OCTOBER 26–29, 2020

2020 VIRTUAL ANNUAL MEETING & EXHIBIT

OCTOBER 26–29, 2020
SOCIETY OF ACTUARIES
Antitrust Compliance Guidelines

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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.

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- **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.

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Mortality and Longevity Strategic Research

Jean-Marc Fix
Chair, Mortality and Longevity Strategic Research Program

Tuesday, October 27 2020
SOA Strategic Research Programs

Part of SOA’s 2017-2021 Strategic Plan
Goals of the MLRP Steering Committee

- Research → Education
- Investigate
  - Mortality modeling
  - Mortality improvement
- Coordinate, centralize and communicate
- Use our skills for the greater goods: public interest research
  - Good for the public
  - Good for us
Mortality and Longevity

Examines the factors impacting models and mortality predictions, and the analysis of longevity trends.
Strategic Research Programs

In support of the SOA's 2017-2021 Strategic Plan, the SOA will focus its research efforts on five key Strategic Research Programs. The SOA develops, creates, and updates research focusing on retirement, mortality, health care, technology, and climate-related topics. These research areas bring together existing projects, resources, and materials, and consider new research studies and papers to be developed over the next five years. Learn more about the strategic research programs below:

1. **Aging and Retirement**
   - Focuses on the societal impact of aging populations and the solutions for mitigating risks.

2. **Actuarial Innovation and Technology**
   - Focuses on the evolution of technology as it applies to the actuarial profession and industry.

3. **Mortality and Longevity**
   - Includes the development of mortality and longevity models, and the analysis of mortality trends.

4. **Health Care Cost Trends**
   - Focuses on the forces that shape health care cost and utilization, and the changes over time.

Upcoming Programs

- **Catastrophe Climate**
  - Studies climate trends and their impact on extreme and catastrophic events.

Podcasts

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SOA Strategic Research Programs

- Aging and Retirement
- Actuarial Innovation and Technology
- Mortality and Longevity
- Health Care Cost Trends
- Catastrophe Climate

Download Infographi...
Strategic Research Programs

In support of the SOA’s 2017-2021 Strategic Plan, the SOA will focus its research efforts on five key Strategic Research Programs. The SOA develops, creates, and updates research covering retirement, mortality, health care, technology, and climate change areas. These research areas bring together existing projects, resources, and stakeholders, and combine with new research studies and papers to be developed over the next five years. Learn more about the strategic research programs below.

- **Aging and Retirement**
  Enhance the societal impact of aging populations and the solutions for mitigating risks.

- **Actuarial Innovation and Technology**
  Highlights the evolution of actuarial science as it applies to the actuarial profession and industry.

- **Mortality and Longevity**
  Enhance the actuarial forecasting models and mortality projections, and the analysis of longevity trends.

- **Health Care Cost Trends**
  Focus on the factors that shape health care cost and utilization, and the changes over time.

Upcoming Programs

- **Catastrophe and Climate**
  Studies climate risk and its impact on extreme and catastrophic events.

Podcasts
Mortality and Longevity Research Update
2009 – 2016 Individual Life Persistency Study

Tony Phipps
Chair, Individual Life Experience Committee

Tuesday, October 27 2020
The History:

• LIMRA and SOA jointly sponsored and published US Individual Life Insurance Persistency report
  • Earliest available on SOA website: 01-02 report
  • Most recent: 09-13 report
• voluntary participation
• anniversary-to-anniversary method
• “13 month” study
• Starting with 09-16 study, Individual Life Experience Committee will be providing report and analysis
The Data:

- VM-51 format
- Mandated submissions, required by NYDFS, KID
- Original data: calendar year format, years 2009-2016
- Transformed to anniversary-to-anniversary format
- Standard ordinary, fully underwritten individual life
  - Use appropriate caution or adjust appropriately in making benchmarking comparisons
## The Exposure – Policy Count

