Mortality Projections: A US Perspective on Approaches and Challenges

International Actuarial Association
Mortality Working Group Meeting

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US Social Security Administration
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Perspective: “Aging” Not Mainly from Mortality
Aging (change in age distribution) mainly due to drop in birth rates

![Aged Dependency Ratio 2019 TR](chart)

- Actual and TR Intermediate
- TFR remains at 3.0 after 1964
- TFR remains at 3.3 after 1964
Various Alternative Projection Approaches Using Data

Extrapolating past trends:
1) Age setback (*early method*)
2) Mortality rate by age and sex (*Lee/Carter*)
3) Life expectancy at birth (*Vaupel/Oeppen*)
4) Mortality rate by trend all ages (*2011 Technical Panel, CBO 2013-5*)

Or reflect changing conditions:
5) Improvement by cohort (*UK CMI, SOA*)
6) Mortality rate by age, sex, cause (*OCACT/TR, 2015 Technical Panel*)
2) Extrapolation by Age and Sex

- Example: Lee and Carter
- Fit the average trend of a selected period
- Future conditions must replicate the past—on average
- Age gradient never changes
- No deceleration in mortality decline
Mortality Decline Varies Over Time
Conditions: Antibiotics/economy 1936-54; Medicare/Medicaid 1968-82

**Female Historical (2018 Trustees Report, Plus 2016 and 2017 Data)**

Annual Percent Reduction in U.S. Mortality Rates

- 1900 to 1936
- 1936 to 1954
- 1954 to 1968
- 1968 to 1982
- 1982 to 1999
- 1999 to 2009
- 2009 to 2017

**Male Historical (2018 Trustees Report, Plus 2016 and 2017 Data)**

Annual Percent Reduction in U.S. Mortality Rates

- 1900 to 1936
- 1936 to 1954
- 1954 to 1968
- 1968 to 1982
- 1982 to 1999
- 1999 to 2009
- 2009 to 2017
3) Will Life Expectancy Rise Linearly? 
Vaupel/Oeppen 2002; best nations

• Requires *accelerating* rate of decline in mortality rates if retain age gradient

• LE most affected by lowest ages—only so much gain possible

• Most disagree
  – Vallin/Meslé
4) Extrapolate All Ages the Same

- Ignores historical age gradient
- Result:
  - Substantial bias for population age distribution
- Thus, large bias for cost as % of payroll
  - Less mortality decline at young ages raises cost
  - More mortality decline at older ages raises cost
Appropriate Data: by Age Critical
Age-gradient in past reduction is clear
5) Extrapolation by Cohort

• U.K. (& SOA-RPEC): “Phantoms never die” data issues
• Post-WW2 births: antibiotics young, statins later
• What does change up to age x say above age x?
  – Is cohort healthier at x if lower mortality up to x?
  – Or is cohort compromised by impaired survivors?
  – What does one cohort imply for the next cohort?
• Period effects from known changes in conditions are stronger—especially in the U.S.
6) Projection by Age, Sex, Cause

- SSA/OCACT/Trustees Reports (2015 Technical Panel)
- Requires selecting ultimate rates of decline
- Allows change in age gradient
- Results in deceleration in mortality decline

**Comparison of Historical, 2015 Trustees Report, and Ron Lee***

<table>
<thead>
<tr>
<th>Age</th>
<th>Historical (Dec 2015 data)</th>
<th>AGE</th>
<th>Ron Lee</th>
<th>2015TR Intermediate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-14</td>
<td>2.79</td>
<td>1.22</td>
<td>2.14</td>
<td>2.77</td>
</tr>
<tr>
<td>15-49</td>
<td>0.63</td>
<td>0.61</td>
<td>1.06</td>
<td>1.07</td>
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<tr>
<td>50-64</td>
<td>1.61</td>
<td>1.27</td>
<td>0.05</td>
<td>1.34</td>
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<tr>
<td>65-84</td>
<td>0.92</td>
<td>2.11</td>
<td>0.91</td>
<td>1.06</td>
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<tr>
<td>85+</td>
<td>-0.18</td>
<td>1.30</td>
<td>-0.11</td>
<td>0.65</td>
</tr>
<tr>
<td>65+</td>
<td>0.51</td>
<td>1.78</td>
<td>0.48</td>
<td>0.88</td>
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<tr>
<td></td>
<td>0.75</td>
<td>1.59</td>
<td>0.48</td>
<td>0.99</td>
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</table>

* Fit 1950-2011, using Medicare-enrollment data for 65 and over, rather than HMD data
See Actuarial Note 158 https://www.ssa.gov/oact/NOTES/pdf_notes/note158.pdf
Age-adjusted Death Rates for Heart Disease, Cancer, Stroke, and Unintentional Injuries: United States, 1900-2015

(courtesy Robert Anderson, NCHS)

Rate per 100,000 standard population

NOTE: Data prior to 1933 contain death-registration states only. Data for 2015 is provisional.
Mortality Decline by Cause of Death:
Rate of change from 1979 to 2017

**FEMALE**

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Cardiovascular</th>
<th>Cancer</th>
<th>Violence</th>
<th>Respiratory</th>
<th>Other</th>
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<tr>
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<tr>
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<td>5.5</td>
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- Cardiovascular
- Cancer
- Violence
- Respiratory
- Other
Age-Sex Extrapolation vs. Age-Sex-Cause Projection

