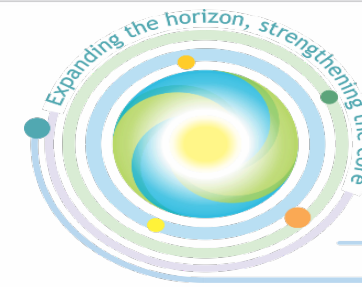Institute of
Actuaries of India
Statutory body under an Act of Parliament

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Expanding the horizon, strengthening the core

Mortality Improvement

Murshid Kuttihassan

VP and Actuary, MetLife Noida

March 2019

Supercentenarian (age>110)

Emma Morano
29 November 1899 – 15 April 2017

- Before her death at 117, Emma was the last living person born in the 1800s. She remains the oldest Italian ever.

- Emma credited her longevity success in part to eating raw eggs, cookies, staying single, and positive thinking.
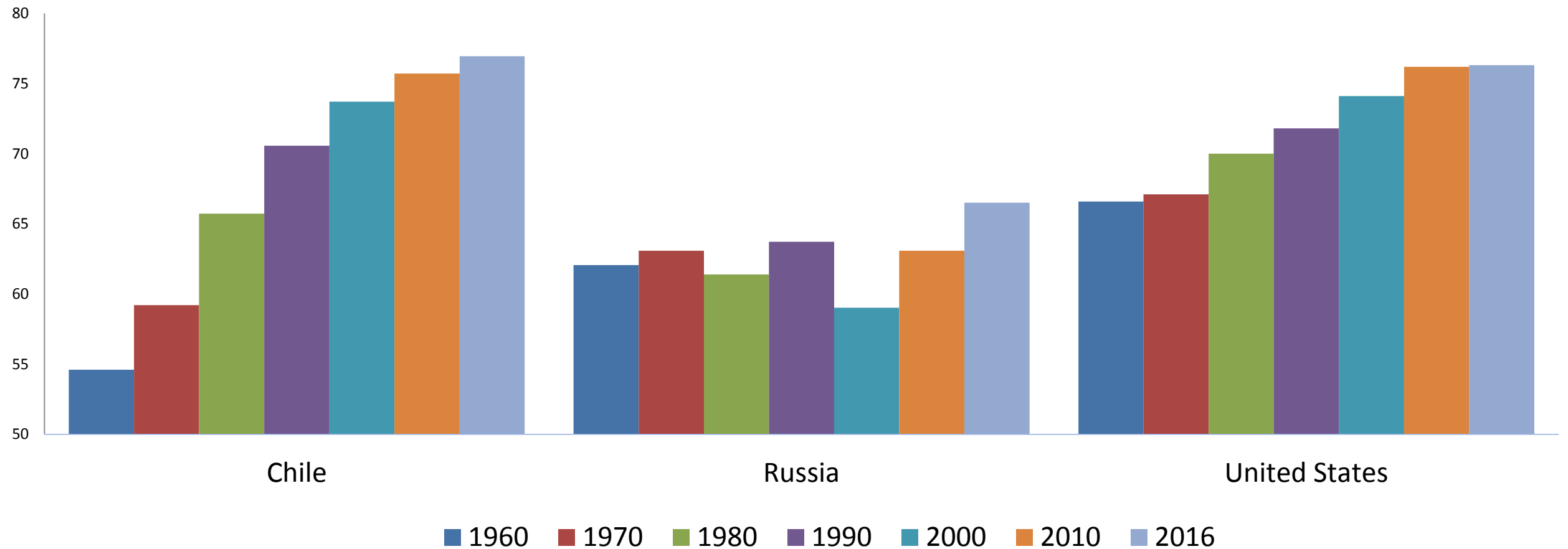
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Mortality Improvement Overview

1	Life, Annuity, & Health Blocks
2	Understanding the Past & Present
3	Framing the Future – Current Trends
4	Modeling Approaches

Changing Life Expectancy

Three Different Country Experiences

Life Expectancy (Males, 1960 -2016)

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Life Insurance Mortality Considerations

1   Underwriting for Mortality Risk is Changing in Life Insurance

2   Quicker, Paperless, & Less Invasive Underwriting

Alternative Sources for Health Information

3   Net Amount at Risk Is Significant (e.g. Pandemic PV impact)

Annuity & Pension Mortality Considerations

1 High-Level Risk Assessment on Group & Pension Business

No Underwriting for Retail Annuities

2 Pension Transfer Market - Large Blocks of Liability Being Transferred In Single Transactions

3 Longevity Risk is a "Slow Bleed" Risk that Can Emerge Over Time

Perpetuity Value is an Upper Bound on PV (interest-rate sensitive)