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole Life</td>
<td>48,856,460</td>
<td>50,333,678</td>
<td>141,767,438</td>
</tr>
<tr>
<td>Term</td>
<td>24,218,470</td>
<td>19,569,886</td>
<td>118,005,424</td>
</tr>
<tr>
<td>Universal Life</td>
<td>16,633,560</td>
<td>11,622,142</td>
<td>43,325,795</td>
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<tr>
<td>ULSG</td>
<td></td>
<td>1,928,336</td>
<td>11,989,439</td>
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<tr>
<td>VL/VUL</td>
<td>5,357,602</td>
<td>4,370,794</td>
<td>12,893,797</td>
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<tr>
<td>VULSG</td>
<td></td>
<td>2,091,642</td>
<td>5,145,812</td>
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<tr>
<td>Total</td>
<td>92,066,092</td>
<td>89,916,478</td>
<td>333,127,704</td>
</tr>
</tbody>
</table>
The Exposure – Amount (Billions)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole Life</td>
<td>2,110</td>
<td>3,653</td>
<td>8,134</td>
</tr>
<tr>
<td>Term</td>
<td>7,544</td>
<td>9,316</td>
<td>49,400</td>
</tr>
<tr>
<td>Universal Life</td>
<td>2,003</td>
<td>1,573</td>
<td>4,865</td>
</tr>
<tr>
<td>ULSG</td>
<td></td>
<td>889</td>
<td>4,069</td>
</tr>
<tr>
<td>VL/VUL</td>
<td>1,305</td>
<td>1,092</td>
<td>2,751</td>
</tr>
<tr>
<td>VULSG</td>
<td></td>
<td>665</td>
<td>1,554</td>
</tr>
<tr>
<td>Total</td>
<td>12,962</td>
<td>17,188</td>
<td>70,773</td>
</tr>
</tbody>
</table>
The Results:

• Unless otherwise indicated, lapse rates in the following slides are amount-weighted lapse rates

• Study Years are labeled as the year in which the anniversary of exposure was initiated/begun

• A great deal of detail will be available when final study results and data is published

• The following slides provide an initial high level review
Lapse Rates, Count vs Amount
Study Years 2009-2015, All Products

By Amount
By Count
Lapse Rates by Study Year
All Products
Lapse Rates by Study Year
All Products, Policy Years 1-9 Only
Lapse Rates by Face Amount Band
10 Year Level Term
Lapse Rates by Face Amount Band
20 Year Level Term
Lapse Rates by Face Amount Band
Traditional Whole Life

- $100K - $249K
- $250K – $499K
- $500K - $999K
- $1.0M – 2.49M
- $2.5M +
Lapse Rates by Face Amount Band
Universal Life

$100K - $249K
$250K – $499K
$500K - $999K
$1.0M – 2.49M
$2.5M +
Lapse Rates by Product
$500,000 - $999,999 Band
ILEC project work:

• 2009 – 2015 years have been published and reported for mortality experience

• 2016 pending final review and ILEC report

• 2017 upcoming

• MIB functioned as statistical agent on behalf of NYDFS, KID for years 2009 – 2017

• NAIC is statistical agent starting with study/calendar year 2018
  • 2018 submissions originally due 6/2020, delayed to 2021
Mortality Research

Larry Stern
Upcoming Vice Chair, Mortality and Longevity Strategic Research Program

Tuesday, October 27 2020
Mortality Improvement Research

- Consistent Mortality Improvement Framework
- Decomposition of US Population into Socioeconomic Categories
Consistent Mortality Improvement Framework
V1.0
Consistent Mortality Improvement Framework

- The purpose of this project is to develop a tool for practicing actuaries to model mortality improvement like the approaches used by RPEC and CMI:
  - Life insurance
  - Annuities
  - Retirement
Consistent Framework...RPEC Methodology

- Graduated Historical Rates
- Smooth Transition Considering A/P/C Components
- Future Long-Term Rate (LTR) Structure

