



**2019 HEALTH**  
MEETING

JUNE 24-26 | PHOENIX, AZ



## **Session 101, Developing Mortality Improvement Assumptions for your Product and Target Market**

[SOA Antitrust Disclaimer](#)

[SOA Presentation Disclaimer](#)

# 2019 Health Meeting

**CYNTHIA MACDONALD**

**Session 101, Developing Mortality Improvement Assumptions  
for Your Product and Target Market**

June 25, 2019



# SOCIETY OF ACTUARIES

## Antitrust Compliance Guidelines

Active participation in the Society of Actuaries is an important aspect of membership. While the positive contributions of professional societies and associations are well-recognized and encouraged, association activities are vulnerable to close antitrust scrutiny. By their very nature, associations bring together industry competitors and other market participants.

The United States antitrust laws aim to protect consumers by preserving the free economy and prohibiting anti-competitive business practices; they promote competition. There are both state and federal antitrust laws, although state antitrust laws closely follow federal law. The Sherman Act, is the primary U.S. antitrust law pertaining to association activities. The Sherman Act prohibits every contract, combination or conspiracy that places an unreasonable restraint on trade. There are, however, some activities that are illegal under all circumstances, such as price fixing, market allocation and collusive bidding.

There is no safe harbor under the antitrust law for professional association activities. Therefore, association meeting participants should refrain from discussing any activity that could potentially be construed as having an anti-competitive effect. Discussions relating to product or service pricing, market allocations, membership restrictions, product standardization or other conditions on trade could arguably be perceived as a restraint on trade and may expose the SOA and its members to antitrust enforcement procedures.

While participating in all SOA in person meetings, webinars, teleconferences or side discussions, you should avoid discussing competitively sensitive information with competitors and follow these guidelines:

- **Do not** discuss prices for services or products or anything else that might affect prices
- **Do not** discuss what you or other entities plan to do in a particular geographic or product markets or with particular customers.
- **Do not** speak on behalf of the SOA or any of its committees unless specifically authorized to do so.
- **Do** leave a meeting where any anticompetitive pricing or market allocation discussion occurs.
- **Do** alert SOA staff and/or legal counsel to any concerning discussions
- **Do** consult with legal counsel before raising any matter or making a statement that may involve competitively sensitive information.

Adherence to these guidelines involves not only avoidance of antitrust violations, but avoidance of behavior which might be so construed. These guidelines only provide an overview of prohibited activities. SOA legal counsel reviews meeting agenda and materials as deemed appropriate and any discussion that departs from the formal agenda should be scrutinized carefully. Antitrust compliance is everyone's responsibility; however, please seek legal counsel if you have any questions or concerns.

# Presentation Disclaimer

*Presentations are intended for educational purposes only and do not replace independent professional judgment. Statements of fact and opinions expressed are those of the participants individually and, unless expressly stated to the contrary, are not the opinion or position of the Society of Actuaries, its cosponsors or its committees. The Society of Actuaries does not endorse or approve, and assumes no responsibility for, the content, accuracy or completeness of the information presented. Attendees should note that the sessions are audio-recorded and may be published in various media, including print, audio and video formats without further notice.*

# Goals

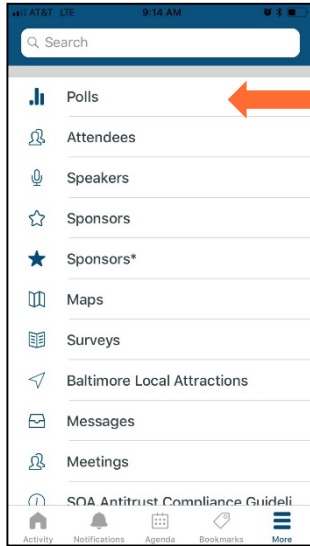
- Provide an understanding of where mortality improvement & SOA experience studies intersect
- Review SOA and other data sources and existing improvement 'scales'
- Dive into SOA Pension mortality improvement scales and model

# Quick Survey



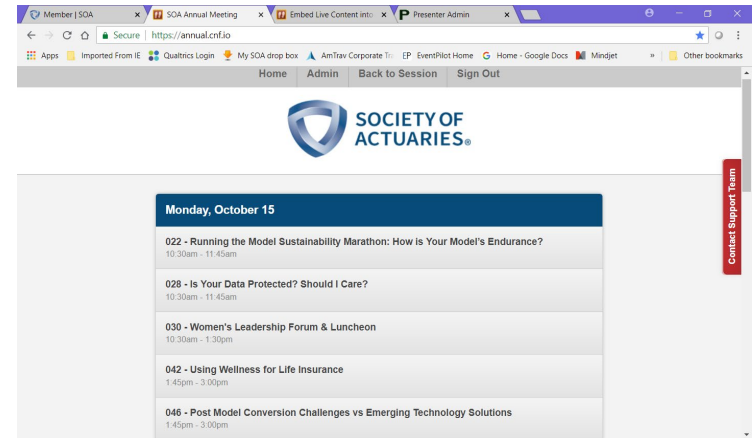
# To Participate, look for Polls in the SOA Event App or visit [health.cnf.io](https://health.cnf.io) in your browser

Find The Polls Feature Under **More**  
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Session in the Agenda



or

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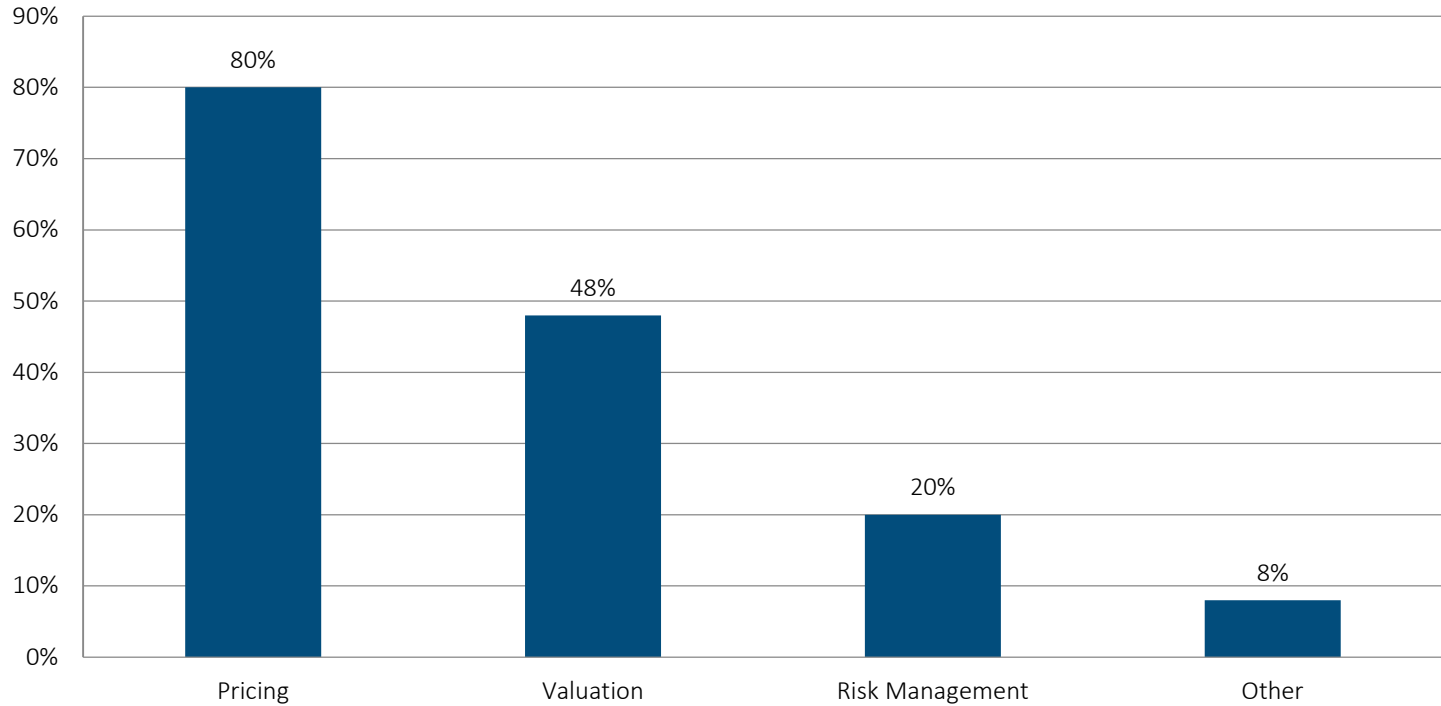


# How do you use mortality improvement assumptions? (Choose all that apply)

- A. Pricing
- B. Valuation
- C. Risk Management
- D. Other



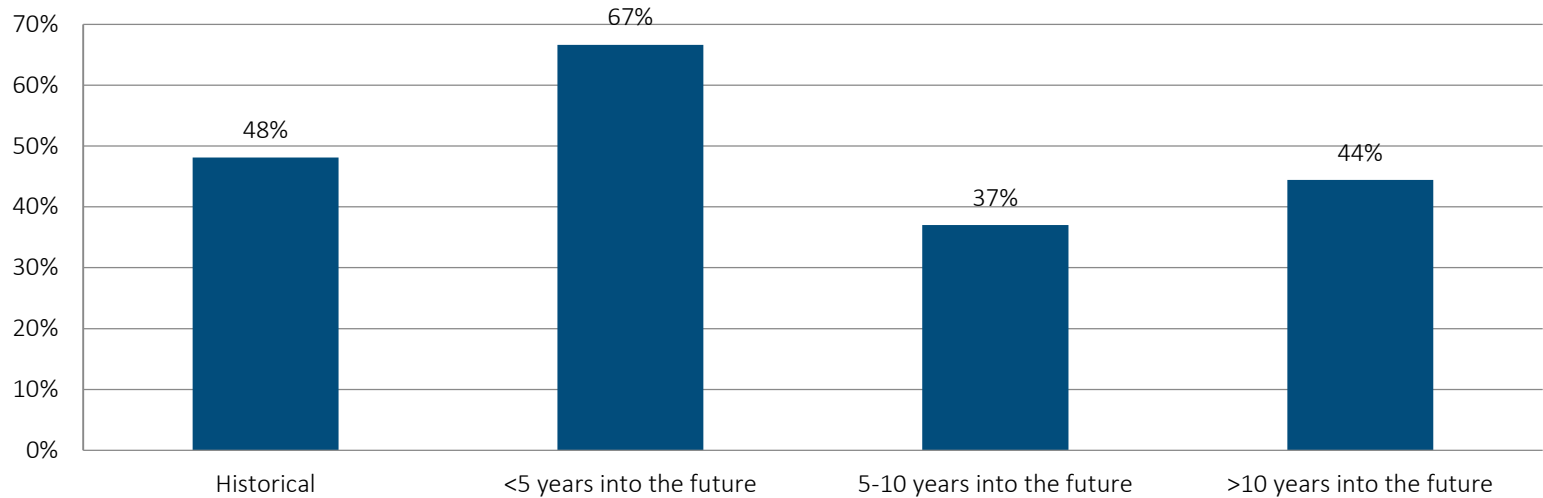
## How do you use mortality improvement assumptions?



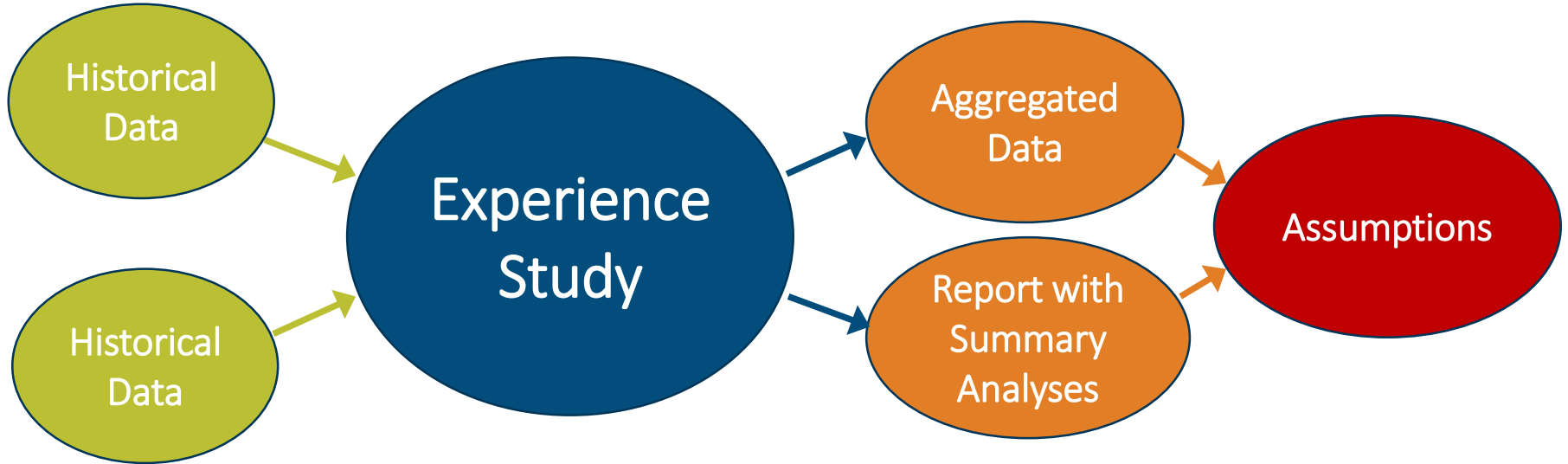
What time horizon is of most interest when you are making mortality improvement assumptions? (Choose all that apply)

- A. Historical
- B. < 5 years into the future
- C. 5-10 years into the future
- D. > 10 years into the future