4 Longevity Risk & Mortality Risk Can Be Somewhat Offsetting

Health & Disability Morbidity Considerations

1   Morbidity and Mortality are Related but Difficult To Correlate

2   Costs are Driven by the Length and Severity of Sickness

**3**   Some Liabilities Can Be Hard to Invest For and Predict (LTC)

Historical Mortality Improvement

Life expectancy, 2015

Shown is period life expectancy at birth. This corresponds to an estimate of the average number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life
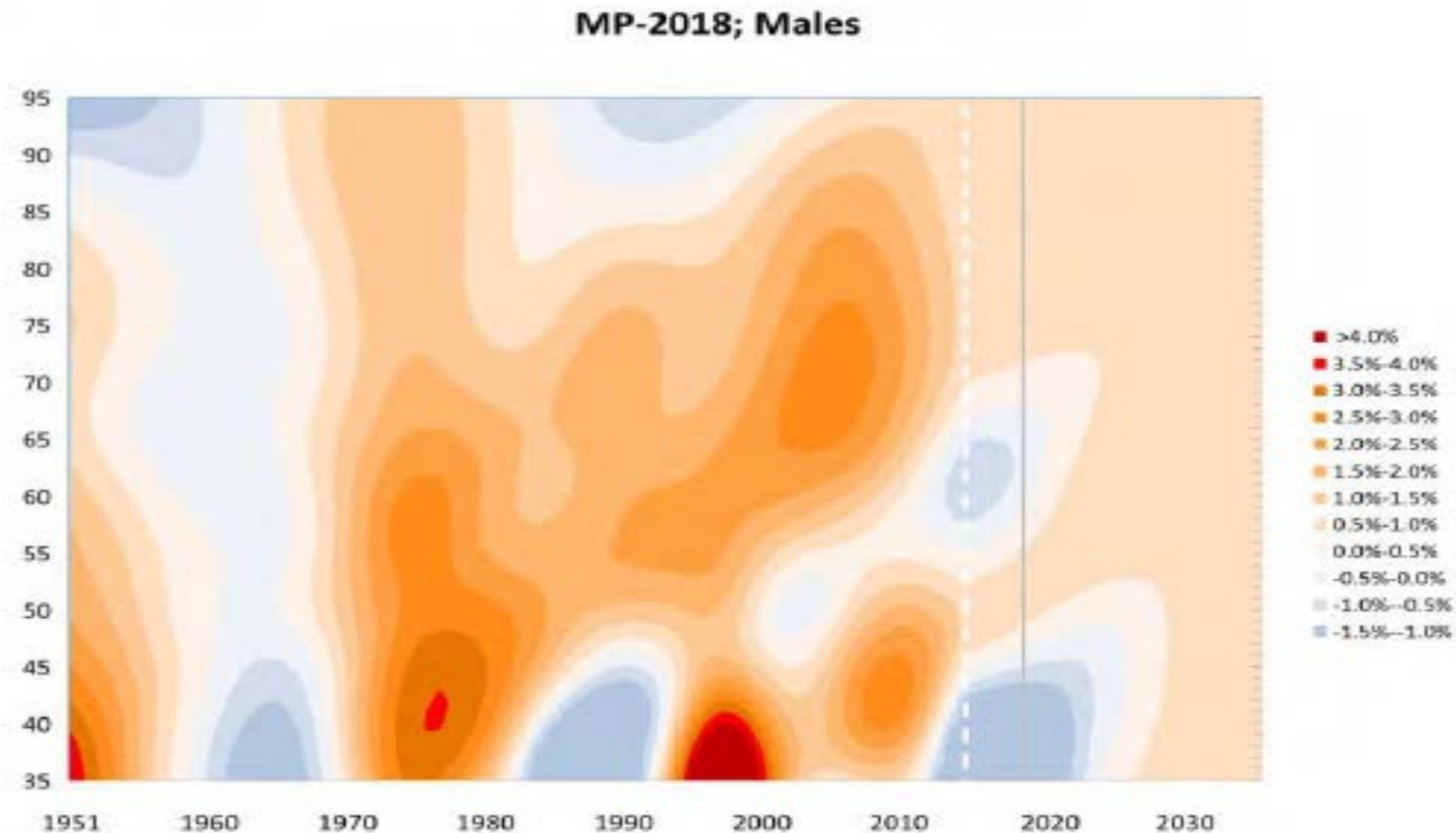
Our World in Data

2015

No data | <20 | 30 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85

1901
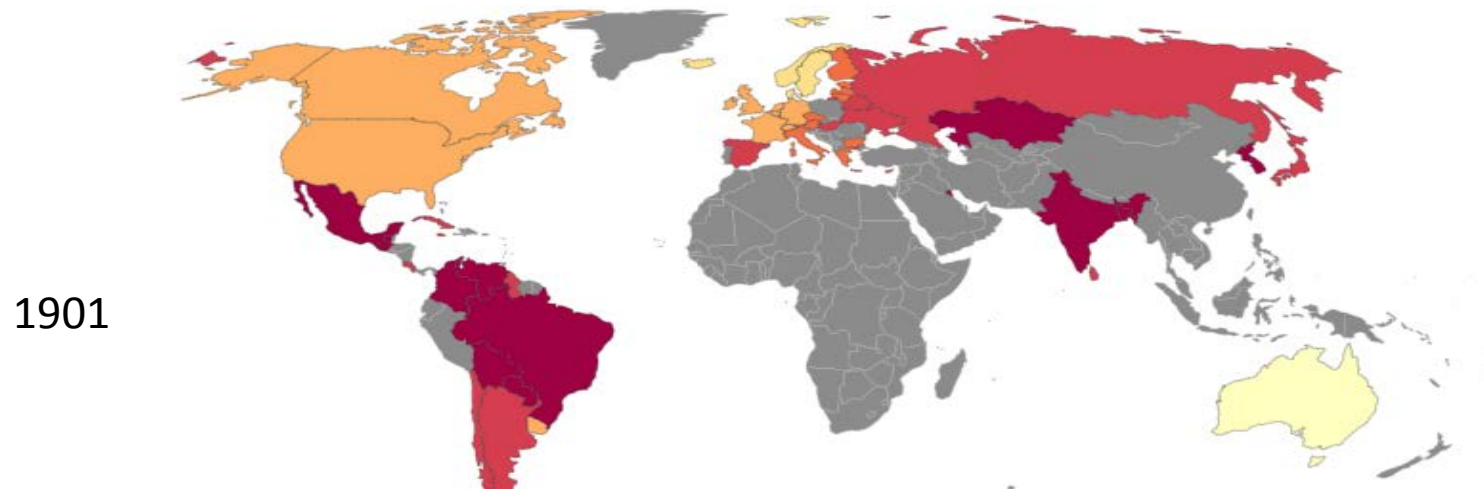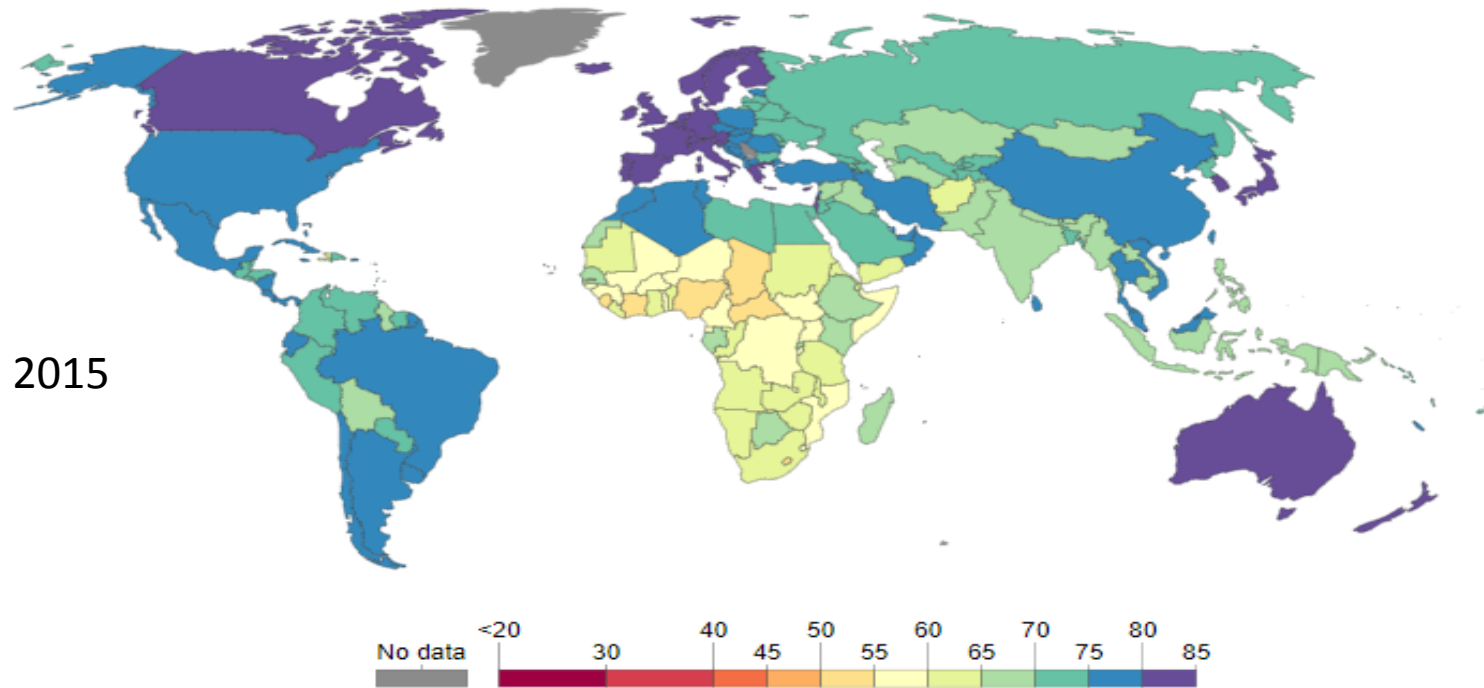
Clean Water
Sanitation
Vaccinations
Child Mortality Improvement
Smoking Cessation
Improved Work Environments
Statins & Other Drugs
Rise in Wealth