Step 1: 19xx
Step 2: 20xx
Step 3: Recent Past
Consistent Framework V1.0...Key Decision Points

- **Step 1: Graduated historical rates**
  - From what underlying population should historical mortality rates be derived?
    - If anything other than US general population, is the dataset sufficiently robust?
    - SOA Experience Studies
  - Graduation methodology and “set-back” years
    - Whittaker-Henderson
    - GAM
  - How to determine A/P/C splits for underlying population
    - Cohort 45° diagonal
    - A/P horizontal
Consistent Framework V1.0...Key Decision Points

• Step 2: Future long-term rate (LTR)
  • What is long term – is it the same for age-period and cohort effects?
  • Should the SOA framework specify any “default” LTR structure?
    • No – need to provide additional education/guidance
    • Yes – how should the default be structured?
• What roles played by---
  • Cause of death research – input from Forum; CoD POG
  • Historical long-term US population MI trends
  • Known unknowns
  • SSA long-term assumptions
Consistent Framework V1.0...Key Decision Points

- Step 3: Smooth transition (considering A/P/C components)
  - Think in terms of subdividing transition period
    - 3a is period from end of usable historical data to the jumping off year
    - 3b is the period from jumping off year to first year of LTR Structure
  - How to connect from last year of historical data to first year of LTR structure
    - RPEC used cubic spline
      - The first year or two of period 3 the progress toward LTR is slow
      - Around year 3 the transition accelerates
      - Near end of period 3, the transition decelerates
      - Creates a zero slope at both ends
  - Could consider linear
- To what extent should CoD research influence Step 3 interpolations
  - Especially for 3a period because historical CoD is known
Consistent Framework - Data

- The MP2018 calculation process uses historical Social Security mortality data to estimate the initial improvement rates.
- For insured data, initial attempt was to use historical SOA mortality experience for NS and SM categories.
  - Not enough data to achieve credible results.
  - Has led to the project to decompose US population data into socioeconomic categories to “mimic” insured data.
Version 1.0 of the Mortality Improvement Tool

Current Capabilities as of May 2020:

- Can replicate the MP2018 forward interpolation process
- Can perform variations of this process:
  - Either linear interpolation or the default cubic spline approach
  - Weight on cohort effects can be varied from 0% to 100%
  - Speed of convergence to long term rates can be varied
- User can enter their own set of initial rates and long-term rates (or simply use the MP2018 values)
Version 1.0 of the Mortality Improvement Tool

What is not included in version 1.0?

The MP2018 calculation process uses historical Social Security mortality data to estimate the initial improvement rates. The mortality data is first subjected to a complex graduation process. We decided for v1.0 this complex process is best left out of the model. Therefore, v1.0 offers no built-in capability for a user to smooth or graduate their own data.
Version 1.0 of the Mortality Improvement Tool

Features we would like to add:

In addition to permitting users to use MP2018 initial rates or enter their own rates, we have discussed estimating smoker versus non-smoker improvement rates from individual life data and providing those rates within the Tool. However, an initial attempt to implement this idea has led to some questions about whether we have enough data to achieve credible results.
How Much Data is Needed to Reliably Estimate Improvement Rates?

Credibility increases as a function of:

- The number of lives covered by the data
- The number of years of data available
- The level of mortality rates -- in other words, it is easier to achieve credible results for older age cohorts than for younger age cohorts that have low mortality rates
## Datasets – Credibility Example

<table>
<thead>
<tr>
<th></th>
<th>Cohort Size At Age 60</th>
<th>Years of Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Security</td>
<td>2,000,000</td>
<td>65</td>
</tr>
<tr>
<td>Individual Life: Non-Smokers</td>
<td>200,000</td>
<td>7</td>
</tr>
<tr>
<td>Individual Life: Smokers</td>
<td>20,000</td>
<td>7</td>
</tr>
</tbody>
</table>
Mortality by Socioeconomic Category in the United States
The purpose of this project is to study trends in mortality by socioeconomic category in the United States from 1999 to 2018.