## What time horizon is of most interest when you are making mortality improvement assumptions?



# In's and Out's of SOA Experience Studies



# Mortality Valuation Tables/Scales

LOB		Life/Annuities	Pensions
Who		SOA/Academy	SOA
What		Statutory	Tax

# Latest Mortality Studies & Data

- Individual Life, 2009-15
  - <https://www.soa.org/resources/research-reports/2019/2009-2015-individual-life-mortality/>
- Individual Payout Annuities, 2009-13
  - <https://www.soa.org/resources/experience-studies/2016/2009-13-individual-payout-annuity/>
- Group Annuity, 2007-16
  - <https://www.soa.org/resources/experience-studies/2018/group-annuity-experience/>
- Private Pensions, 2010-2014
  - <https://www.soa.org/globalassets/assets/files/resources/experience-studies/2019/pri-2012-mort-tables-exposure-draft.pdf>

# Challenges with Insured Industry Data for Mortality Improvement

- Mortality improvement requires
  - A consistent, large body of data
  - Over a long period of time
- Insured industry data
  - Cover relatively short period of time
  - Lack of homogeneity across time
    - Different data contributors may participant in each study
    - Mix of attributes or factors may change over time
    - Underwriting, distribution considerations

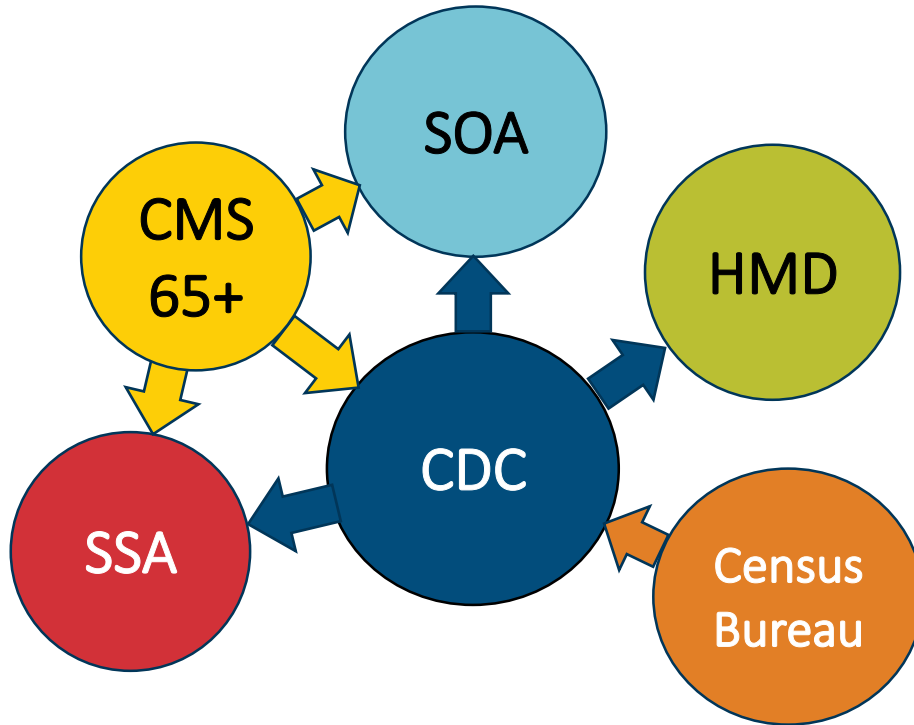
# As a Result.....

Past improvement scales, developed by SOA/AAA or SOA for 'valuation', have been based on population data

- Scale AA – Group Annuities
  - <https://www.soa.org/globalassets/assets/library/research/transactions-of-society-of-actuaries/1990-95/1995/january/tsa95v4722.pdf>
- Scale G2 – Individual Payout Annuities
  - <https://www.soa.org/resources/experience-studies/2011/2012-ind-annuity-reserving-rpt/>
- PBR improvement – Individual Life
  - <https://www.soa.org/resources/experience-studies/2018/2018-mortality-improvement/>
- MP2014, MP2015, MP2016, MP2017, MP2018 – Pensions



# Universe of U.S. Population Data



CDC	Centers for Disease Control & Prevention
CMS	Centers for Medicare & Medicaid Services
SSA	Social Security Administration
HMD	Human Mortality Database
SOA	Society of Actuaries

# Locations of U.S. Population Data Sources

- Centers for Disease Control (CDC)
  - WONDER - Data tool at <http://wonder.cdc.gov>
- Social Security Administration (SSA)
  - <https://www.ssa.gov/OACT/HistEst/DeathHome.html>
- Human Mortality Database (HMD)
  - <http://www.mortality.org/>
- Society of Actuaries (SOA)
  - <https://www.soa.org/resources/research-reports/2018/us-mortality-rates-2000-2016/>
  - <https://www.soa.org/research/topics/research-emerging-topics/#population>

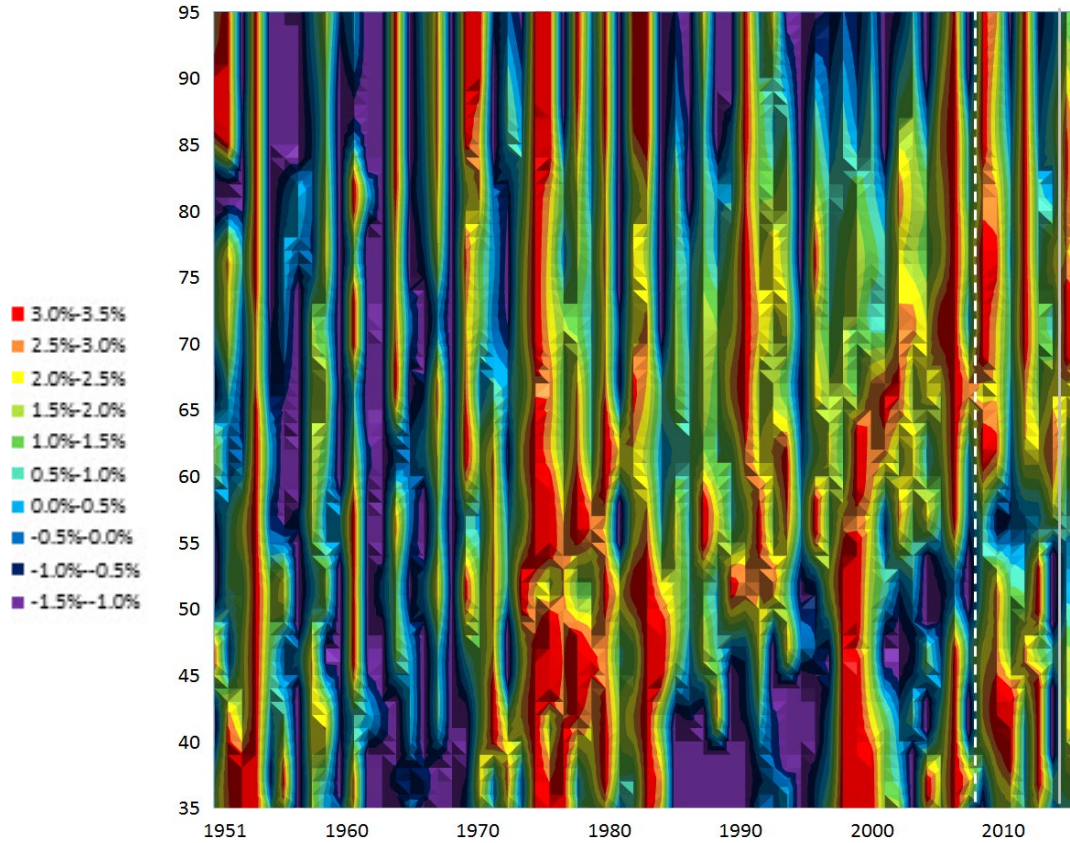
# MP20xx Mortality Improvement Scales and the RPEC\_2014 Model



# RPEC Literature Search

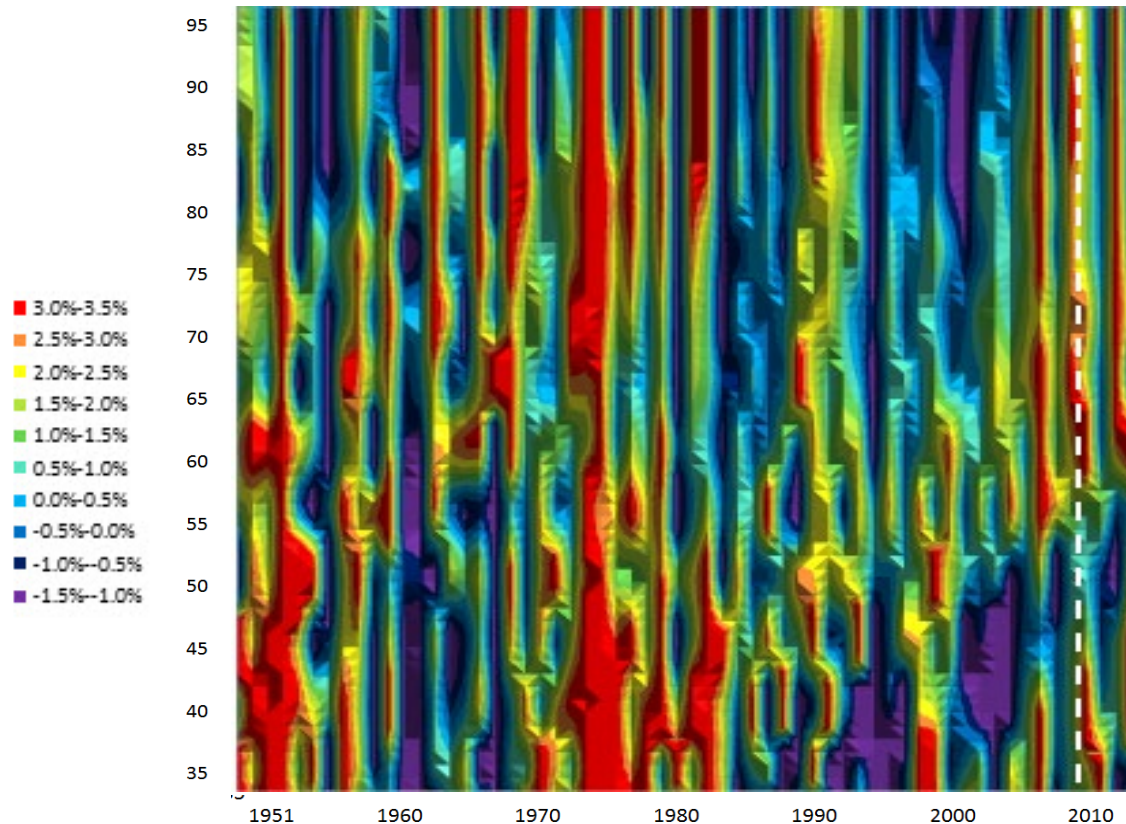
- Reviewed existing mortality improvement models
- CMI model
- Long-term improvement assumptions
- Analysis of age-period-cohort factors
- Other factors – socioeconomic status, smoking, obesity
  - <https://www.soa.org/globalassets/assets/files/research/exp-study/research-2013-lit-review.pdf>

# Ungraduated Historical SSA Mortality Rates - Males



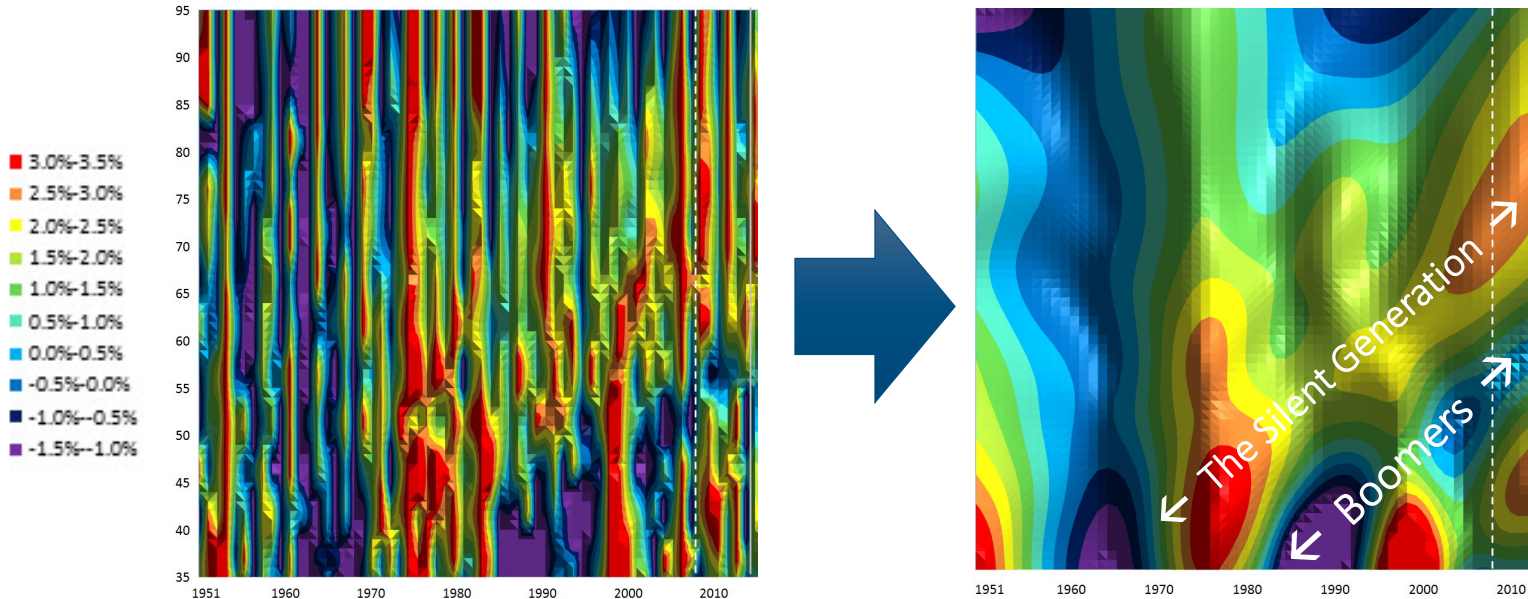
- Volatility makes patterns difficult to identify in the ungraduated experience
- Cohort effects are still visible even without graduation

