintock’s table (Late 1800’s); American Annuitant Table (1918);
    Standard Annuity Table (1937)

• http://mort.soa.org/
History of Life Mortality at the SOA

1941 VBT & CSO by AIA/ASA  
"1 Table"  
Minimum Age: 1  
Maximum Age: 100

1958 CSO  
4 Tables:  
2 Gender *  
2 ANB/ALB  
Maximum Age:  
Male 99  
Female 102

1980 CSO  
12 Tables:  
2 Gender *  
3 Smoker *  
2 ANB/ALB  
Max Age 99

2001 CSO  
S & U  
56 Tables (+VBT)  
Max Age: 120

2015 VBT / 2017 CSO  
132 tables  
Max Attained Age: 120  
Max Issue Age: 95
History of Pension Mortality at the SOA

1949 Merger Volume I Transactions 1949 Standard Annuity table

First design for use in projecting future mortality

Distinct starts between Group and Individual Annuities:
1951 Group Annuity Table
1955 American Annuity Table:

Annuity tables built periodically for insured annuitant valuation
1971 IAM / GAM
1983 IAM / GAM

Insured Plans vs. Privately Sponsored (Uninsured Plans)

UP-1984: Experience from large uninsured pension plans
UP-1994 unloaded
GAR 1994 with loads for insurance valuation

Differentials for new mortality drivers; Focus on improvement scales
Scale AA
RP-2000: M/F Employee/Healthy Annuitant/Disabled Retiree/Combined Healthy

Scale BB / BB-2D

Scale GAR 1994 with loads for insurance valuation

UP-1984:

Experience from large uninsured pension plans

Scale AA

RP-2000:
M/F Employee/Healthy Annuitant/Disabled Retiree/Combined Healthy

Scale BB / BB-2D

RP-2014 MP-2014/5/6

22 tables Employee/Healthy Annuitant/Disabled Retiree/Combined Healthy

Collar
Amount

Annual Update of Mortality Improvement Scales to reflect emerging US population mortality trends

Employee/Healthy Annuitant/Disabled Retiree/Combined Healthy
Resources

- The History of Actuarial Mortality Tables in the United States, Edwin C. Hustead, FSA 1988
- Pension Section Mortality Resources
  - https://www.soa.org/professional-interests/pension/resources/pen-mortality-resources.aspx
The View Ahead....

• What will future mortality studies hold?
  • Underwriting methods changing/evolving
  • More evidence as to what drives relative mortality risk classification in population and insured cohorts

• Growing move to streamline UW and analytics for risk assessment

• What socioeconomic variables are important to gain access to for pension mortality analysis?
The View Ahead....

• Resources for mortality analysis consistent with membership
  • 2016: Chinese Actuarial Association Life Mortality Study Review
• Longevity Advisory Group
• SOA Strategic Research Program Initiative
• Broader and Deeper Projects
  • Mortality Modeling project with Institute and Faculty of Actuaries
  • Components of Historical Mortality Improvement
  • CMS / CDC Combination for feed-in to mortality improvement models
  • CDC Cause of Death Analysis
The View Ahead....

• Human Mortality Database work
  • Cause of Death in 8 specific countries
  • State Level Mortality
  • Causes of Death by State

Causes-of-death Component of the Human Mortality Database

The cause-of-death component of the Human Mortality Database results from the collaboration between researchers in the Department of Demography at the University of California, Berkeley, USA, and at the National Institute for Demographic Studies (INED) in Paris, France, with the help of financial backers and scientific collaborators from around the world (see acknowledgments).

We seek to provide open, international access to these data. Cause of death data are available either as unadjusted, or as adjusted for ICD change in countries for which ICD transitions are documented by bridge-coding studies with sufficient details. The adjustment is carried out using information from bridge-coding studies. No adjusted series is presented for countries without sufficient bridge-coding information.

Causes-of-Death series explanatory notes
List of the cause-of-death categories and corresponding ICD codes
An example of what the data files look like

<table>
<thead>
<tr>
<th></th>
<th>Canada</th>
<th>Czech Republic</th>
<th>England &amp; Wales</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td></td>
<td>Japan</td>
<td>Norway</td>
</tr>
<tr>
<td>Sweden</td>
<td></td>
<td>U.S.A</td>
<td></td>
</tr>
</tbody>
</table>
SOA Mortality and Longevity Research -- Learnings on US Population Databases

CINDY MACDONALD, FSA, MAAA, CFA
Friday, January 6, 2017
Universe of U.S. Population Data
Medicare (CMS)

• General:
  • Considered most reliable data source for ages 65+ (age verification required)

• Timing:
  • Data are made available in January of year y:
    • Preliminary deaths for the year y-2
    • Final deaths for the year y-3
    • Preliminary enrollment counts as of January 1, y-1
    • Final enrollment counts as of January 1, y-2

• Availability:
  • Raw data is not publicly available. The SOA obtains this data from CMS via direct request.
Medicare (CMS) (cont.)