20th Century

HISTORICAL DRIVERS

https://ourworldindata.org/life-expectancy (CLIO-INFRA TO 1949; UN POPULATION DIV FOR 1950 TO 2015)

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U.S. Historical Mortality Improvement

## "Cohort Effects" Seen Along a 45° **Diagonal**

MP-2018; Males

The vertical dashed white line on the heat map is the boundary between the historical and projected rates, and the thin vertical gray lines indicate the 2018 rates.
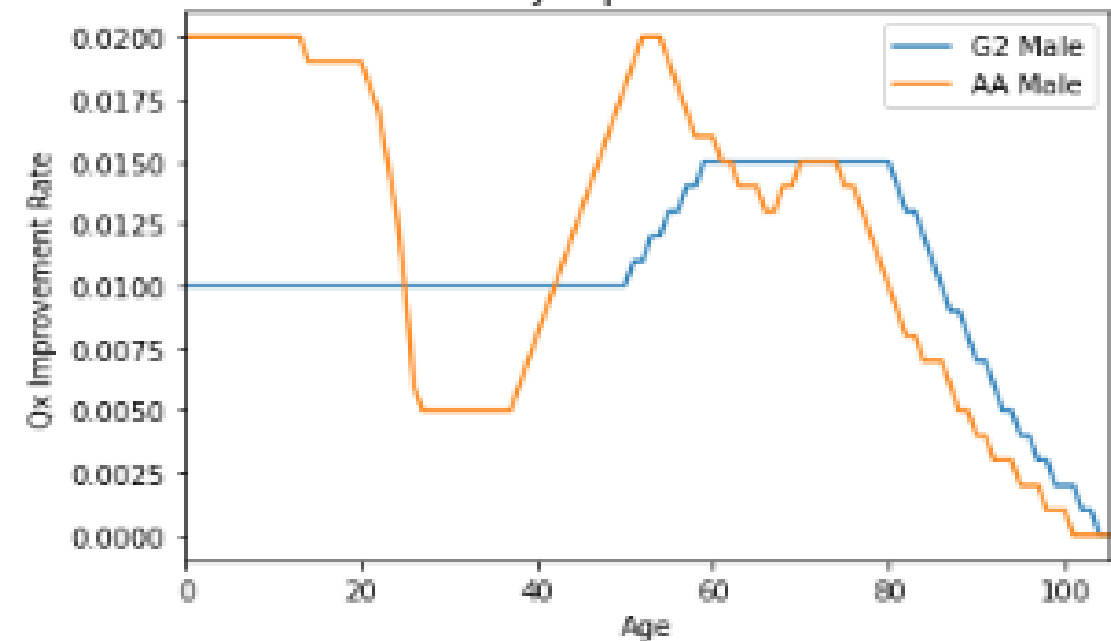
https://www.soa.org/resources/experience-studies/2018/mortality-improvement-scale-mp-2018/

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Mortality Improvement Scales at a Glance