Lee maintaining full age-gradient offsets lack of deceleration
Result: OASDI actuarial deficit unchanged using Lee estimates
2015 Technical Panel

- Endorsed projections by cause with age-gradient
- Suggested *average* age-adjusted 1% annual rate of decline
  - To match average rate since 1950, overall
  - Understood this incorporated deceleration
- Chairperson Alicia Munnell, after TR 2016, said she was glad Trustees did not adopt the 1% rate of decline
Mortality Experience: All Ages

Reductions continue to fall short of expectations
Mortality Experience: Ages 65 and Older

Reductions since 2009 continue to fall short of expectations
Mortality Experience: Ages Under 65

Actual increase since 2010
Developing Assumptions by Cause

- Scientific approach reflecting biology
- Trustees and SSA/OCACT develop in consultation with other experts
- Johns Hopkins recent survey of medical researchers and clinicians came to very similar medium term expectations—individually
  - Trustees’ medium-term rates by cause had not been published
Cardiovascular: JHU Less Optimistic than Trustees over Age 50 for Next 30 Years

Cardiovascular Disease-Female
Average Annual Percent Reduction
JHU values are for the period 2009-2040

Cardiovascular Disease-Male
Average Annual Percent Reduction
JHU values are for the period 2009-2040
Respiratory: JHU More Optimistic under Age 50, Less Optimistic over Age 85

**Respiratory-Female**

*Average Annual Percent Reduction*

*JHU values are for the period 2009-2040*

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<th>1979 to 2010</th>
<th>2010 to 2038</th>
<th>2038 to 2088</th>
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<tr>
<td>Under Age 15</td>
<td>-0.1</td>
<td>-0.3</td>
<td>-0.4</td>
</tr>
<tr>
<td>Ages 15 - 49</td>
<td>-0.2</td>
<td>-0.4</td>
<td>-0.5</td>
</tr>
<tr>
<td>Ages 50 - 64</td>
<td>-0.6</td>
<td>-0.8</td>
<td>-1.0</td>
</tr>
<tr>
<td>Ages 65 - 84</td>
<td>-1.4</td>
<td>-1.6</td>
<td>-1.8</td>
</tr>
<tr>
<td>Ages 85 and older</td>
<td>-2.0</td>
<td>-2.2</td>
<td>-2.4</td>
</tr>
<tr>
<td>Total</td>
<td>-3.0</td>
<td>-3.2</td>
<td>-3.4</td>
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**Respiratory-Male**

*Average Annual Percent Reduction*

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<td>-0.9</td>
</tr>
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<td>-0.8</td>
<td>-1.0</td>
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<td>-3.5</td>
<td>-3.7</td>
<td>-3.9</td>
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Cancer: JHU Very Similar to Trustees’ Expectations

**Cancer-Female**

*Average Annual Percent Reduction*

*JHU values are for the period 2009-2040*

- Under Age 15: 1.8
- Ages 15 - 49: 1.3
- Ages 50 - 64: 0.9
- Ages 65 - 84: 0.4
- Ages 85 and older: 1.3
- Total: 1.8

**Cancer-Male**

*Average Annual Percent Reduction*

*JHU values are for the period 2009-2040*

- Under Age 15: 1.1
- Ages 15 - 49: 1.3
- Ages 50 - 64: 1.2
- Ages 65 - 84: 0.6
- Ages 85 and older: 1.3
- Total: 1.3
How Future Conditions Might Change

• Smoking decline for women
  – Started and stopped later than men

• Obesity—sedentary lifestyle

• Difference by income/earnings

• Health spending—must decelerate
  – Advances help only if apply to all

• Human limits
  – Increasing understanding of deceleration
Sam Preston 2010—must consider cumulative effects and increasing duration of obesity for aged in future
Death Rates Vary by Career Average Earnings Quintile
Bosley, Morris, Glenn (2018): have the spreads stabilized? At ages 65-69:
Does Health Spending Affect Mortality?

Note rise, at least through 2009

![Graph showing National Health Expenditures With and Without Medicare and Medicaid as a Percent of GDP]
Health Spending Cannot Continue to Rise at Historical Rates

Note Trustees’ deceleration

Annual Percent Change in Medicare Cost per Beneficiary Relative to GDP per Worker: 2015 TR
Is There an Omega?

It appears we are rectangularizing the survival curve.
Death Rates Will Continue to Decline: But How Fast and for Whom?

• Must understand past and future conditions
  – Persistent historical “age gradient”
  – Avoid simple extrapolation of past periods
  – Cannot ignore changing conditions
    • “Limits” on longevity due to physiology
    • Latter half of 20th century was extraordinary
  – So deceleration seems likely
  – Cause-specific rates allow basis for assumptions

• Results: in the 1982 TR, we projected LE65 in 2013 to be 19.0; actual was 19.1
For More Information…http://www.ssa.gov/oact/

• Documentation of Trustees Report data & assumptions

• Historical and projected mortality rates
https://www.ssa.gov/oact/HistEst/DeathHome.html

• Annual Trustees Reports
https://www.ssa.gov/oact/TR/index.html
Thank you