• Considerations:
  • Data only for ages 65+
  • Population only includes those covered by Medicare and Social Security
    • Subset of the population covered by other data sources
  • Death counts at age 65 artificially low
  • Different “as-of” date for population counts compared to other sources
  • Emerging population counts and deaths are adjusted in the following year to reflect retroactive enrollments
    • “Final” data is essentially lagged one year behind other sources
Universe of U.S. Population Data
CDC Wonder Database

• Under National Center for Health Statistics (NCHS)
• Data tool at [http://wonder.cdc.gov](http://wonder.cdc.gov)
  • Years 1999-2015
  • Death counts available for single ages 0-99, 100+ aggregated
  • Population counts available for single ages 0-84

• Considerations
  • No age verification for underlying data
  • 30-year linear phase-in of Medicare data over age 65
  • Limited to 75,000 rows of downloadable data
  • Output restricted for low number of deaths

• Annual updates – recently in December
CDC - Public Use Data Files

• Mortality Multiple Cause Files (deaths)
  • Years 1968-2015 at http://www.cdc.gov/nchs/data_access/Vitalstatsonline.htm
  • More detail for advanced ages
  • 2005 & later – no State or County info; available through NAPHSIS

• Population files
  • Years 1990-2015 at https://www.cdc.gov/nchs/nvss/bridged_race.htm
  • Ages 0-84 available on-line; ages 85+ available by request
  • Older data at https://www.census.gov/popest/data/
Universe of U.S. Population Data

- CMS 65+
- CDC & Census Bureau

Diagram showing data flow connections between CMS 65+, CDC & Census Bureau, and other parts of the universe.
Social Security Administration (SSA)

• General:
  • Current basis used for improvement scales MP 2014-2016 & Scale G2
  • Smoothed mortality rates

• Timing:
  • New data available with Trustees’ Report (generally June/July)
  • Lagged by 3 years (i.e., SSA tables published in 2016 included $q_x$ values through 2013)

• Availability:
  • Publicly available on the SSA website
    • https://www.ssa.gov/OACT/HistEst/DeathHome.html
Social Security Administration (SSA)

• Data sources:
  • CDC/NCHS data used below age 65
  • Medicare data used for ages 65+

• Other considerations
  • Data published are smoothed mortality rates
    • No way to back into raw exposures and deaths without using other sources
  • Raw rates smoothed using methodology developed by H.S. Beers
    • Adopting the data set means adopting the smoothing method by default
    • Method detailed in Actuarial Study No. 120: [link]
Universe of U.S. Population Data

- CDC & Census Bureau
- CMS 65+
- SSA
SOA U.S. Population Mortality Release

  • Based on same data (NCHS/Medicare) that SSA uses for their publications, but without smoothing
  • 2014 information still considered preliminary
SOA U.S. Population Mortality Observations

• Exposure-weighted mortality improvement has declined in recent years
  • Averaged 2.1% for males and 1.7% for females from 2004-2010
  • Negative for males (-0.7%) in 2014 and close to zero (0.0%) for females
    • Driven by increase in mortality rates among young adults
  • 2013: Males = 0.4%, Females = -0.1%
SOA U.S. Population Mortality Release

- Historical average mortality improvement rates, ages 65-84

<table>
<thead>
<tr>
<th>Year</th>
<th>Males</th>
<th>Females</th>
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</thead>
<tbody>
<tr>
<td>2001</td>
<td>2.0%</td>
<td>1.4%</td>
</tr>
<tr>
<td>2002</td>
<td>1.7%</td>
<td>0.7%</td>
</tr>
<tr>
<td>2003</td>
<td>2.3%</td>
<td>1.6%</td>
</tr>
<tr>
<td>2004</td>
<td>4.3%</td>
<td>3.4%</td>
</tr>
<tr>
<td>2005</td>
<td>1.4%</td>
<td>0.7%</td>
</tr>
<tr>
<td>2006</td>
<td>3.3%</td>
<td>2.8%</td>
</tr>
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<td>2.4%</td>
<td>1.8%</td>
</tr>
<tr>
<td>2008</td>
<td>0.4%</td>
<td>-0.2%</td>
</tr>
<tr>
<td>2009</td>
<td>3.8%</td>
<td>4.0%</td>
</tr>
<tr>
<td>2010</td>
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<td>2011</td>
<td>1.2%</td>
<td>0.6%</td>
</tr>
<tr>
<td>2012</td>
<td>0.8%</td>
<td>0.7%</td>
</tr>
<tr>
<td>2013</td>
<td>0.3%</td>
<td>0.4%</td>
</tr>
<tr>
<td>2014</td>
<td>0.7%</td>
<td>1.1%</td>
</tr>
</tbody>
</table>
Universe of U.S. Population Data