# Ungraduated Historical SSA Mortality Rates - Females



- Female improvement shows fewer 'red' peaks
- Cohort effects are visible in the ungraduated female data as well

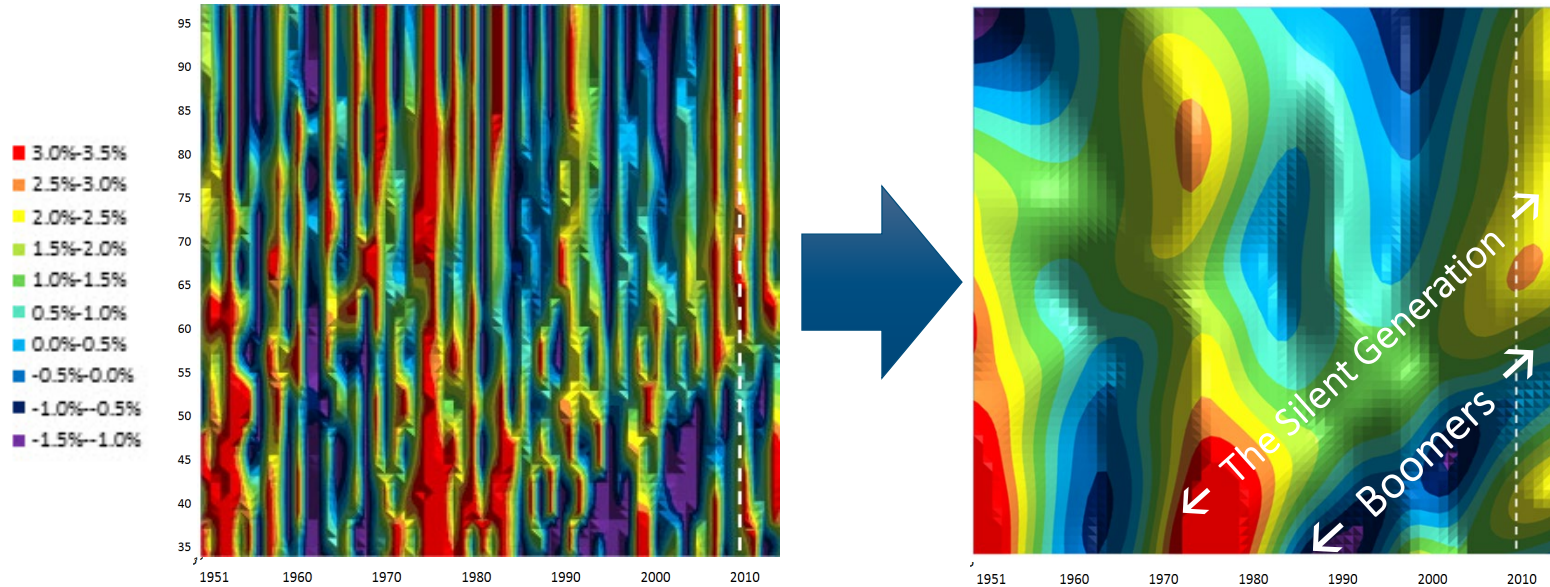
# Graduated SSA Experience (Male)



- Graduation allows the trends to emerge which show the period-effect ridges as well as more clearly defined cohort influences



# Graduated SSA Experience (Female)



- Female experience shows similar diagonal cohort patterns



# Mortality Improvement for Pension Plans

- Heat maps showed presence of cohort effects and period effects in U.S. historical data
- RPEC aimed to reflect these effects in future mortality improvement projection
- Decided to create a 2-dimensional improvement scales

# RPEC\_2014 Model

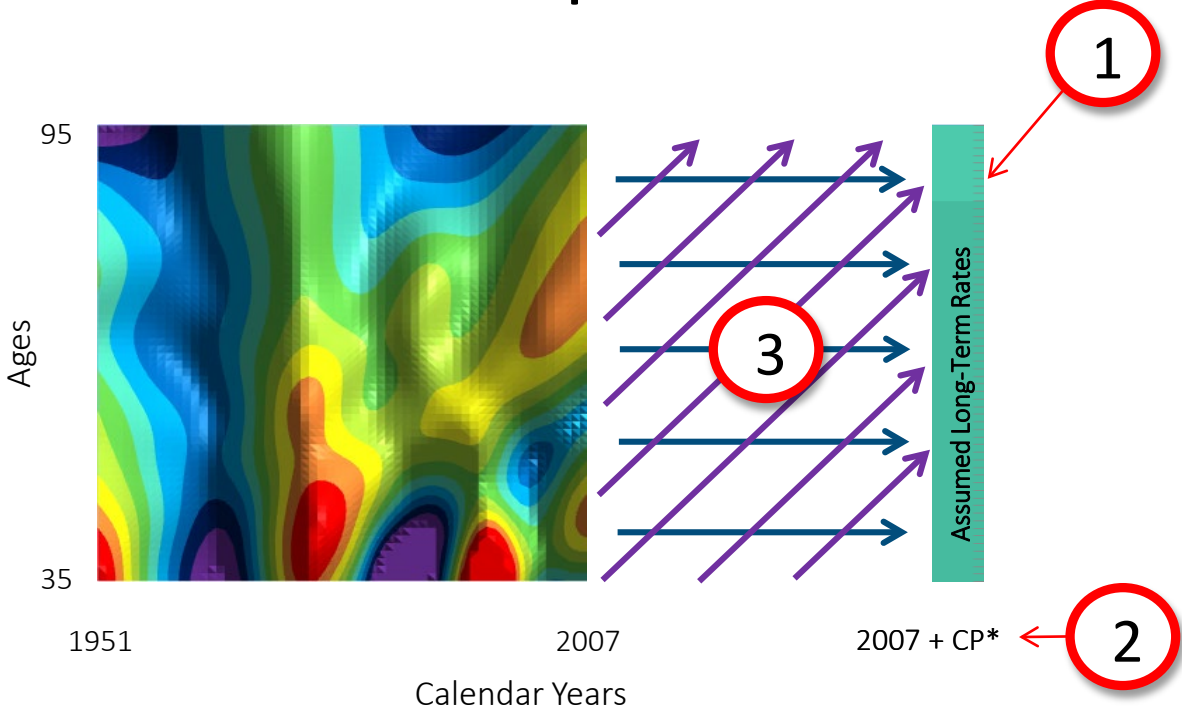
- Two-dimensional rates based on same principles underpinning CMI (UK) model
  - Near-term rates should look like the recent past
  - Long-term rates should be based on “expert opinion”
  - Smooth transition between near- and long-term rates
- Historical mortality trends based on SSA population data

# RPEC\_2014 Model

Three key assumptions in RPEC\_2014 model:

1. Long-term rate of mortality improvement
2. Length of convergence period
3. Blending of age/period and cohort interpolations

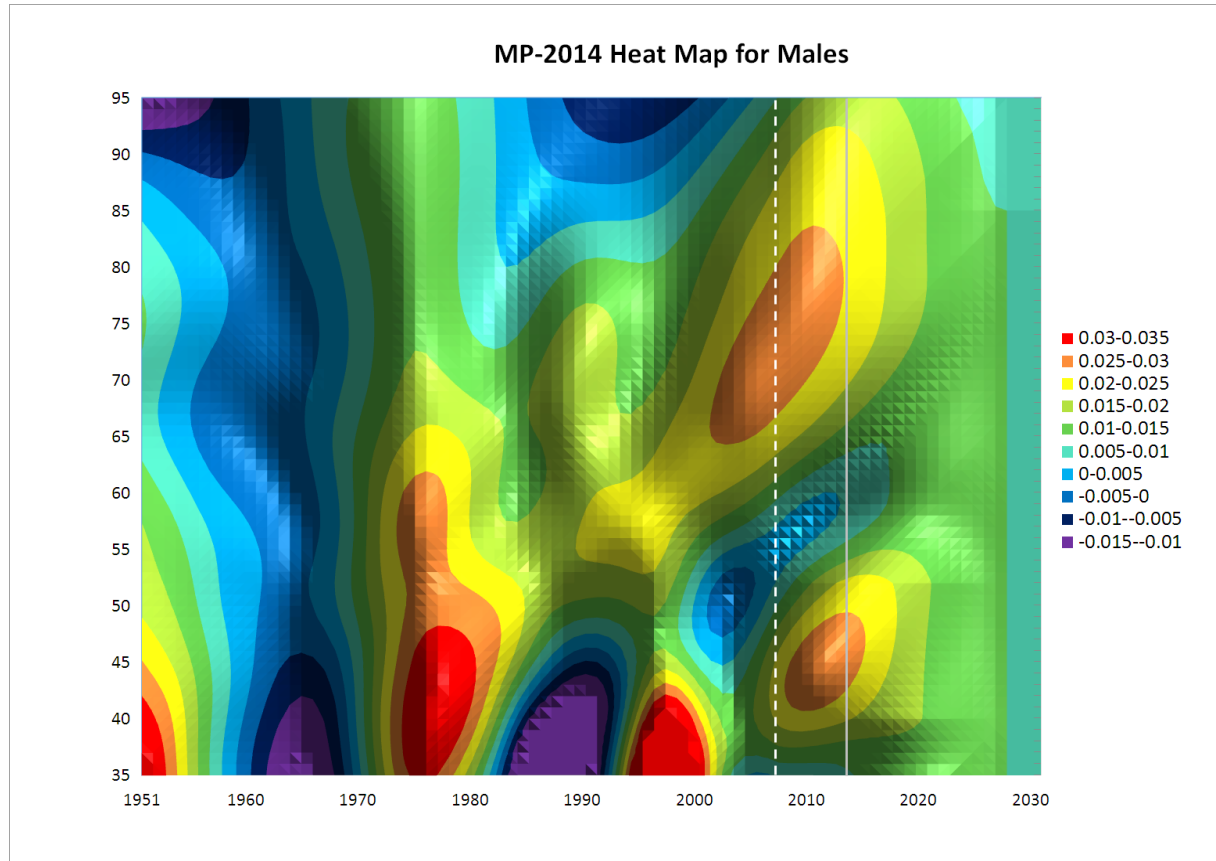
# RPEC\_2014 Model: Interpolation



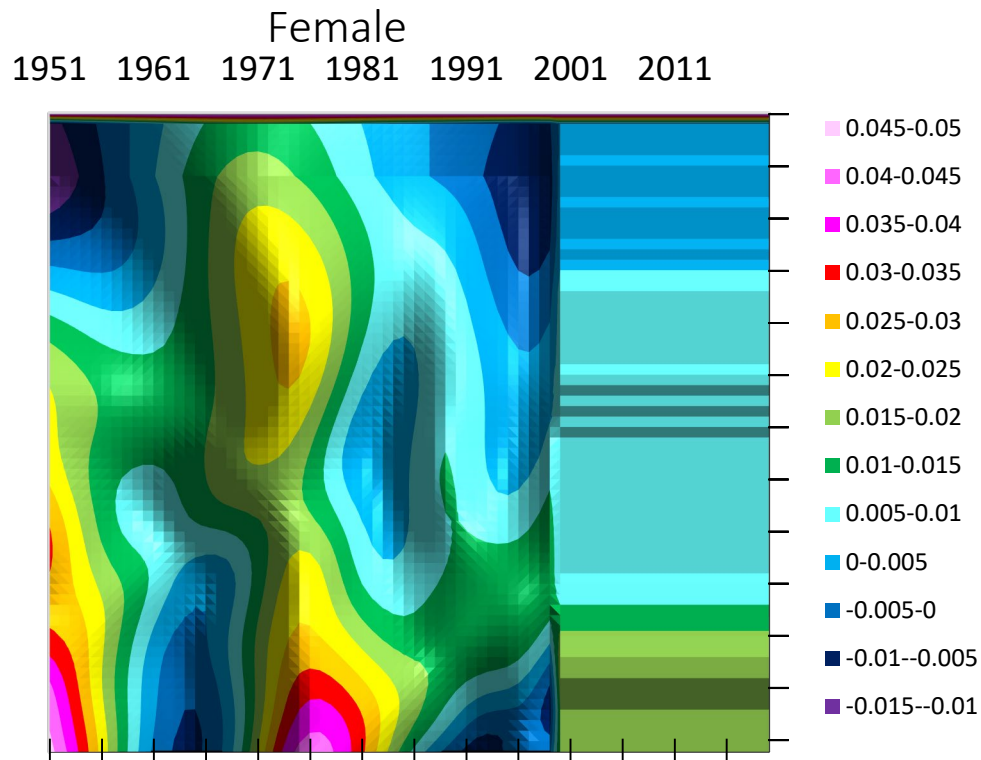
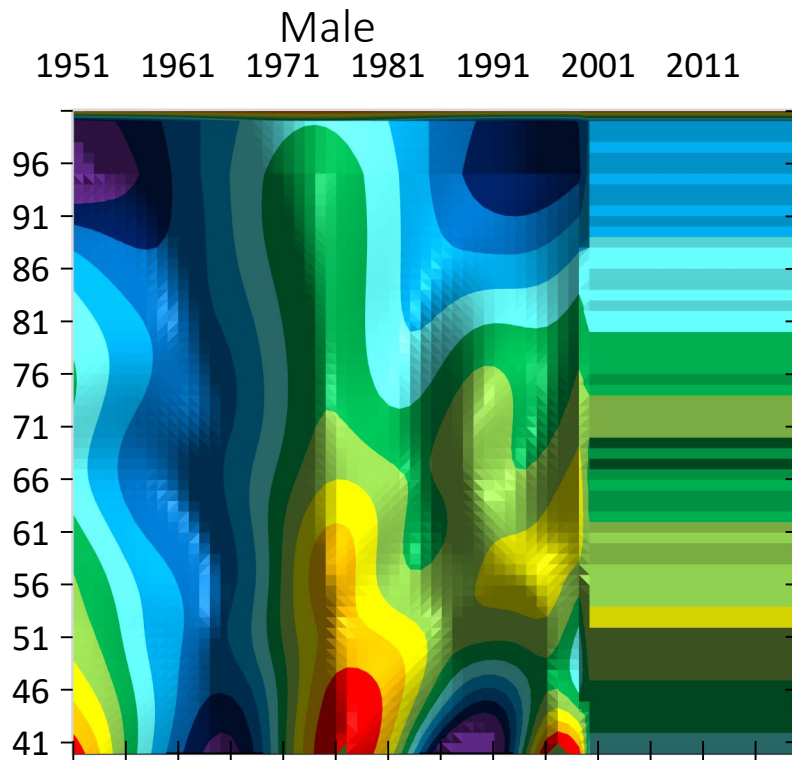
# Scale MP-2014 Assumptions