The MP Pension Mortality Improvement Rate Varies by Calendar Year

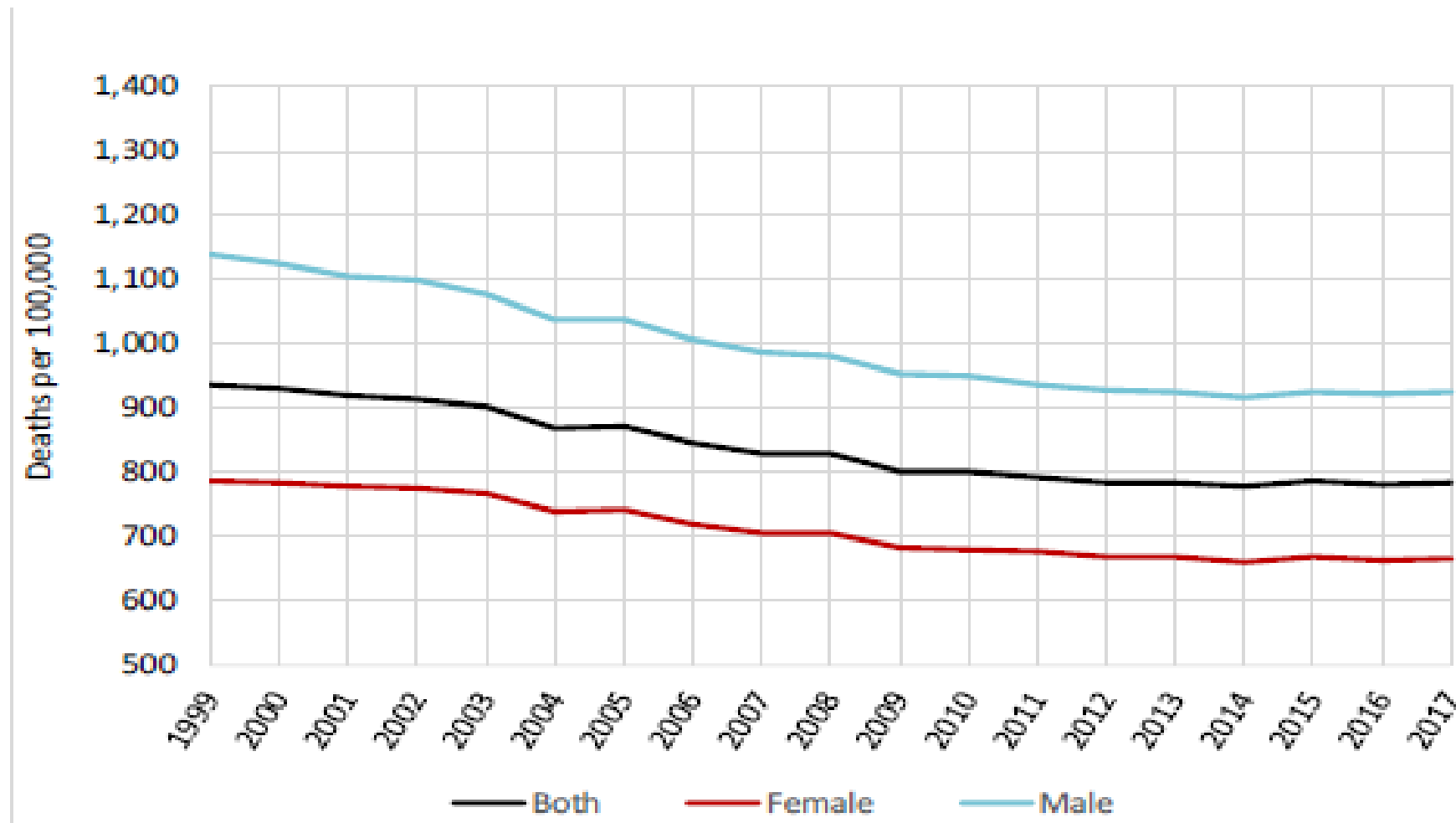

MP-2017 Male Mortality Improvement
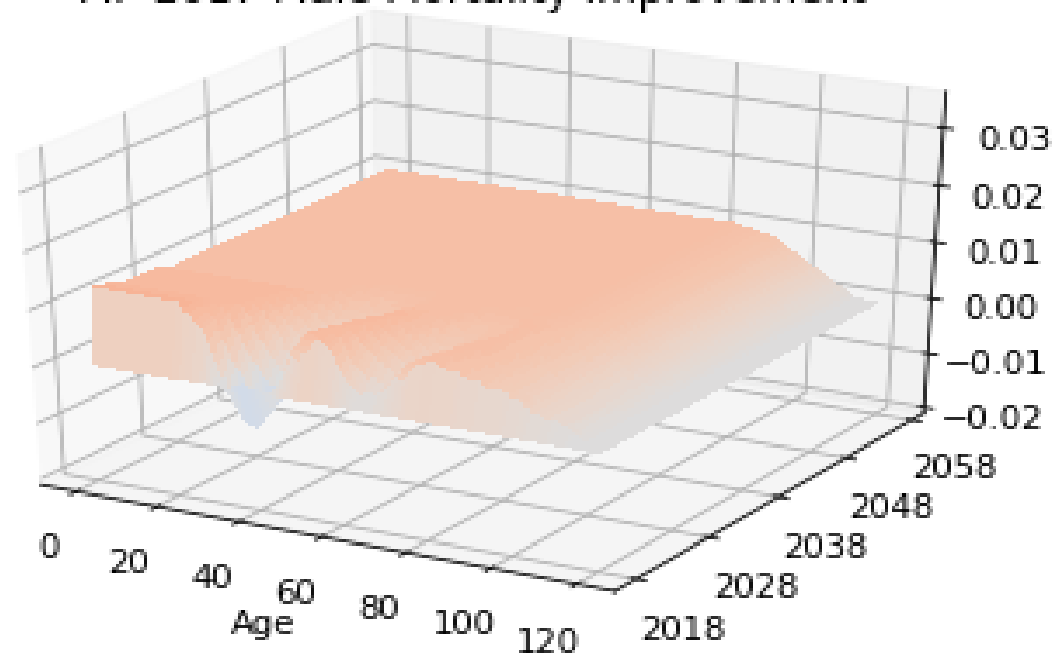
Mortality Improvement Rates

U.S. Mortality Improvement Slowing

Recent Years Have Even Shown a Mortality Increase

AGE-ADJUSTED MORTALITY 1999-2017

"US Population Mortality Observations - Updated with 2017 Experience" , Society of Actuaries, January 2019,
https://www.soa.org/Files/resources/research-report/2019/us-population-mortality-observations.pdf