Diagram showing connections between SOA, CMS 65+, SSA, and CDC & Census Bureau.
Human Mortality Database (HMD)

• General:
  • Sourced straight from NCHS
  • Data tabulated using Lexis triangles
    • Results in slightly different mortality rates than CDC

• Timing:
  • Currently available through 2014
  • Recent history of updates has been inconsistent
    • Updates are less regular than those from SSA/CMS

• Availability:
  • Publicly available
    • http://www.mortality.org/
    • Deaths available from 0 – 109, 110+
Human Mortality Database (HMD)

• Other considerations
  • Internationally recognized source of data
    • Contains data for 38 countries
  • Information organized by both period and cohort
  • Medicare data not used
  • Information may be less reliable at ages 65 and up
Universe of U.S. Population Data

- SOA
- CMS 65+
- CDC & Census Bureau
- SSA
- HMD
Comparison of Rates between Sources
Males, 2011

<table>
<thead>
<tr>
<th>Male age</th>
<th>SSA-Published</th>
<th>SOA (SSA-Raw)</th>
<th>CMS</th>
<th>CDC</th>
<th>HMD</th>
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<td>35</td>
<td>.00162</td>
<td>.00160</td>
<td>N/A</td>
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<td>55</td>
<td>.00784</td>
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<td>.26688</td>
<td>.29124</td>
<td>.29124</td>
<td>.24312</td>
<td>.29824</td>
</tr>
</tbody>
</table>
THANK YOU!

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SOA Mortality and Longevity Research

LIVING TO 100 SYMPOSIUM

ANDREW PETERSON, FSA, EA, MAAA

January 6, 2017
Agenda

• Historical context
• Consumer-oriented longevity projects
Historical context
Changes Over the Century

Data: SSA Actuarial Study 120 – Periods 1900-2000, 50% male, 50% female

*13,283
20th Century Life Expectancy Improvements

Data: SSA Actuarial Study 120 – Periods 1900-2000, 50% male, 50% female
Squaring of the Life Curve, 1900-2000

Number of **Persons** Living at Each Age ($l_x$)

Data: SSA Actuarial Study 120 – Periods 1900-2000, 50% male, 50% female
Findings from “The Health Inequality Project”

Expected Age at Death vs. Household Income Percentile - By Gender at Age 40

Women, Bottom 1%: 78.8
Women, Top 1%: 88.9
Men, Bottom 1%: 72.7
Men, Top 1%: 87.3

Source: The Health Inequality Project, https://healthinequality.org/
20th Century Mortality Observations

• Life expectancy continually increased
  • At birth: dramatic increases, especially pre-1950
  • At “middle age”: slower, steadier increases

• Most current forecasts assume slower life expectancy increases in the future, including at older ages*

• Undervaluing future mortality improvement:
  • Understates retirement needs and results in mispricing of annuities / pensions
  • Overprices life insurance

• Increasing variability within sub-populations

Consumer-oriented longevity projects
Serving the public on longevity topic: Sampling of SOA research

• 2015 Risk & Process of Retirement Survey
  • Short report: Living Longer and Impact on Planning

• Diverse Risk Essays

• Challenges and Strategies for Financing an Increasingly Long Life
Consumer-oriented projects

• Actuaries Longevity Illustrator
  (Joint project with the American Academy of Actuaries)
• Age Wise Infographics
• Managing Retirement Decisions
• Managing Post-Retirement Risks

Age Wise is a series of infographics to help individuals understand how life expectancy and the decisions they make impact their plans for a happy, healthy and well-funded retirement.

You may live much longer than you think.
Many people base their planning on what their grandparents or parents experienced, but individual life expectancies have improved dramatically over the past century. Current trends suggest that...

1 out of 3 males & 1 out of 2 females who are in their mid-50s today will live to be 90

Will your retirement income plan be enough?

Couples should consider their combined planning timeline.
For a couple who are 65 today...

Odds a wife outlives her husband by...