- Scale MP-2014 is the output from the RPEC\_2014 model when RPEC's selected assumptions are used.
- The “committee-selected” assumption set:
  1. Long-term rates:
    - Flat **1.0%** through age 85
    - Slight linear taper to **0.85%** at age 95
    - Then linear decrease to **0.0%** at age 115
  2. Convergence periods: **20 years** for both age/period and cohort effects
  3. Blending of age/period and cohort interpolations:  
**50%/50%**

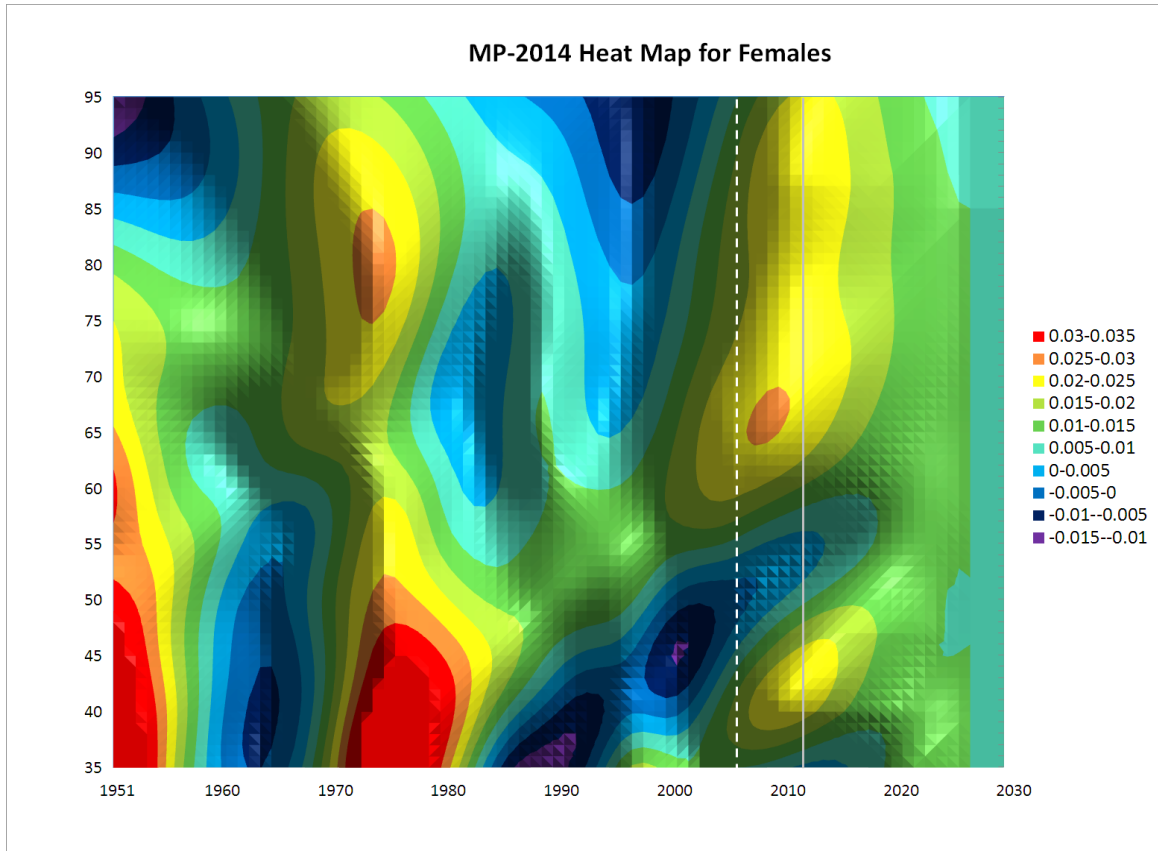
# Scale MP-2014: Heat Map for Males



# Observed U.S. MI vs Scale AA



# Scale MP-2014: Heat Map for Females





# Evolution of RPEC\_2014 Model and “MP” Scales



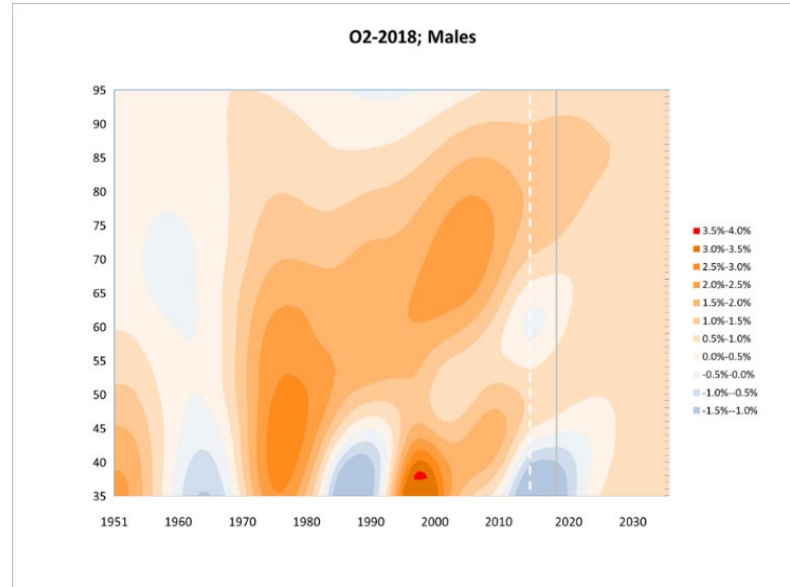
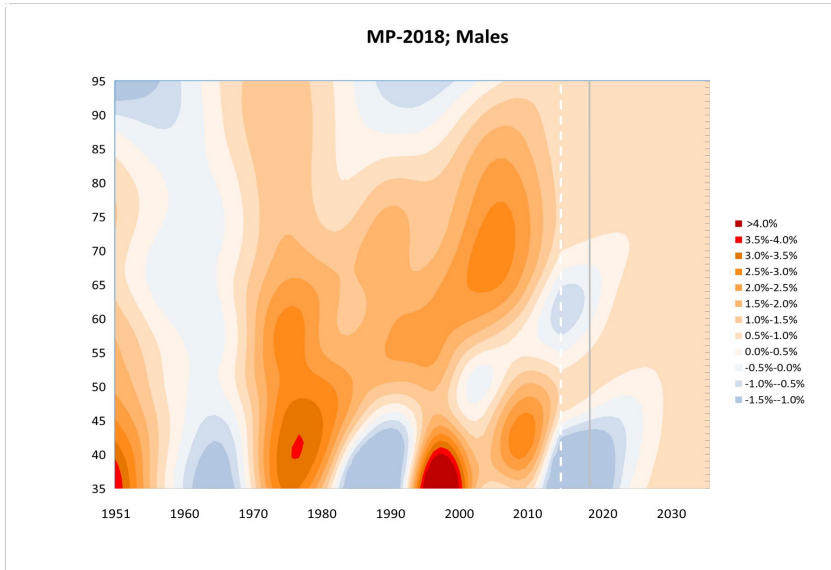
# Beyond MP2014

- RPEC\_2014 model uses recent mortality improvement as a starting point and “jumping-off” slope for projection
  - Most recent years of data are very important to model output
- Each October, RPEC has published annual updates to the RPEC\_2014 model and a new MPyyyy Scale to reflect most recent available data

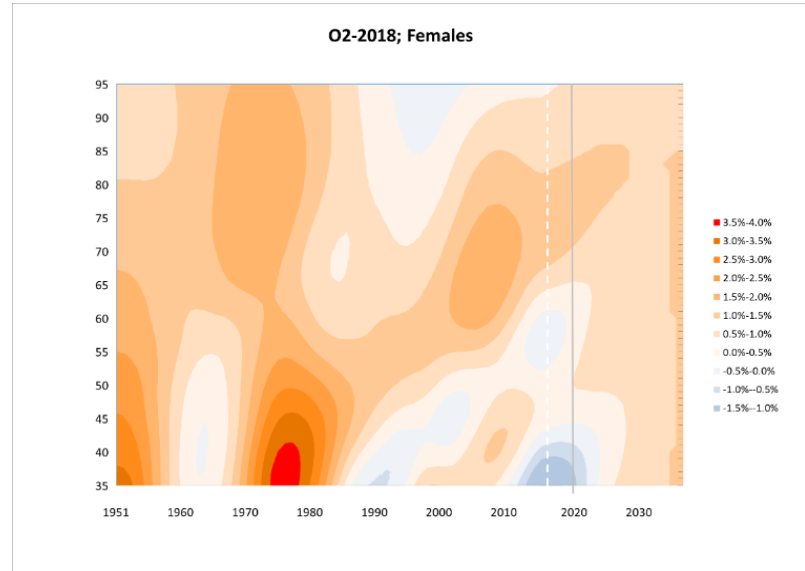
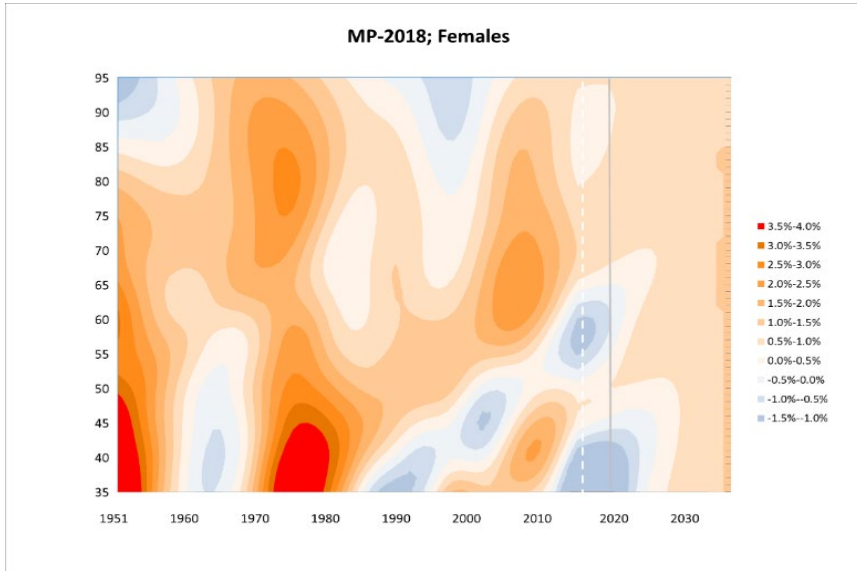
# Improvements Over Time

- Use of more current data
  - Scale MP-2014 based on data through 2009, 5 year lag
  - Scale MP-2015 based on data through 2011, 4 year lag
  - Scale MP-2016 based on data through 2014, 2 year lag
- 2016: RPEC\_2014 changes
  - Set “jumping off” slope equal to zero
  - Shortened age/period (“horizontal”) component of the convergence period from 20 years to 10 years
- 2018: RPEC introduced the RPEC\_O2 model
  - O2 model, which uses “order-2” historical Whittaker-Henderson graduation, now available
  - MP2018 used the RPEC\_2014 “order-3” historical Whittaker-Henderson graduation

# Heat Map Comparison - Males



# Heat Map Comparison - Females



# Pension Plan Studies and MP20xx Scales

## Retirement Plans Experience Studies

The SOA offers studies and table reports on mortality and pensions for use by actuaries. Studies often contain many files for download, including multiple ZIP files, PDFs and Excel files. Table reports are often accompanied by Excel workbooks with complimentary materials.

### 2019

#### **Exposure Draft: Pri-2012 Private Retirement Plans Mortality Tables**

May

The Society of Actuaries' Retirement Plans Experience Committee (RPEC) has released an exposure draft of the Pri-2012 Private Retirement Plans Mortality Tables. The primary focus of this study was a comprehensive review of recent mortality experience of private retirement plans in the United States.