Experience Varies by Age and Time Period

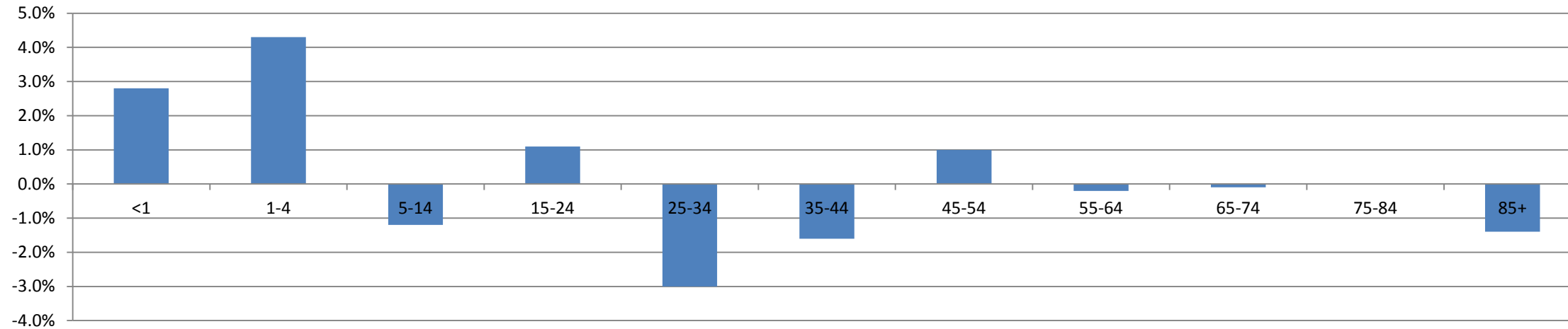## U.S.   2016 - 2017

U.S.   1999 - 2017

"US Population Mortality Observations - Updated with 2017 Experience" , Society of Actuaries, January 2019,
https://www.soa.org/Files/resources/research-report/2019/us-population-mortality-observations.pdf
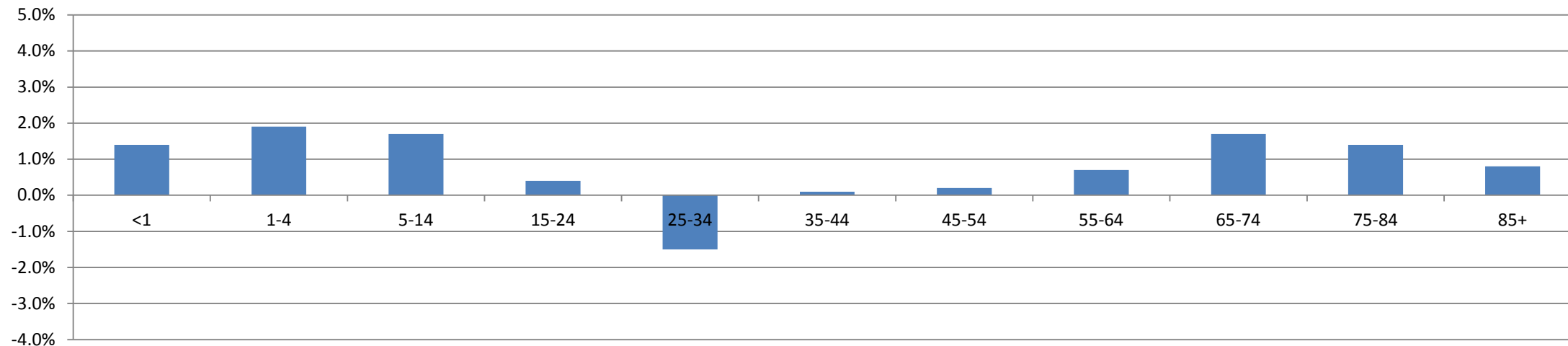
Future Life Expectancy by Country

Future Life Expectancy More Relevant For Insurance Than L.E. at Birth

Life Expectancy for 65 year-old Male

Legend: Chile, Japan, UK, US, Brazil

OECD Health Database https://stats.oecd.org/index.aspx?DataSetCode=HEALTH_STAT

Cause of Death at Different Ages

U.S. Population Study

COD PROPORTION OF DEATHS BY AGE GROUP

Legend: Other, Assault, Liver, Suicide, Diabetes, Stroke, Pulmonary, Accidents, Alzheimer's/Dementia, Cancer, Heart