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>5+ years</td>
<td>45%</td>
</tr>
<tr>
<td>10+ years</td>
<td>31%</td>
</tr>
<tr>
<td>15+ years</td>
<td>20%</td>
</tr>
</tbody>
</table>

Odds a husband outlives his wife by...

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>5+ years</td>
<td>30%</td>
</tr>
<tr>
<td>10+ years</td>
<td>19%</td>
</tr>
<tr>
<td>15+ years</td>
<td>11%</td>
</tr>
</tbody>
</table>

25% will die within 5 years of each other, and there is a 50% chance that one person in the couple will be alive at 92.

It’s not just luck or genes.
Some factors that influence how long you live may be beyond your control. Others depend upon the choices you make every day. A successful retirement plan will address both.

For a personalized look at longevity, see www.longevityillustrator.org © 2016 Society of Actuaries
Age Wise is a series of infographics to help you understand how life expectancy and the decisions you make impact your plans for a happy, healthy and well-funded retirement.

Take the Long View: Expect the Unexpected in Retirement

No matter how well we plan, no one can predict all the expenses that could occur during a retirement lasting 30 years or more.

In a study conducted in 2015, the Society of Actuaries identified common expenses, which they labeled “shocks” because of their sudden, disruptive nature.

According to the research:

7 out of 10 retirees have experienced at least one “shock” during retirement.

2 of those 7 have experienced three or more shocks.
Many of these expenses aren’t so unexpected after all.

Here are three most common “shocks” and what you can do to plan for them:

28% of retirees reported unexpected expenses for major home repairs/upgrades.

**Tip:**
Consider having a home inspection prior to your retirement date, and periodically after that, to identify and budget for major repairs and accommodations.

24% reported unexpected large dental expenses.

**Tip:**
Visit your dentist to determine what work needs to be done now and what you might expect in the future.

20% reported unexpected out-of-pocket medical and prescription drug expenses.

**Tip:**
Talk to your doctor about alternative treatments and look into retailers’, manufacturers’, and other group discount programs.
Actuaries Longevity Illustrator

• Online tool to illustrate longevity risk
• Focuses on range of outcomes, not single life expectancy
• Provides results for individuals and couples
• Joint project created by the American Academy of Actuaries and the Society of Actuaries

• http://www.longevityillustrator.org/
Actuaries Longevity Illustrator (cont.)

Addressing misconceptions...

![Probability of Dying in a Specific Year](chart)

- **Probability of Dying in a Specific Year**
- **Years from now**
- **Jack**
- **Jill**
Valuable graphic outcomes – three perspectives

• Probability of living to a certain age – introduces the concept of longevity as a range.

• Planning horizon – arranged in the order of chance of survival and shows single and joint lifetime information

• Probability of living for a specified number of years – charts the probability of surviving in terms of years for single and joint lifetimes
Demonstration
http://www.longevityillustrator.org/
Conclusions

• SOA Risk Survey shows tendency for individual to underestimate their life expectancy

• The Actuaries Longevity Illustrator provides an easy tool to help individuals better understand longevity
  • Range of outcomes & joint life aspects

• Actuarial profession is working to make a difference...but lots of work is needed!
Contact Details:
Andy Peterson, SOA Senior Staff Fellow
apeterson@soa.org / 847-706-3591
Welcome to the Actuaries Longevity Illustrator

Planning for retirement can be complicated, and there are many factors that must be taken into account. One of the most important, and sometimes misunderstood, is your longevity – that is, how long you might actually live. This is different from your life expectancy, which is how long an individual of your age, gender, and health would be anticipated to live on average. There is still a significant chance that you will live for many years beyond that, and you should consider this possibility when planning your retirement. This Actuaries Longevity Illustrator helps you do that by letting you see how long you might live with different degrees of certainty based on the expectations for an average individual with your characteristics. Take a look. You might be surprised by the results!

If your retirement plans involve two people, the considerations become even more complex. The Longevity Illustrator addresses two crucial concerns, “How long can we expect to live as a couple, and how long can we expect a survivor to live after one of us has died?” The Longevity Illustrator helps you to consider the likelihood of these possible outcomes.

Developed by the American Academy of Actuaries and the Society of Actuaries, the Longevity Illustrator is designed to provide you with perspectives on your longevity risk—the uncertainty of how long you and your spouse/partner might live. It does not address your finances, your investments, your earning potential or your anticipated expenses; consult with a financial professional about those aspects of your retirement planning. We invite you to use the Longevity Illustrator to enhance your understanding of the potential risk for outliving your financial resources.