#### **Pub-2010 Public Retirement Plans Mortality Tables**

January

### 2018

#### **Mortality Improvement Scale MP-2018**

October

#### **Exposure Draft: Pub-2010 Public Retirement Plans Mortality Tables**

August

### 2017

#### **Mortality Improvement Scale MP-2017**

October

### 2016

#### **Mortality Improvement Scale MP-2016**

October

### 2015

#### **Mortality Improvement Scale MP-2015**

October

### 2014

#### **Mortality Improvement Scale MP-2014**

October

#### **RP-2014 Mortality Tables**

October

#### **Mortality Improvement Scale MP-2014 Exposure Draft**

February

#### **RP-2014 Mortality Tables Exposure Draft**

February

### 2013

#### **Literature Review and Assessment of Mortality Improvement Rates in the U.S. Population: Past Experience and Future Long-Term Trends**

August

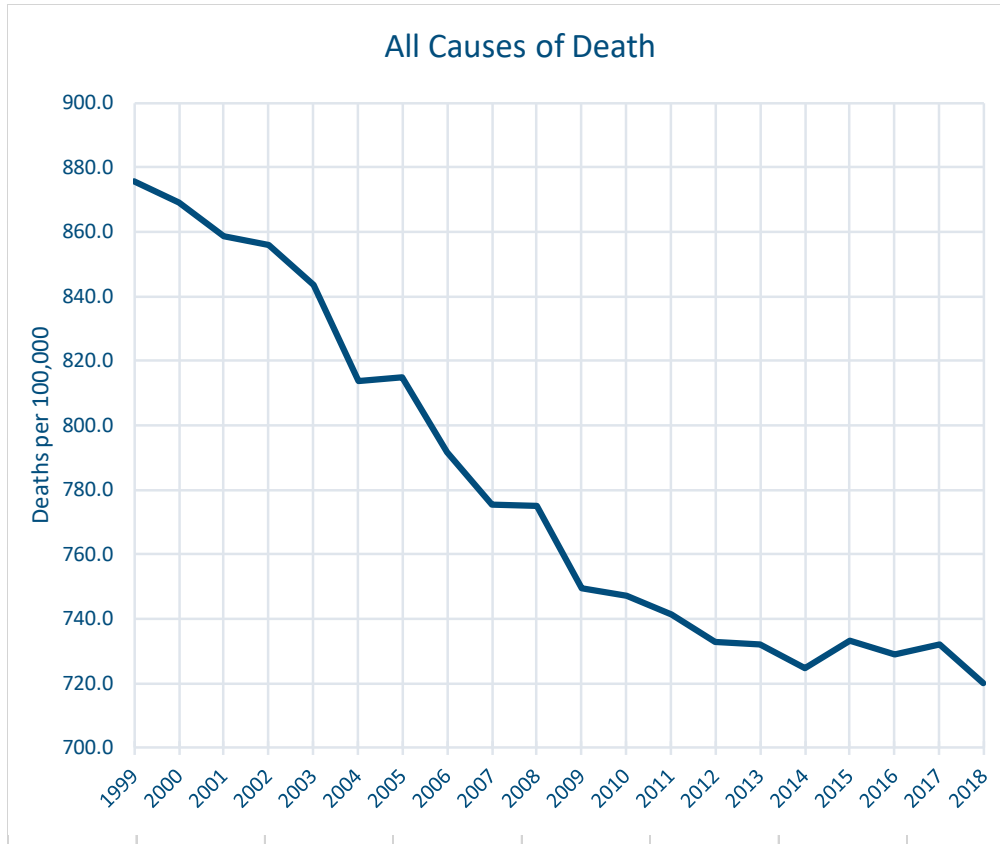
### 2012

#### **Mortality Improvement Scale BB Report**

March

- <https://www.soa.org/research/topics/pension-exp-study-list/>

# Hot off the press...2018 U.S. Population Mortality



Year	Deaths per 100,000	Year over Year % Change
1999	875.6	n/a
2000	869.0	-0.8%
2001	858.8	-1.2%
2002	855.9	-0.3%
2003	843.5	-1.4%
2004	813.7	-3.5%
2005	815.0	0.2%
2006	791.8	-2.8%
2007	775.3	-2.1%
2008	774.9	-0.1%
2009	749.6	-3.3%
2010	747.0	-0.3%
2011	741.3	-0.8%
2012	732.8	-1.1%
2013	731.9	-0.1%
2014	724.6	-1.0%
2015	733.1	1.2%
2016	728.8	-0.6%
2017	731.9	0.4%
<b>2018</b>	<b>720.2</b>	<b>-1.6%</b>

# THANK YOU!

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**SOCIETY OF  
ACTUARIES®**

Session 101

***Developing Mortality Improvement Assumptions for your  
Product and Target Market***

June 2019 SOA Health Meeting – Phoenix, AZ

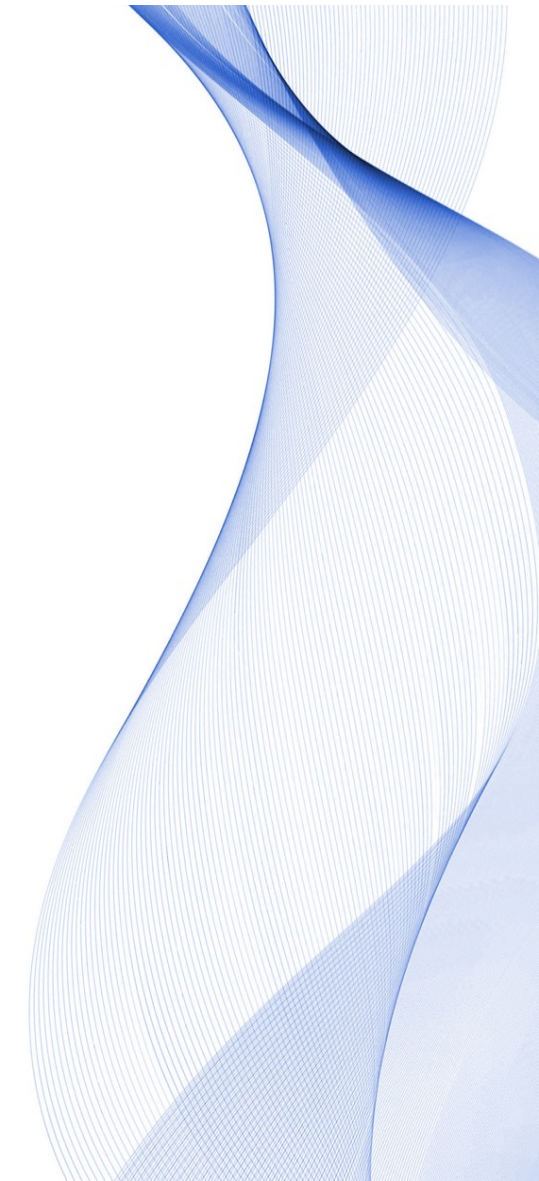
*Jim Filmore, FSA, MAAA*

*Vice President, Group & Living Benefits Pricing*

Munich Re Life US

# Agenda

1. Polling of Audience
2. Headlines in the News
3. Digging Deeper Into the Data
4. Your Product & Target Market
5. Predicting the Future
6. Questions?





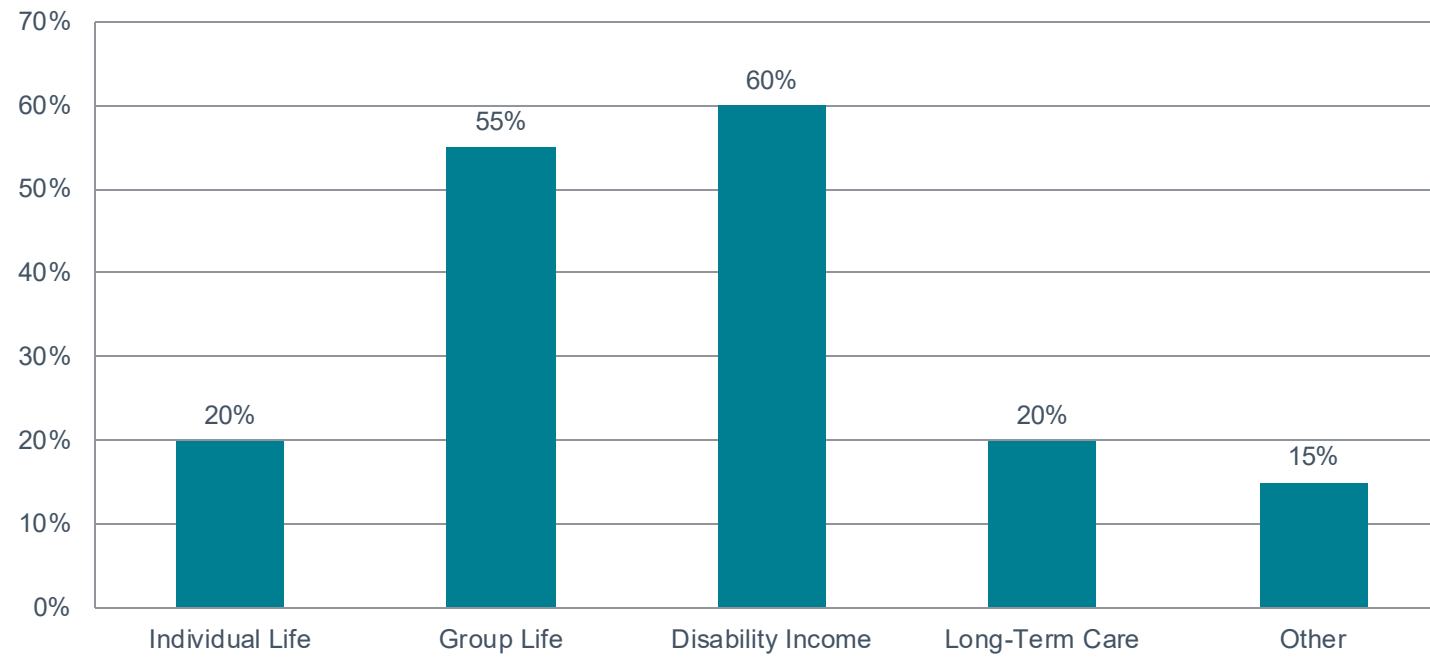
# Polling of Audience

# Polling Question #1

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- 1) For what insurance products are you most interested in mortality improvement trends?
- A. Individual Life
  - B. Group Life
  - C. Annuity/Longevity
  - D. Disability
  - E. Long-Term-Care
  - F. Other

### For what product(s) are you most interested in mortality improvement trend?





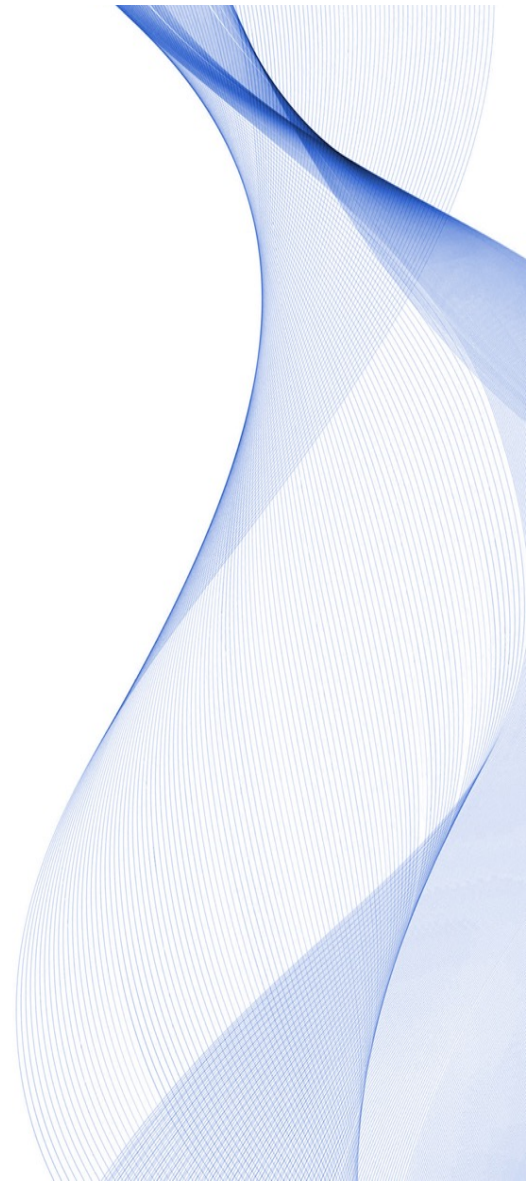
# Polling Question #2

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2) What interest do you hear from actuaries today regarding mortality improvement trends as compared to how much you heard in the past?

- A. More interest in MI currently
- B. More interest in MI previously
- C. Same level of interest

What interest do you hear from actuaries today regarding mortality improvement trends as compared to how much you heard in the past?





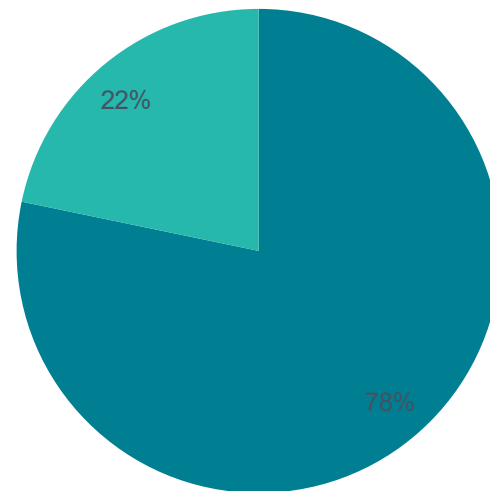
# Polling Question #3

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3) Have you heard any questions or comments over the past year either within your company or on the news regarding changes in mortality trends in the United States?

- A. Yes
- B. No

Have you heard any questions or comments over the past year either within your company or on the news regarding changes in mortality trends in the United States?



■ Yes  
■ No



# Headlines in the News



# Headlines in the News



# Digging Deeper Into the Data



# Overall Population Trend from SOA Study

<https://www.soa.org/resources/research-reports/2018/population-mortality-observations/>



CALENDAR ACTUAF



Future Actuaries Education & Exams Professional Development Research Professional Sections

## US Population Mortality Observations - Updated with 2017 Experience

January 2019

This report covers the latest emerging trends in U.S. population mortality. The SOA relied upon data furnished by the Centers for Disease Control and Prevention (CDC). Observations are based on the CDC's recent release of 2017 mortality experience, along with prior mortality experience data from 1999 through 2016.