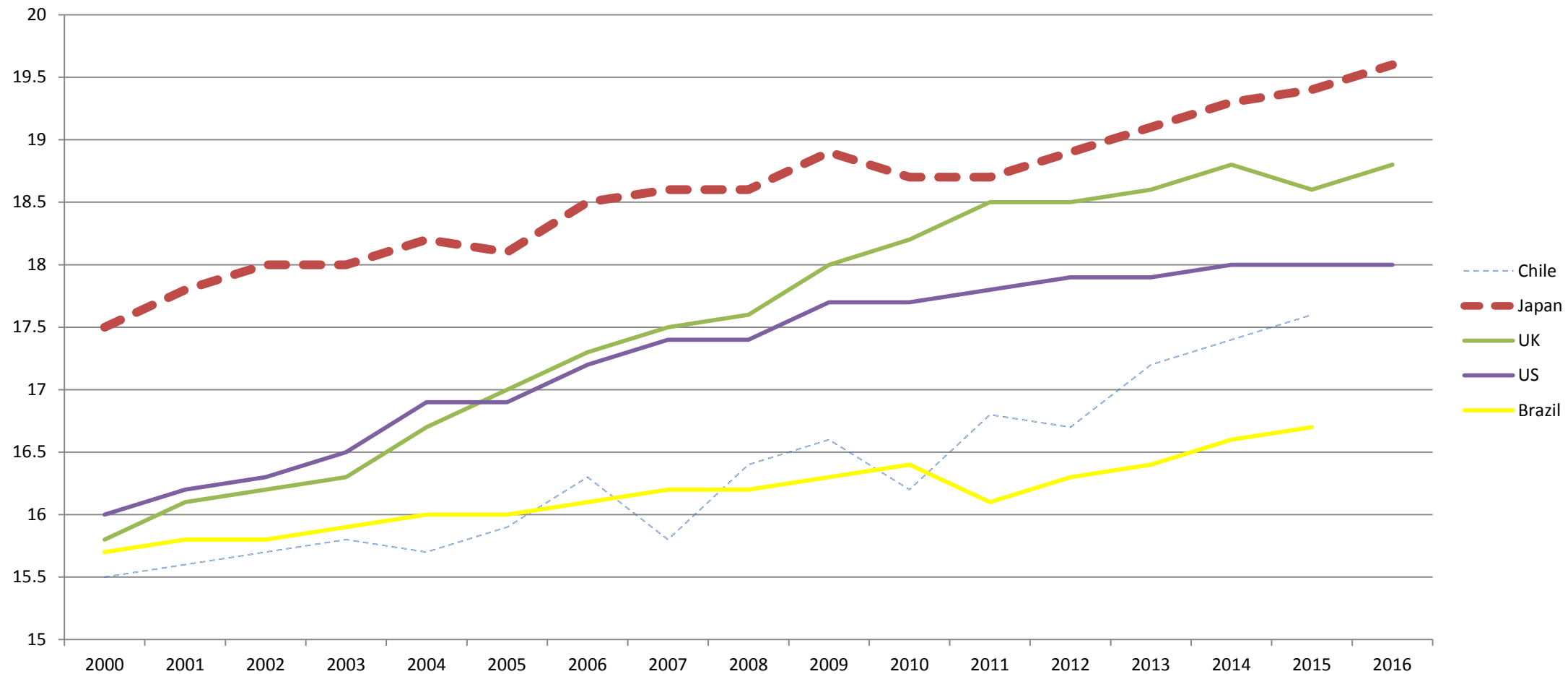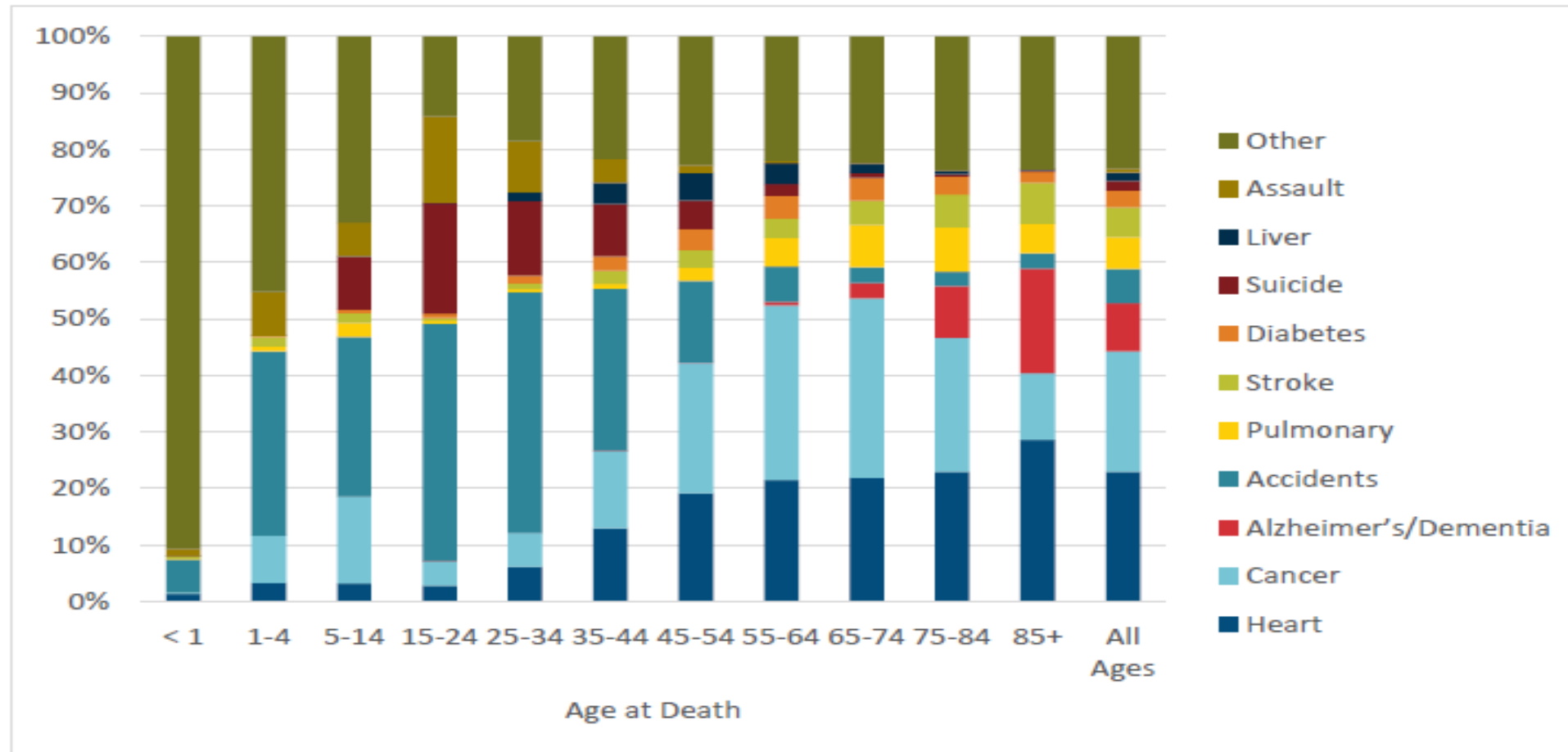Age at Death: < 1, 1-4, 5-14, 15-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75-84, 85+, All Ages

"US Population Mortality Observations - Updated with 2017 Experience" , Society of Actuaries, January 2019
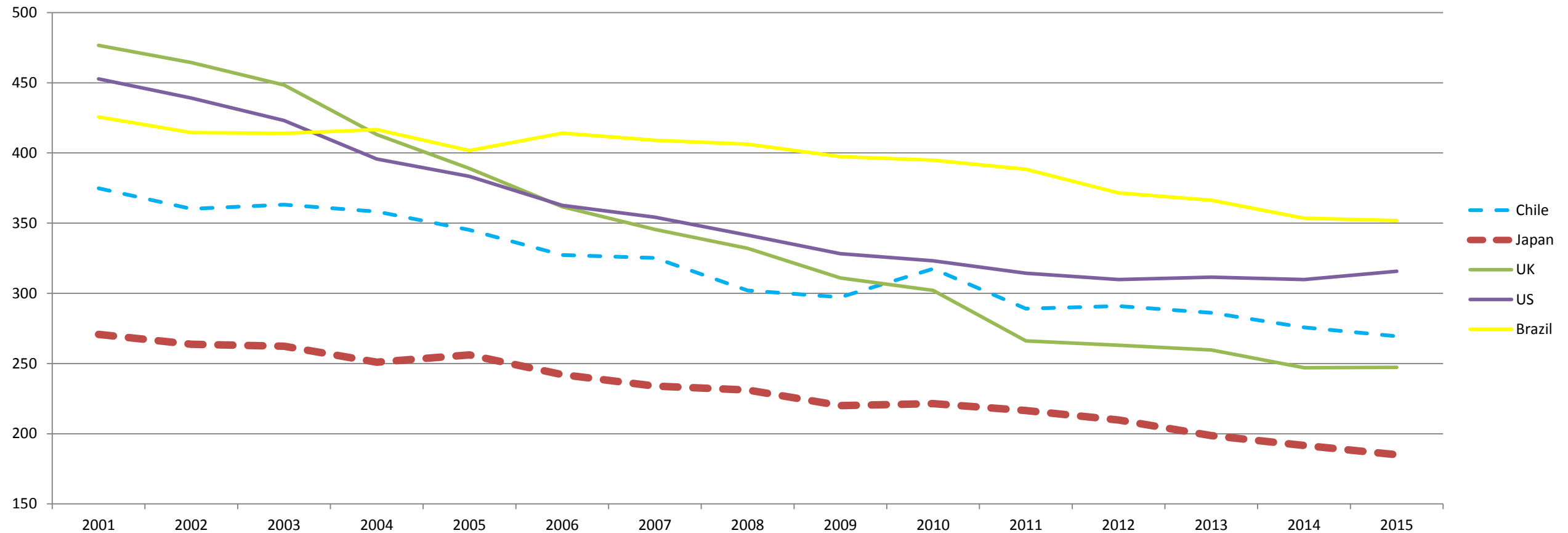https://www.soa.org/Files/resources/research-report/2019/us-population-mortality-observations.pdf
Murphy SL, Xu JQ, Kochanek KD, Arias E. Mortality in the United States, 2017. NCHS Data Brief, no 328. Hyattsville, MD: National Center for Health Statistics. 2018., Human Mortality Database www.mortality.org