How it works

You will answer a few questions about your health and demographic characteristics. The Longevity Illustrator will then produce charts that allow you to see the probabilities associated with how long you (and your spouse/partner, if applicable) may live, which will help you understand the likelihood that you may live for a much longer time than your life expectancy would suggest. This will allow you to consider the risks of outliving your financial resources, i.e., the chance of running out of money during your lifetime(s). You can view the results as either charts or as tables of values. You can also print out a summary sheet of the information provided by the Longevity Illustrator.
Enter Your Information

In the chart below, under “Person 1,” enter your name and date of birth. If you want the illustrations to start later than your current age, enter that age; otherwise leave that blank and the illustrations will start at your nearest current age. Also enter your gender, whether you smoke and your general state of health. For your spouse/partner enter the same information (except for the age at which the calculations are to start) in the “Person 2” column. The age for your spouse/partner is set to his or her nearest age at the time the illustrations will start. If you are single or do not wish to use the joint-life features in the program, leave the “Person 2” entries blank.

You can always come back to this page to see how a change in what you enter affects the subsequent answers. In fact, you might find it very informative to see how the results change when you enter different ages and/or health statuses.

**Person 1**
- **First Name**: Jack
- **Date of Birth**: 07/1/1965
- **Age for Illustration to Start**: 67
- **Gender**: Male
- **Do you smoke?**: Yes
- **General Health**: Average

**Person 2**
- **First Name**: Jill
- **Date of Birth**: 07/1/1968
- **Age for Illustration to Start**: 67
- **Gender**: Female
- **Do you smoke?**: No
- **General Health**: Excellent

**FAQ**
- **What should I enter for “Age for Illustration to Start”?**
- **How do I answer the smoking question if I have previously smoked, but quit?**
- **What do you mean by “general health”?**
- **Why does the tool only ask about age, gender, smoking, and health? What about other factors that affect longevity?**

[View Results]
Results

Probability of Living to a Certain Age

This graph introduces the concept of longevity as a range. It illustrates the likelihood that you will live at least to certain ages. If you chose to enter an illustration age later than your nearest age, the calculations assume 100% likelihood that you will live from your nearest age to the age you entered. For instance, the chart shows that the likelihood is 60% that you will live from the later of your nearest age or the illustration age entered to 85, while Jill has a 55% chance of living to 85.

Note that these probabilities are calculated from your nearest age or from the illustration age if you entered one. If you chose to enter an illustration age later than your nearest age, the Longevity Illustrator assumes a 100% chance that you will live to the age you chose and also a 100% chance that Jill will live the same number of years.
Results

Planning Horizon

This chart shows a planning horizon based on the information you entered – that is, the number of years you can expect to live from your illustration age with a given probability. This is similar to the information presented in the first chart, but it is arranged in order of chance of survival, not ages. This perspective allows you to consider your retirement spending based on your personal level of comfort or risk tolerance.

In addition to showing your longevity as individuals (the blue and grey bars), the chart provides key information for you as a couple: it shows the probability that both of you will survive (the green bar), as well as the probability that at least one of you will survive (the light red bar). This lets you focus on your longevity as a couple rather than as individuals. For instance, you may be comfortable setting your planning horizon based on a 25% chance that you will survive at least that long. In this case, based on the chart, you could consider 21 years where you are both still alive (the green bar), and then an additional 11 where one of you survives the other (32 years in total). If you want to be more cautious, you might set your planning horizon looking at the 10% chance you will survive longer (26 years as a couple, and an additional 10 years where one of you survives the other (36 years in total). As the chart shows, the common practice of planning for each spouse/partner separately may lead you to underestimate by several years the length of time at least one of you will live.

Note that these probabilities are calculated from your nearest age or from the illustration age if you entered one. If you chose to enter an age later than your nearest age, the Longevity Illustrator assumes a 100% chance that you will live to the age you chose and also a 100% chance that Jill will live the same number of years.

Why is the number of years that either one or both of us will live (the light red bar) greater than the number of years one of us will live (the blue and grey bars)?
Probability of Living for a Specified Number of Years

This chart takes the same information as the previous chart but shows it in a different way. Instead of showing the years you might expect to live with a specific level of certainty, this chart shows the probability that both of you will live a specific number of years in the future from the illustration age you entered. For instance, looking at the 25-year line, there is a 32% chance that you will survive 25 years, but a 41% chance that Jill will survive that same amount of time. In addition, there is a 60% chance that either of you will survive 25 years and only a 13% chance that you both will survive 25 years.

An important point is that it is very likely one of you is going to outlive the other, and you must take this fact into account when making your retirement plans. You should also consider the chance that either of you may live much longer than your average life expectancy.