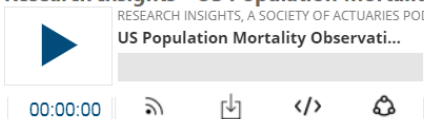
### Materials





- [US Population Mortality Observations – Updated with 2017 Experience](#) 
- [US Population Mortality Observations – Appendices](#)  (Updated 1/09/2019)

### Podcast

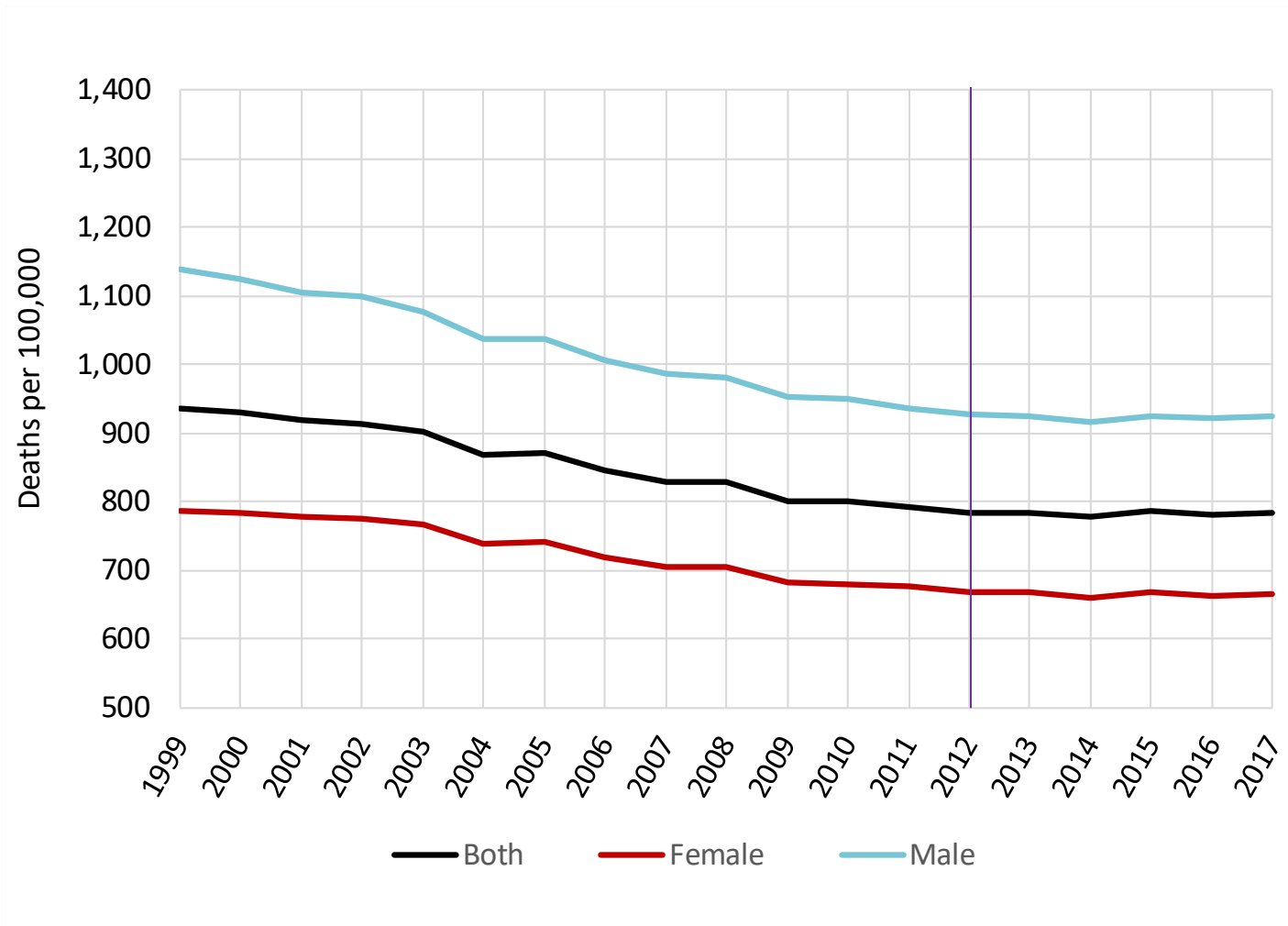
Research Insights - US Population Mortality Observations - Updated with 2017 Experience

RESEARCH INSIGHTS, A SOCIETY OF ACTUARIES POD  
US Population Mortality Observati...



00:00:00    

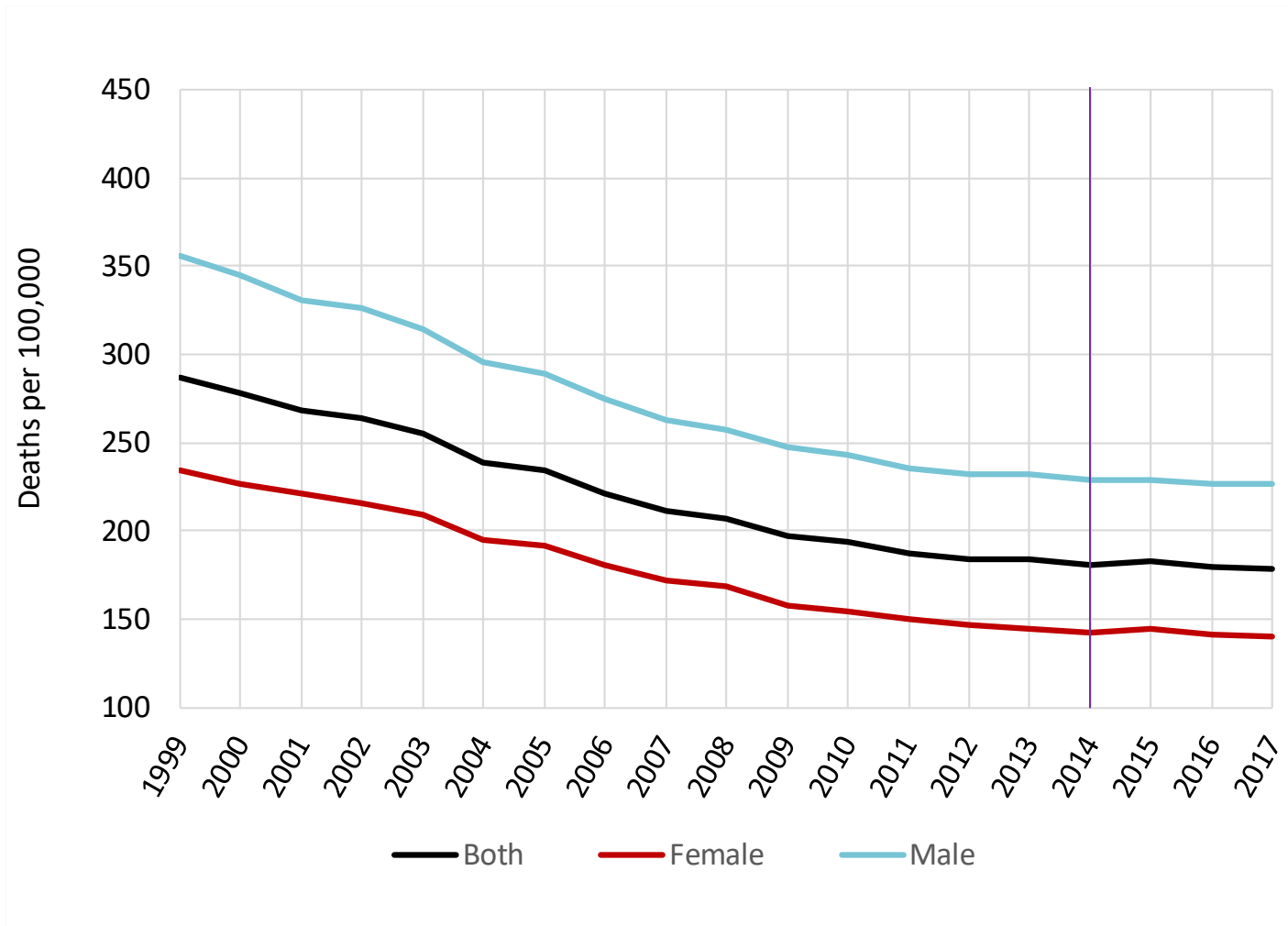
# Overall Population Trend from SOA Study



	Annual Improvement		
	1999-2017	2012-2017	2016-2017
<b>All Ages</b>			
Both	1.0%	0.0%	-0.4%
Female	0.9%	0.1%	-0.4%
Male	1.1%	0.0%	-0.4%
<b>Age Group*</b>			
< 1	1.4%	1.1%	2.8%
1 - 4	1.9%	1.6%	4.3%
5 - 14	1.7%	-1.4%	-1.2%
15 - 24	0.4%	-2.2%	1.1%
25 - 34	-1.5%	-4.7%	-3.0%
35 - 44	0.1%	-2.7%	-1.6%
45 - 54	0.2%	0.2%	1.0%
55 - 64	0.7%	-0.7%	-0.2%
65 - 74	1.7%	0.1%	-0.1%
75 - 84	1.4%	0.9%	0.0%
85+	0.8%	0.2%	-1.4%

\*includes both genders

# Heart Disease Population Trend from SOA Study

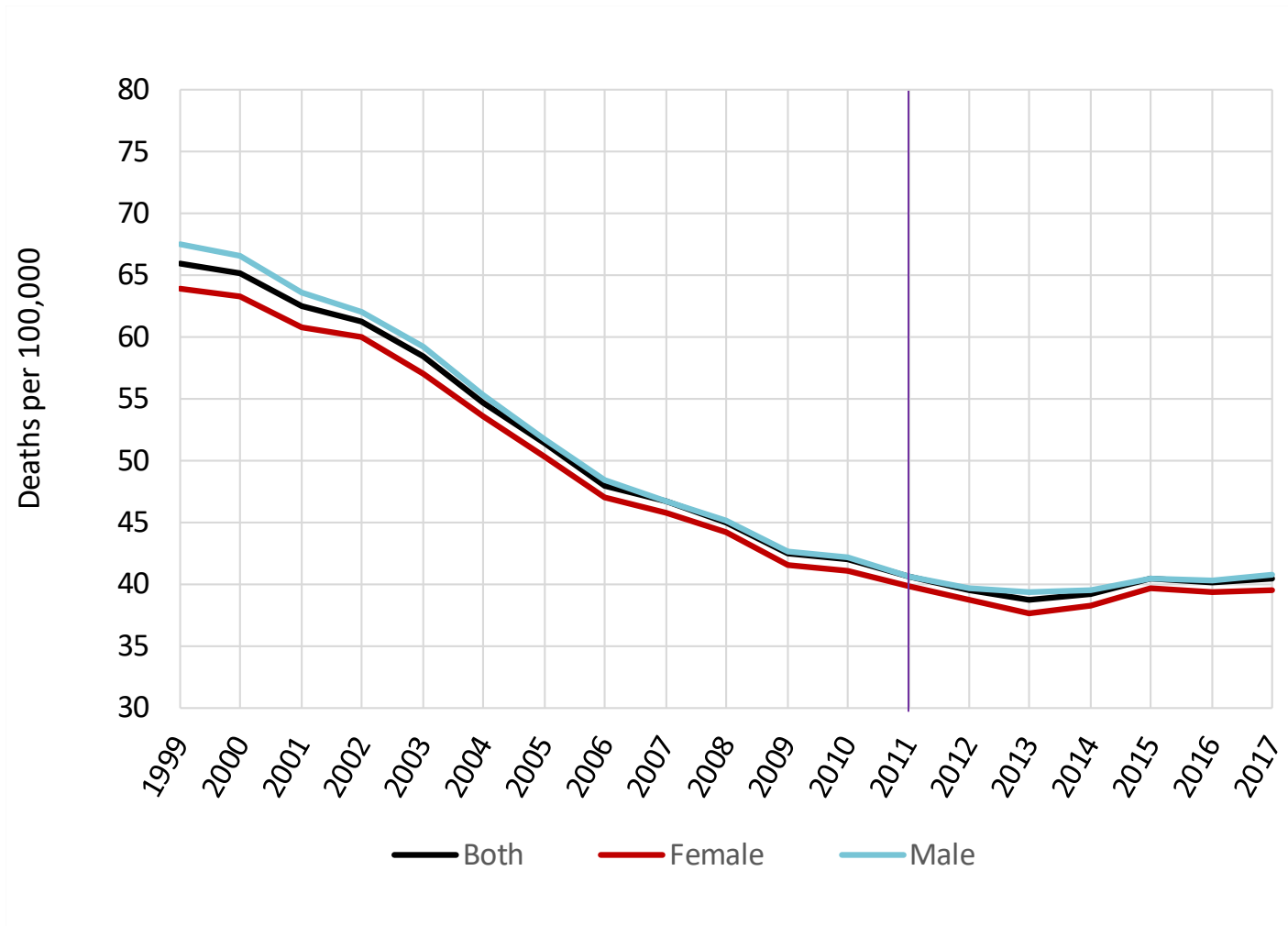


	Annual Improvement		
	1999-2017	2012-2017	2016-2017
<b>All Ages</b>			
Both	2.6%	0.6%	0.2%
Female	2.8%	0.8%	0.5%
Male	2.5%	0.5%	0.0%
<b>Age Group*</b>			
< 1	3.2%	1.9%	-4.2%
1 - 4	2.2%	3.7%	-7.3%
5 - 14	2.4%	-0.5%	4.9%
15 - 24	1.5%	0.6%	3.2%
25 - 34	-0.3%	-1.2%	-5.3%
35 - 44	0.9%	0.3%	1.7%
45 - 54	1.2%	0.7%	3.1%
55 - 64	1.9%	-0.7%	-0.6%
65 - 74	3.2%	-0.2%	-0.1%
75 - 84	3.2%	1.4%	0.8%
85+	2.4%	0.8%	-0.2%