Research prepared by Magali Barbieri at UC Berkeley.

Report can be found on the SOA website:

https://www.soa.org/resources/research-reports/2020/us-mort-rate-socioeconomic/
Mortality by Socioeconomic Category Project

- Project methodology
  - Start with county-level Census Bureau data
  - Death data comes from processed National Center of Health Statistics data
  - Work to find ways to associate each county in each year with some form of socioeconomic index measured by education, occupation, employment, income, home pricing and quality
  - Rank counties by Socioeconomic Index Scores weighted by population stratified into 10 groups (each decile approx. 32 million population)
  - Create mortality estimations (male/female/combined) for each year for each decile
  - Ensure when aggregating back across deciles, result reasonably estimates the full population mortality

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Mortality by Socioeconomic Category Project - Findings

- Growing inequalities in mortality

*Figure 1. Expectation of Life at Birth (in Years) by Socioeconomic Decile for Each Sex, 1999-2018*

*Note.* The 1st decile represents the 10 percent of the population in counties with the lowest SISs and the 10th decile, the 10 percent of the population in counties with the highest SISs.
Largest disparities among the young
Mortality by Socioeconomic Category Project - Findings

- A deterioration of recent trends for all
  - Life expectancy at birth
    - 2010 – 2014 – stabilized
    - 2014 – 2017 – declined
    - 2018 – slight uptick in survival
  - Deteriorating trend all deciles except #10
  - Lowest 20% (decile #1 and #2) no increase in length of life over period 2008 – 2018 for both men and women
  - Highest 20% (decile #9 and #10) continued decline but at much lower rate than before 2010
Mortality by Socioeconomic Category Project - Findings

- An increasing gap with other high-income democracies
Online Tableau Exhibits

Report
Estimates of U.S. Mortality Rates by Socioeconomic Category: 1999-2018

Excel Data Files
County-Level Socioeconomic Data
Mortality Rate Estimates by Age, Sex and Socioeconomic Index Quintile
Mortality Rate Estimates by Age, Sex and Socioeconomic Index Decile

Online Exhibits
To see a "snapshot" of any exhibit, hover over its title below. To open an exhibit and view it, click on its title.

1. National-Level Mortality Rate Estimates: USMDB versus SSA
2a. Map of County-Level Socioeconomic Index Quintiles
2b. Map of County-Level Socioeconomic Index Deciles
3a. USMDB Expected Lifetimes by Year, Sex, Age and Socioeconomic Index Quintile
3b. USMDB Expected Lifetimes by Year, Sex, Age and Socioeconomic Index Decile
4a. USMDB Mortality Rate Estimates by Year, Sex, Age Group and Socioeconomic Index Quintile
4b. USMDB Mortality Rate Estimates by Year, Sex, Age Group and Socioeconomic Index Decile
5a. USMDB Mortality Improvement Rate Estimates by Year, Sex, Age Group and Socioeconomic Index Quintile
5b. USMDB Mortality Improvement Rate Estimates by Year, Sex, Age Group and Socioeconomic Index Decile
6a. USMDB Survival Probabilities by Year, Sex and Socioeconomic Index Quintile
6b. USMDB Survival Probabilities by Year, Sex and Socioeconomic Index Decile
Excel Data Files

United States Mortality Database Lifetables by Age, Sex and Socioeconomic Index Decile

The attached life tables were computed using death and population data from CDC-Wonder by Magali Barbieri, August 22, 2020. The confidence intervals for the mortality rates were computed following the UK Office of National Statistics (https://fingertips.phe.org.uk/documents/Plt%20Life%20Expectancy%20Calculator.xls). Note: see Berkeley/HMD/HMD-funding/Actuaries/SAO-deprivation/Ryan/CDC-Wonder-1999-2018/lifetables-deciles.r.