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Improvements in Fighting Disease

Similar Improvement Trends for Females

Male Cardiovascular Deaths Per 100,000 (Age Standardised)

OECD Health Database https://stats.oecd.org/index.aspx?DataSetCode=HEALTH_STAT

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Improvements in Fighting Disease

Similar Improvement Trends for Females

Male Cancer Deaths Per 100,000 (Age Standardised)

Legend: Chile, Japan, UK, US, Brazil

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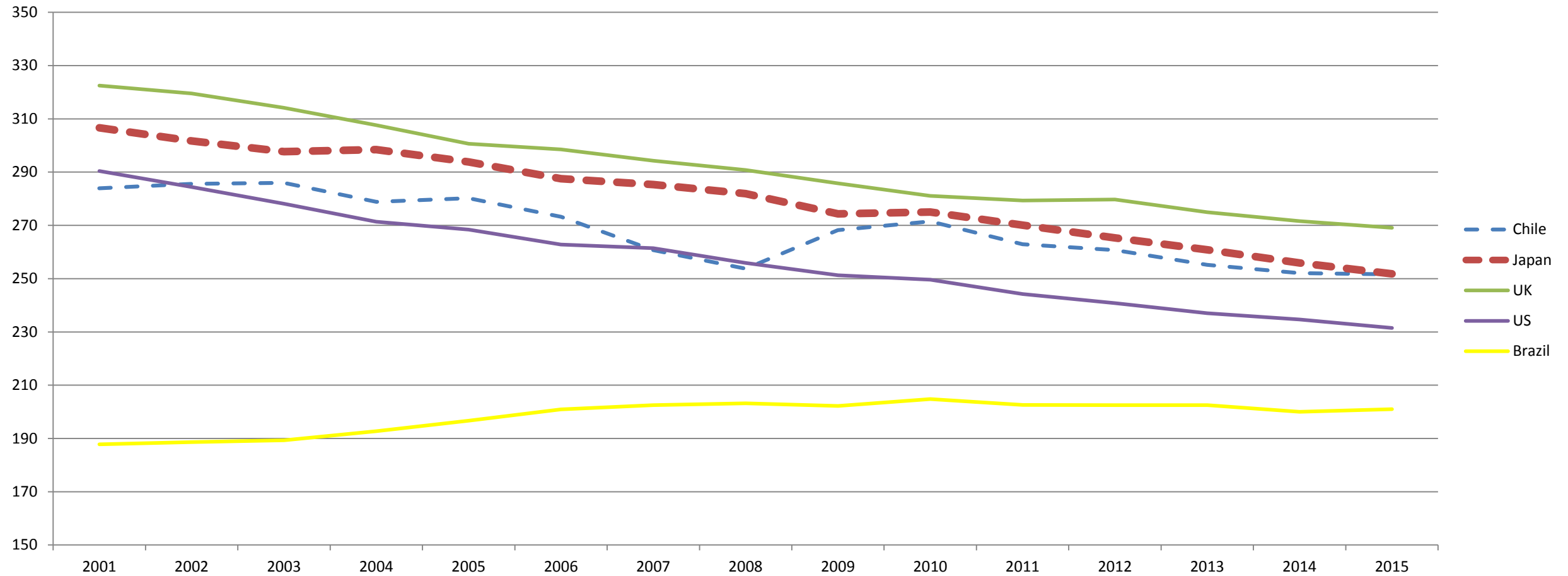
Mortality by Income Study

Median Household Income by County

U.S. CENSUS BUREAU 2008 COUNTY MEDIAN HOUSEHOLD INCOME ESTIMATES
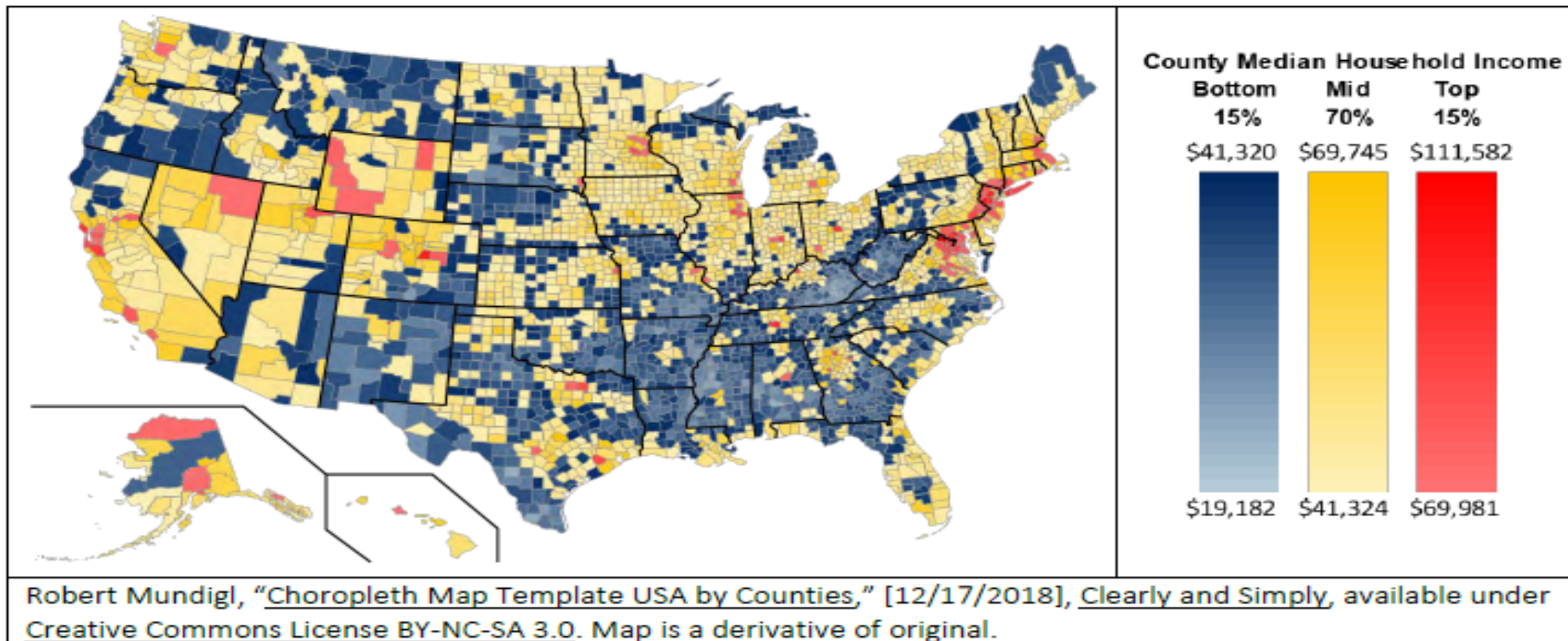
County Median Household Income