\*includes both genders



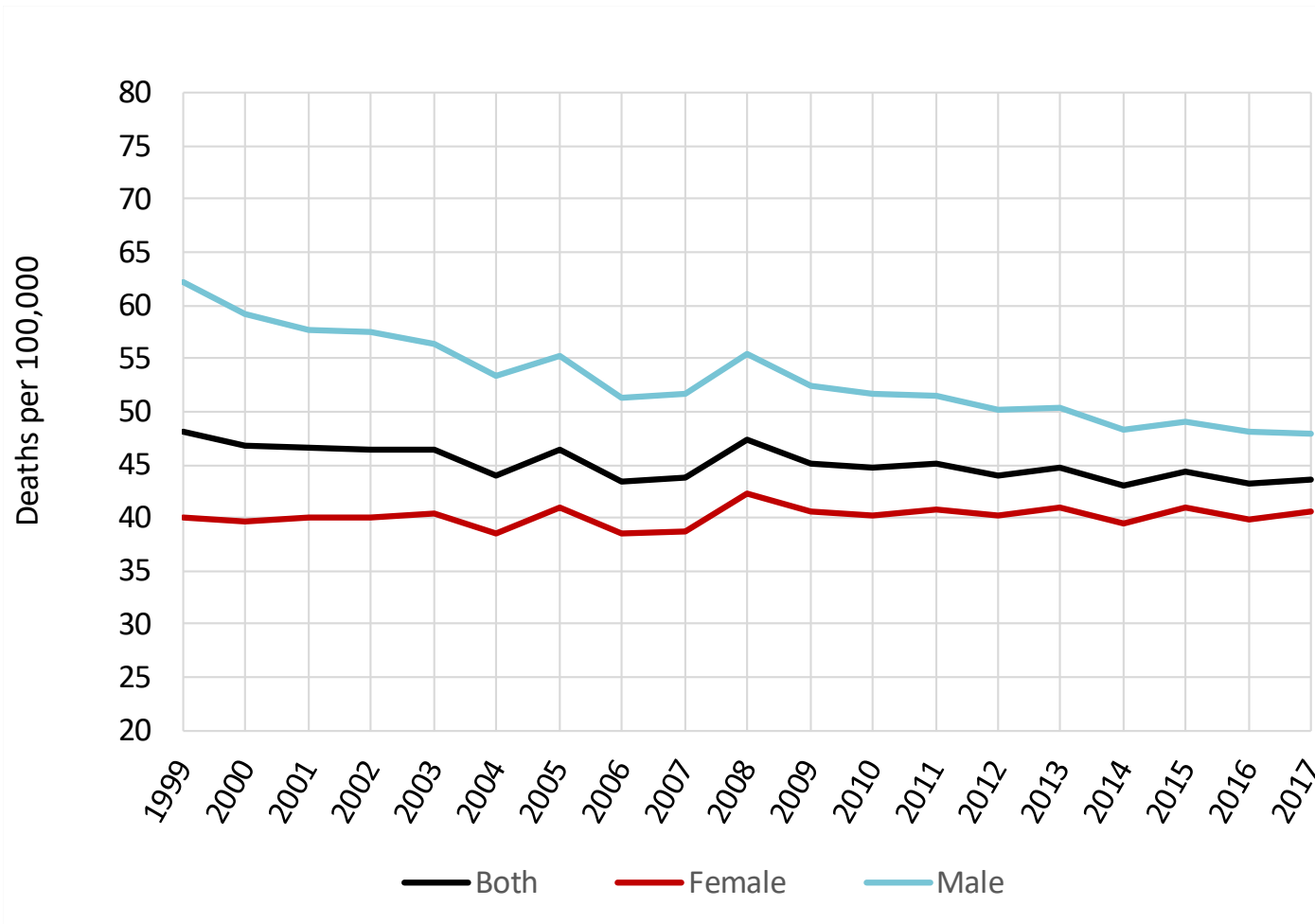
# Stroke Population Trend from SOA Study



	Annual Improvement		
	1999-2017	2012-2017	2016-2017
<b>All Ages</b>			
Both	2.7%	-0.5%	-0.8%
Female	2.7%	-0.4%	-0.4%
Male	2.8%	-0.5%	-1.4%
<b>Age Group*</b>			
< 1	0.4%	0.4%	18.7%
1 - 4	-1.8%	-3.4%	-19.7%
5 - 14	-2.2%	-2.7%	-10.1%
15 - 24	1.5%	3.0%	-5.4%
25 - 34	0.5%	-0.7%	-1.6%
35 - 44	1.4%	-0.7%	3.1%
45 - 54	1.2%	0.8%	2.0%
55 - 64	1.6%	-1.1%	-1.9%
65 - 74	2.9%	-0.2%	-0.5%
75 - 84	3.2%	0.7%	0.9%
85+	2.7%	-1.3%	-2.1%

\*includes both genders

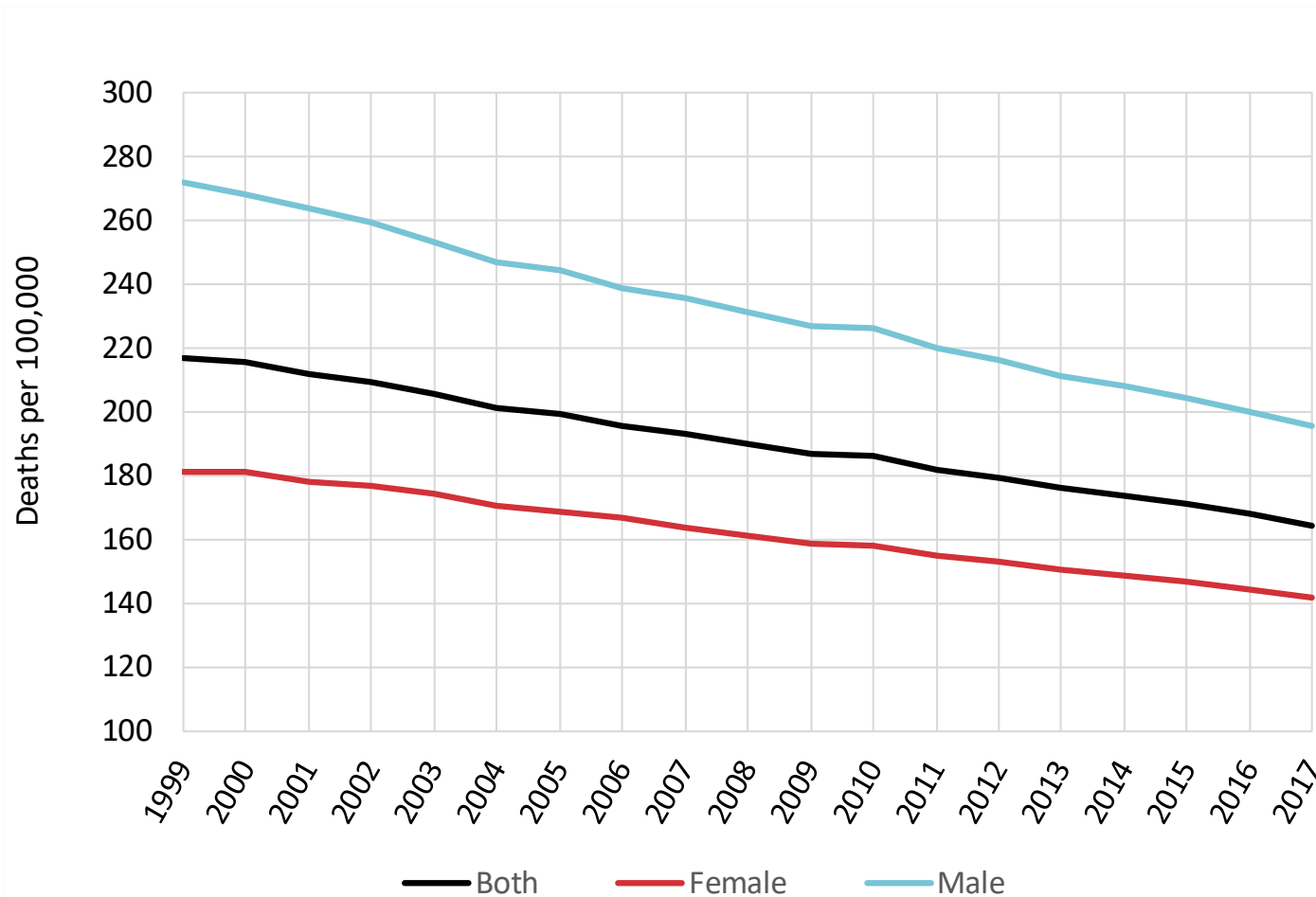
# Pulmonary Population Trend from SOA Study



	Annual Improvement		
	1999-2017	2012-2017	2016-2017
<b>All Ages</b>			
Both	0.5%	0.2%	-1.0%
Female	-0.1%	-0.3%	-2.1%
Male	1.4%	0.9%	0.1%
<b>Age Group*</b>			
< 1	5.3%	6.9%	49.6%
1 - 4	3.3%	9.4%	39.4%
5 - 14	0.2%	-2.4%	6.4%
15 - 24	1.2%	-6.0%	8.2%
25 - 34	0.6%	-1.4%	7.3%
35 - 44	0.7%	1.0%	-2.0%
45 - 54	-0.5%	1.7%	6.8%
55 - 64	0.4%	-2.4%	-3.5%
65 - 74	1.6%	0.9%	0.3%
75 - 84	0.7%	0.9%	-0.1%
85+	-0.5%	-0.4%	-3.5%

\*includes both genders

# Cancer Population Trend from SOA Study



	Annual Improvement		
	1999-2017	2012-2017	2016-2017
<b>All Ages</b>			
Both	1.5%	1.7%	2.1%
Female	1.4%	1.5%	1.9%
Male	1.8%	2.0%	2.4%
<b>Age Group*</b>			
< 1	1.2%	2.0%	14.3%
1 - 4	1.6%	3.6%	14.0%
5 - 14	1.0%	1.3%	2.9%
15 - 24	1.9%	2.4%	3.4%
25 - 34	1.2%	1.7%	6.0%
35 - 44	1.8%	1.0%	1.0%
45 - 54	1.8%	3.1%	4.0%
55 - 64	1.7%	1.4%	2.6%
65 - 74	2.1%	2.1%	1.9%
75 - 84	1.3%	1.8%	2.0%
85+	0.7%	0.7%	1.2%

\*includes both genders

# 1 year trend using % of death and MI from SOA Study

2017 U.S. Population Mortality by COD		
Cause of Death	%	Age-Adjusted One Year Trend
Heart Disease	23.00%	0.20%
Cancer	21.30%	2.10%
Alzheimer's/Dementia	8.50%	-1.30%
Accidents	6.00%	-4.10%
Pulmonary	5.70%	-1.00%
Stroke	5.20%	-0.80%
Diabetes	3.00%	-2.10%
Suicide	1.70%	-3.90%
Liver	1.50%	-1.40%
Assault	0.70%	-0.20%
Other	23.40%	-1.50%
<b>All COD</b>	<b>100%</b>	<b>-0.40%</b>



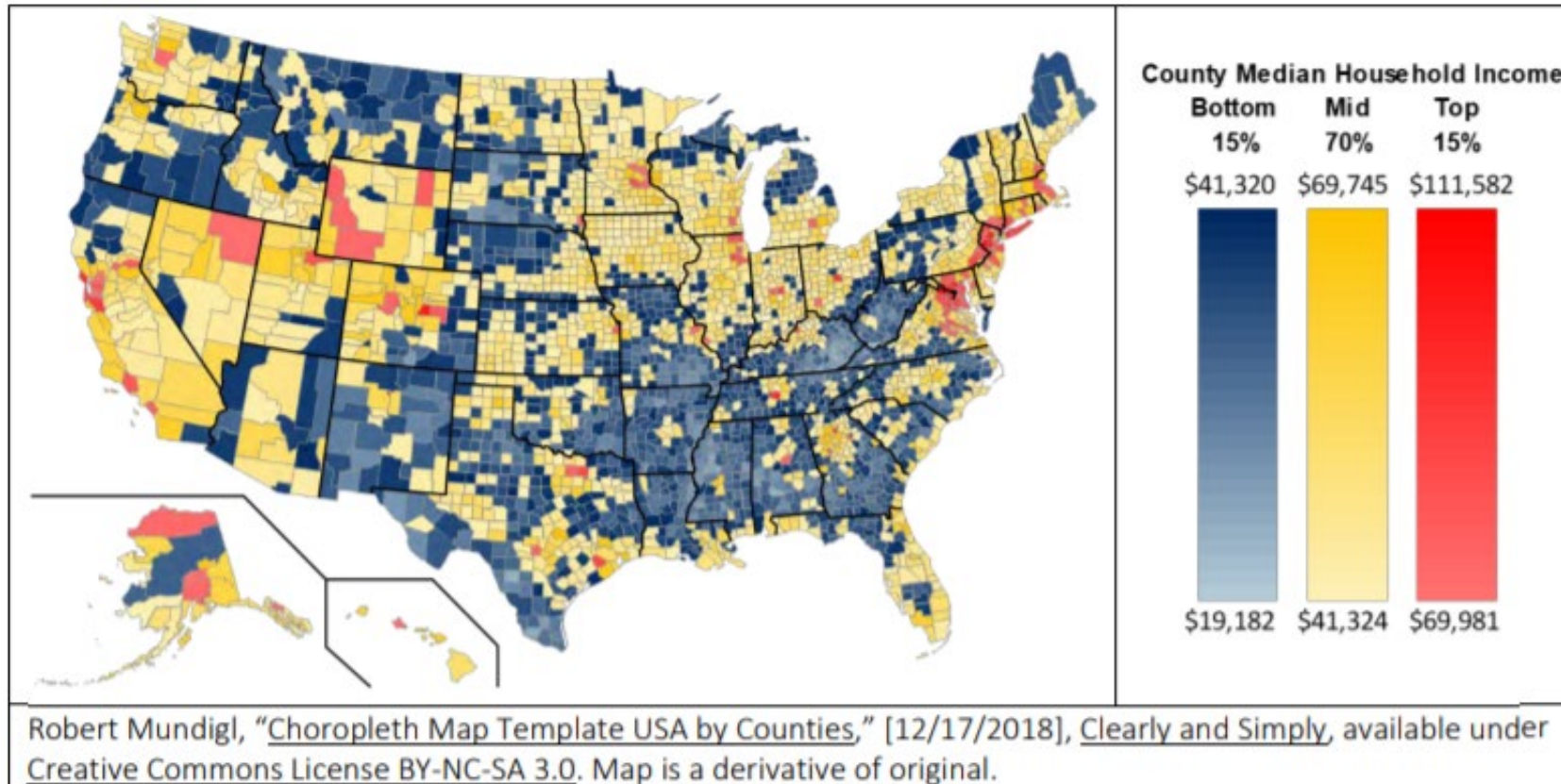
# Mortality Level: Socio-economic impact