The life table columns are described below:

<table>
<thead>
<tr>
<th>Column</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decile</td>
<td>One of the 10 deciles of US counties ranked on their multidimensional socioeconomic score, plus the US as a whole</td>
</tr>
<tr>
<td>Year</td>
<td>Year to which the life table values correspond (1999-2018)</td>
</tr>
<tr>
<td>Sex</td>
<td>Sex (Male, Female, Both sexes combined)</td>
</tr>
<tr>
<td>Age</td>
<td>Age x at last birthday in single year (0...85+ years)</td>
</tr>
<tr>
<td>Mx,lower</td>
<td>Lower 95% confidence bound for the mortality rate at age x</td>
</tr>
<tr>
<td>Mx</td>
<td>Mortality rate at age x</td>
</tr>
<tr>
<td>Mx,upper</td>
<td>Upper 95% confidence bound for the mortality rate at age x</td>
</tr>
<tr>
<td>ax</td>
<td>Years lived in the age interval x to x+1 by those who died in the interval</td>
</tr>
<tr>
<td>qx,lower</td>
<td>Lower 95% confidence bound for the probability of dying between age x and x+1</td>
</tr>
<tr>
<td>qx</td>
<td>Probability of dying between the ages of x and x+1</td>
</tr>
<tr>
<td>qx,upper</td>
<td>Upper 95% confidence bound for the probability of dying between age x and x+1</td>
</tr>
<tr>
<td>lx</td>
<td>Survivors at age x</td>
</tr>
<tr>
<td>sx</td>
<td>Deaths in the age interval x to x+1</td>
</tr>
<tr>
<td>lx</td>
<td>Person-years lived in the age interval x to x+1</td>
</tr>
<tr>
<td>Tx</td>
<td>Cumulative number of person-years lived by those who survived to age x</td>
</tr>
<tr>
<td>sx,lower</td>
<td>Lower 95% confidence bound for the expectation of life at age x</td>
</tr>
<tr>
<td>sx</td>
<td>Expectation of life at age x</td>
</tr>
<tr>
<td>sx,upper</td>
<td>Upper 95% confidence bound for the expectation of life at age x</td>
</tr>
</tbody>
</table>
# Mortality Rate Estimates by Socioeconomic Decile, Sex and Single Year of Age