# County level income

The SOA study used county level median household income

U.S. CENSUS BUREAU 2008 COUNTY MEDIAN HOUSEHOLD INCOME ESTIMATES

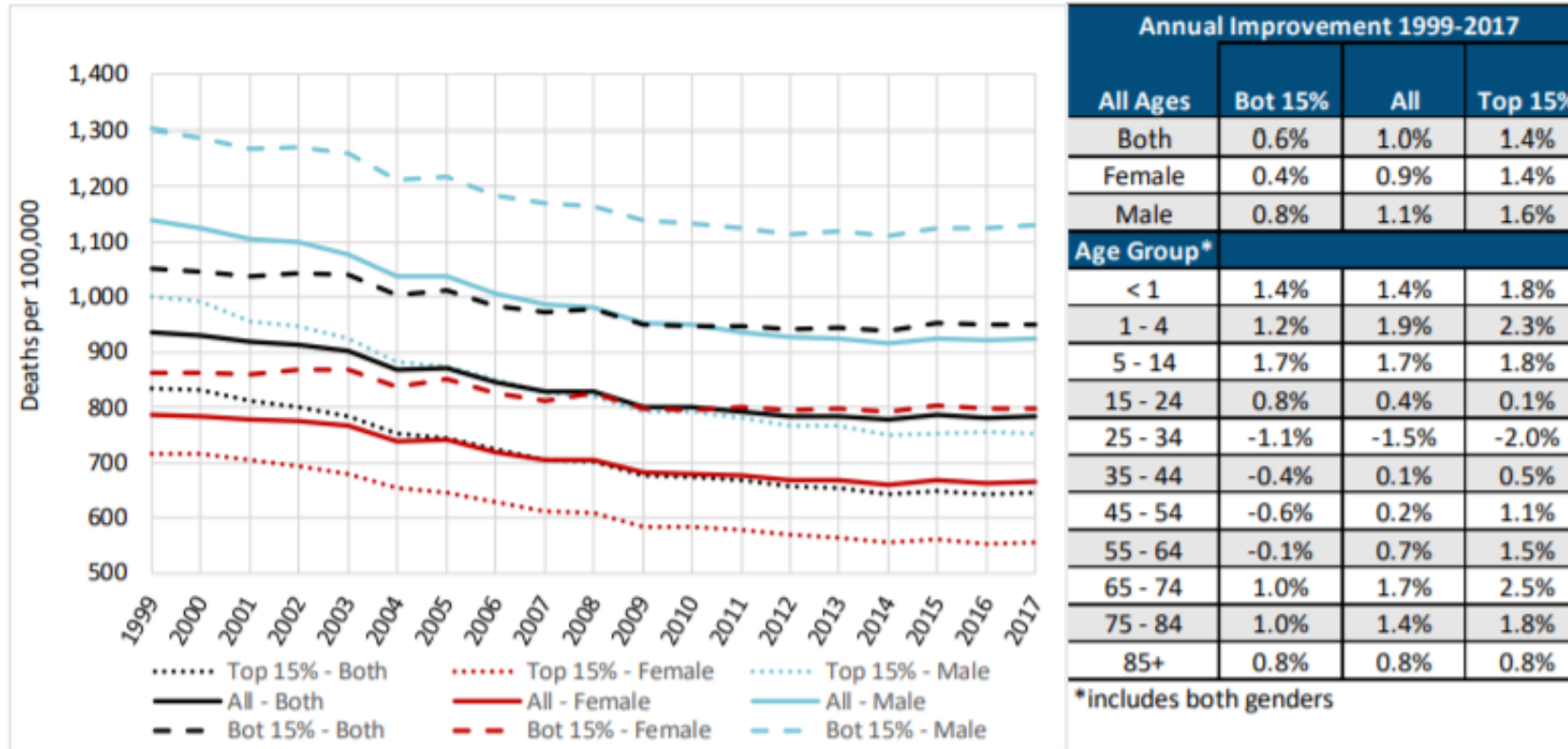


# County level income – mortality improvement

The SOA study used county level median household income

## 4.2 Income Analysis

AGE-ADJUSTED MORTALITY 1999-2017 – TOP 15%, BOTTOM 15% VS. ALL COUNTIES – ALL CAUSES OF DEATH

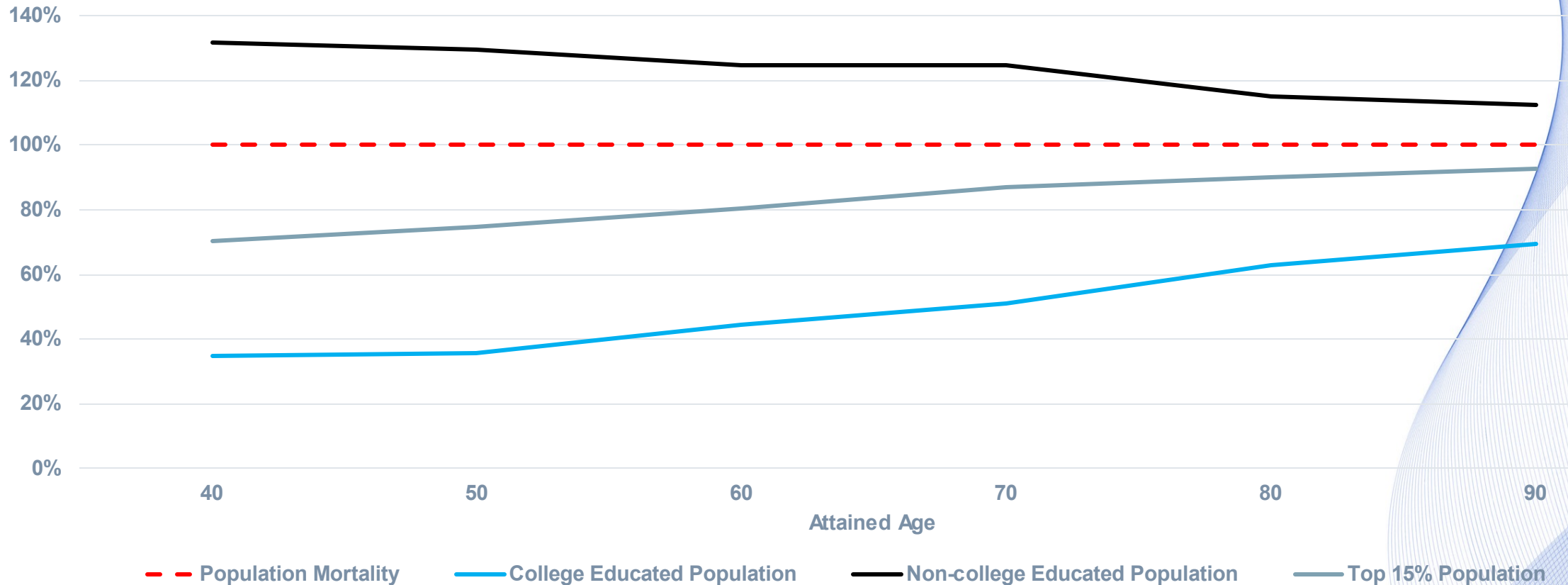




# Population mortality by education and by county level income

Education level is a strong predictor of socio-economic effects on mortality

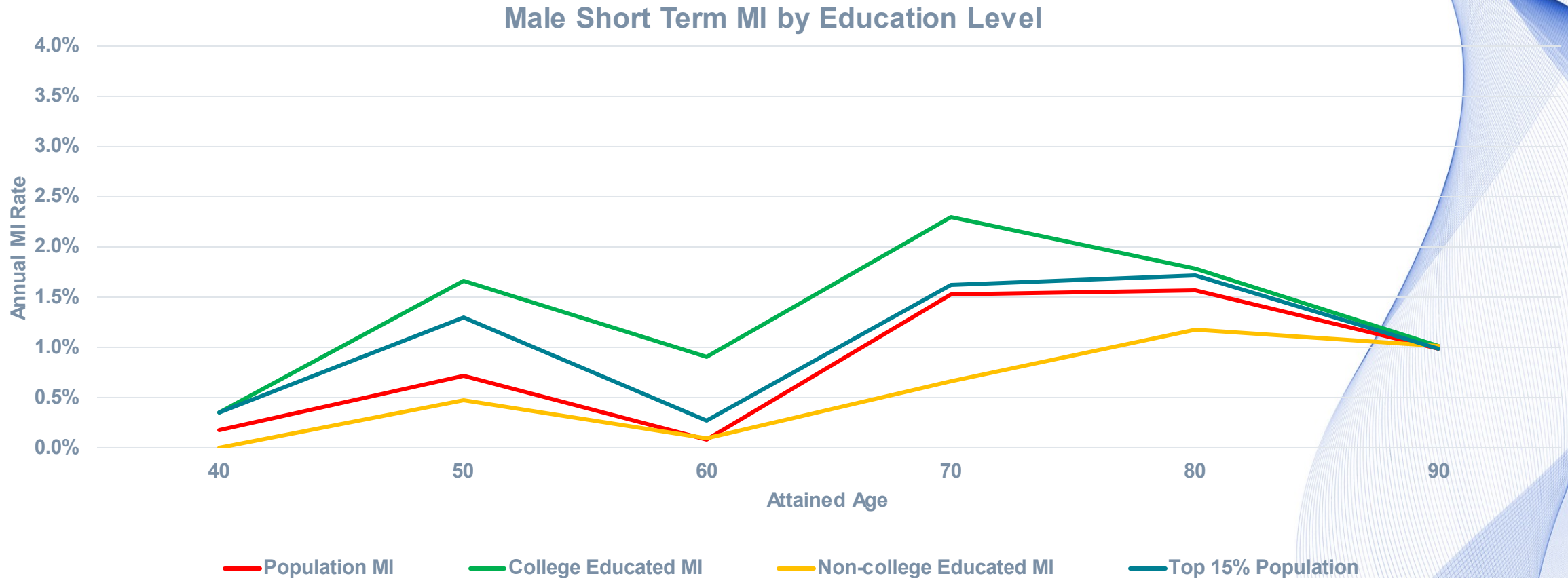
Male Qx A/E (where population = E)





# Mortality improvement by education and by county level income

Education level is another way to look at this



# Your Product & Target Market

# Your Product and Target Market

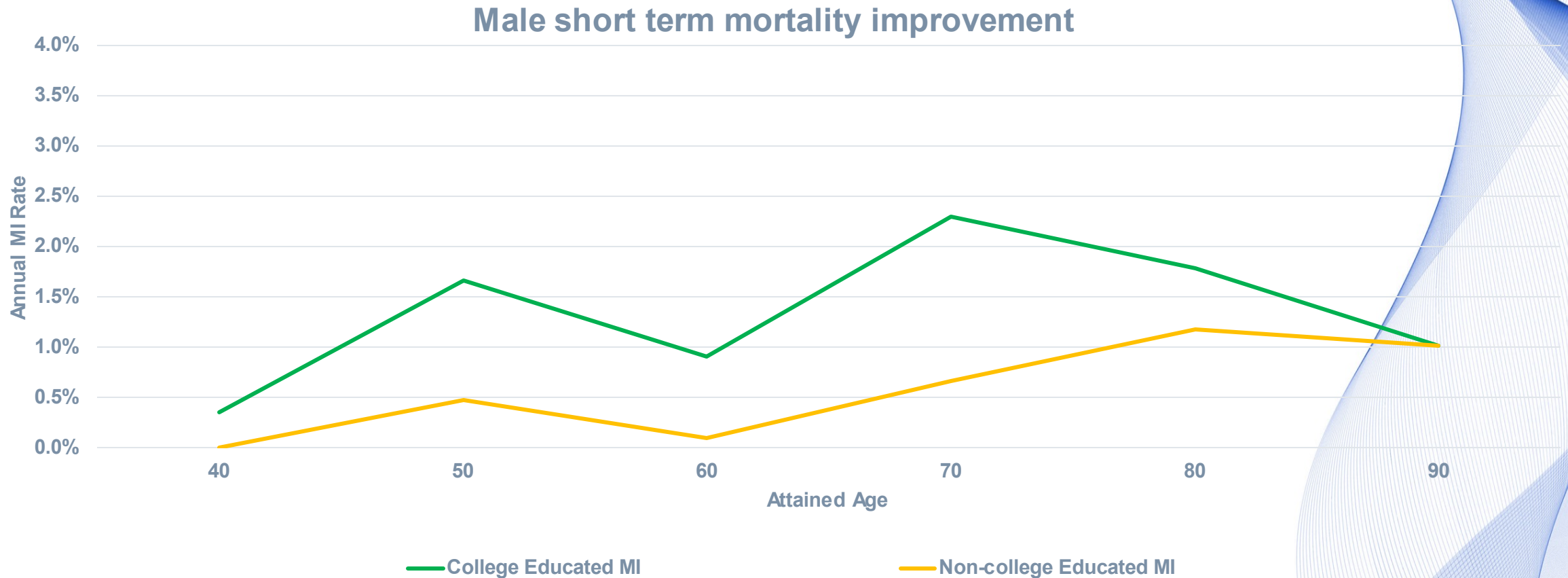
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- Does one high-level MI assumption work?
- What about the demographics of your business?
  - Mix of business by age?
  - Mix of business by gender?
  - Mix of business by income?
  - Mix of business by education level?



# Mortality improvement

Mortality improvement is vastly different by education levels



# Predicting the Future

# Predicting the Future

- “All Cause” Mortality Improvement vs “By Cause” Mortality Improvement
  - The SOA is currently conducting research on this topic and I anticipate that a report will be published in a few months.
- Will the historical sources of MI improvement continue? If so, then for how long and at what rate?
- Will the opioid crisis continue or accelerate?
- Impact of break-points in Mortality Improvement (MI) trend by cause of death?
- Does your product rely upon short-term mortality improvement predictions or long-term ones?
- How confident are you in short-term MI projections vs long-term MI projections?



Questions?



Thank You!