<table>
<thead>
<tr>
<th>Decile</th>
<th>Year</th>
<th>Sex</th>
<th>Age</th>
<th>ma lower</th>
<th>ma upper</th>
<th>ma</th>
<th>mu lower</th>
<th>mu upper</th>
<th>ax</th>
<th>mu lower</th>
<th>mu upper</th>
<th>ax</th>
<th>mu lower</th>
<th>mu upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2002</td>
<td>Male</td>
<td>0</td>
<td>353222</td>
<td>353828</td>
<td>73</td>
<td>0.37974</td>
<td>0.38125</td>
<td>73</td>
<td>0.37101</td>
<td>0.37252</td>
<td>73</td>
<td>0.36238</td>
<td>0.36390</td>
</tr>
<tr>
<td>2</td>
<td>2002</td>
<td>Male</td>
<td>0</td>
<td>353386</td>
<td>353992</td>
<td>73</td>
<td>0.38017</td>
<td>0.38168</td>
<td>73</td>
<td>0.37143</td>
<td>0.37295</td>
<td>73</td>
<td>0.36281</td>
<td>0.36433</td>
</tr>
<tr>
<td>3</td>
<td>2002</td>
<td>Male</td>
<td>0</td>
<td>353541</td>
<td>354147</td>
<td>73</td>
<td>0.38229</td>
<td>0.38380</td>
<td>73</td>
<td>0.37355</td>
<td>0.37506</td>
<td>73</td>
<td>0.36492</td>
<td>0.36644</td>
</tr>
<tr>
<td>4</td>
<td>2002</td>
<td>Male</td>
<td>0</td>
<td>353695</td>
<td>354301</td>
<td>73</td>
<td>0.38441</td>
<td>0.38592</td>
<td>73</td>
<td>0.37561</td>
<td>0.37712</td>
<td>73</td>
<td>0.36684</td>
<td>0.36836</td>
</tr>
<tr>
<td>5</td>
<td>2002</td>
<td>Male</td>
<td>0</td>
<td>353850</td>
<td>354456</td>
<td>73</td>
<td>0.38653</td>
<td>0.38804</td>
<td>73</td>
<td>0.37767</td>
<td>0.37918</td>
<td>73</td>
<td>0.36807</td>
<td>0.36959</td>
</tr>
<tr>
<td>6</td>
<td>2002</td>
<td>Male</td>
<td>0</td>
<td>354005</td>
<td>354611</td>
<td>73</td>
<td>0.38865</td>
<td>0.39016</td>
<td>73</td>
<td>0.37969</td>
<td>0.38120</td>
<td>73</td>
<td>0.36947</td>
<td>0.37099</td>
</tr>
<tr>
<td>7</td>
<td>2002</td>
<td>Male</td>
<td>0</td>
<td>354160</td>
<td>354766</td>
<td>73</td>
<td>0.39077</td>
<td>0.39228</td>
<td>73</td>
<td>0.38072</td>
<td>0.38223</td>
<td>73</td>
<td>0.37026</td>
<td>0.37179</td>
</tr>
<tr>
<td>8</td>
<td>2002</td>
<td>Male</td>
<td>0</td>
<td>354315</td>
<td>354921</td>
<td>73</td>
<td>0.39289</td>
<td>0.39440</td>
<td>73</td>
<td>0.38163</td>
<td>0.38314</td>
<td>73</td>
<td>0.37086</td>
<td>0.37239</td>
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<tr>
<td>9</td>
<td>2002</td>
<td>Male</td>
<td>0</td>
<td>354470</td>
<td>355076</td>
<td>73</td>
<td>0.39491</td>
<td>0.39642</td>
<td>73</td>
<td>0.38238</td>
<td>0.38389</td>
<td>73</td>
<td>0.37109</td>
<td>0.37262</td>
</tr>
</tbody>
</table>

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US counties by socioeconomic decile 2000
US counties by socioeconomic decile 2010
US counties by socioeconomic decile 2016
CA counties by socioeconomic decile 2000
CA counties by socioeconomic decile 2010
CA counties by socioeconomic decile 2016
Expected Lifetimes

USMBD Expected Lifetimes

Age: 60
Decile: 10
Sex: Female
Year: 2008
Lifetime: 25.9
Female Mortality Improvement 1999-2018

Graph 3. Annualized Rate of Mortality Improvement Across the Period from 1999 to 2018
Male Mortality Improvement 1999-2018

Graph 3. Annualized Rate of Mortality Improvement Across the Period from 1999 to 2018

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Female and Male Mortality Improvement 1999-2018

Graph 3. Annualized Rate of Mortality Improvement Across the Period from 1999 to 2018
Conclusions

- Clear socioeconomic gradient in life expectancy at birth and other mortality values with progressively highest rates of survival in each successive decile of affluence.
- Differentials in mortality increased from 1999 to 2018.
- Larger disparities for men but larger divergencies for women.
- Larger inequalities for children as well as for adults below age 60 than above age 60.
- Only in decile #10 does it appear Americans live longer than the average inhabitant of other OECD democracies and live less than the average Japanese.
Possible extensions

- Compute lifetable series by county decile for 1982-2018 using detailed NCHS data and HMD methods
- Compare inter- and intra-decile disparities in mortality
- Investigate differences in cause-of-death structure by decile (Covid-19 in particular)
- Concentrate on mortality variations across deciles for specific categories (racial/ethnic, foreign born, urban/rural, etc...)

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