Bottom 15%	Mid 70%	Top 15%
$41,320	$69,745	$111,582
$19,182	$41,324	$69,981

Robert Mundigl, "Choropleth Map Template USA by Counties," [12/17/2018], Clearly and Simply, available under Creative Commons License BY-NC-SA 3.0. Map is a derivative of original.

"US Population Mortality Observations - Updated with 2017 Experience" , Society of Actuaries, January 2019
https://www.soa.org/Files/resources/research-report/2019/us-population-mortality-observations.pdf
Murphy SL, Xu JQ, Kochanek KD, Arias E. Mortality in the United States, 2017. NCHS Data Brief, no 328. Hyattsville, MD: National Center for Health Statistics. 2018.

Mortality by Income Study

Counties with the Highest Median Household Income

TOP 15% TO ALL COUNTIES MORTALITY RATIO

"US Population Mortality Observations - Updated with 2017 Experience" , Society of Actuaries, January 2019
https://www.soa.org/Files/resources/research-report/2019/us-population-mortality-observations.pdf
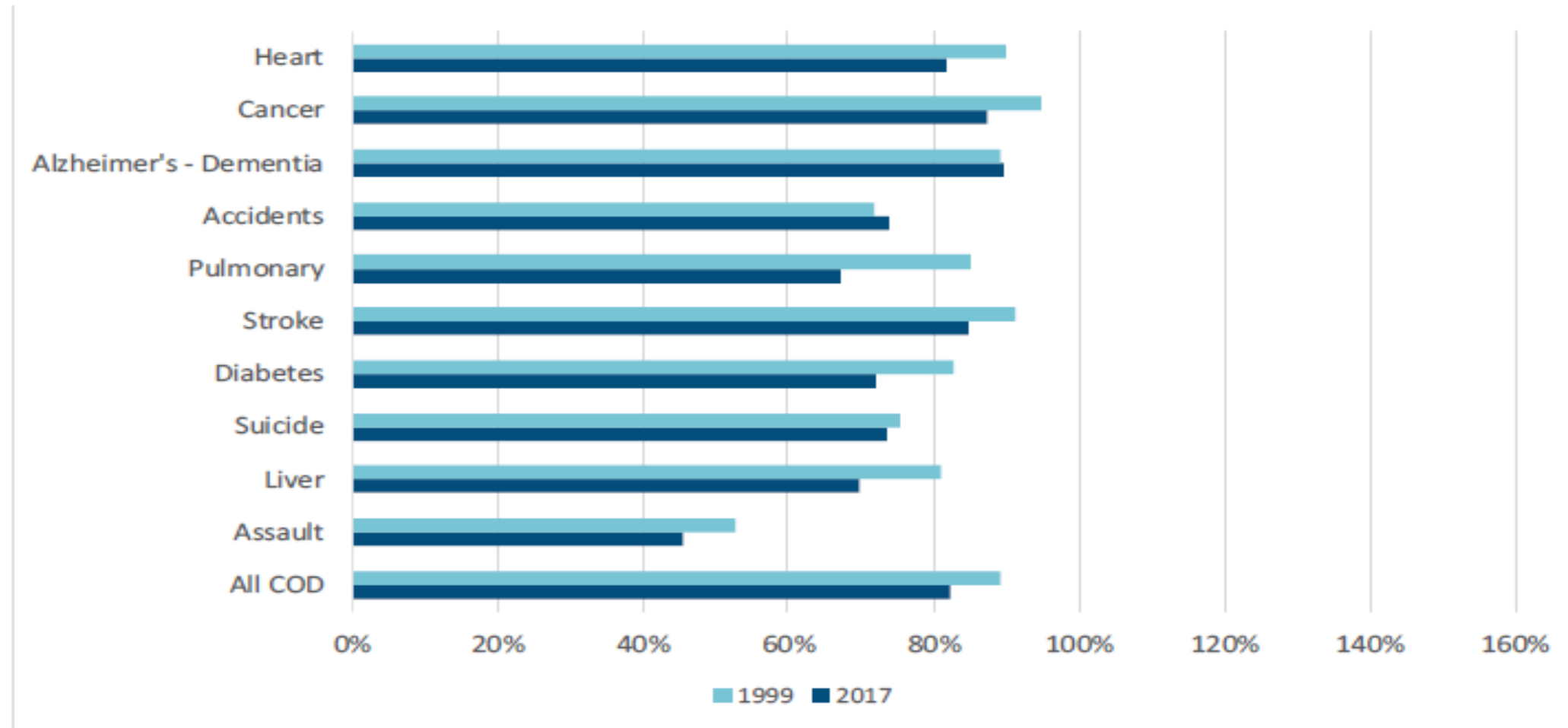Murphy SL, Xu JQ, Kochanek KD, Arias E. Mortality in the United States, 2017. NCHS Data Brief, no 328. Hyattsville, MD: National Center for Health Statistics. 2018.

Mortality by Income Study

Counties with the Lowest Median Household Income

BOTTOM 15% TO ALL COUNTIES ALL AGES MORTALITY RATIO

Categories (top to bottom): Heart, Cancer, Alzheimer's - Dementia, Accidents, Pulmonary, Stroke, Diabetes, Suicide, Liver, Assault, All COD

Legend: 1999, 2017

"US Population Mortality Observations - Updated with 2017 Experience" , Society of Actuaries, January 2019
https://www.soa.org/Files/resources/research-report/2019/us-population-mortality-observations.pdf
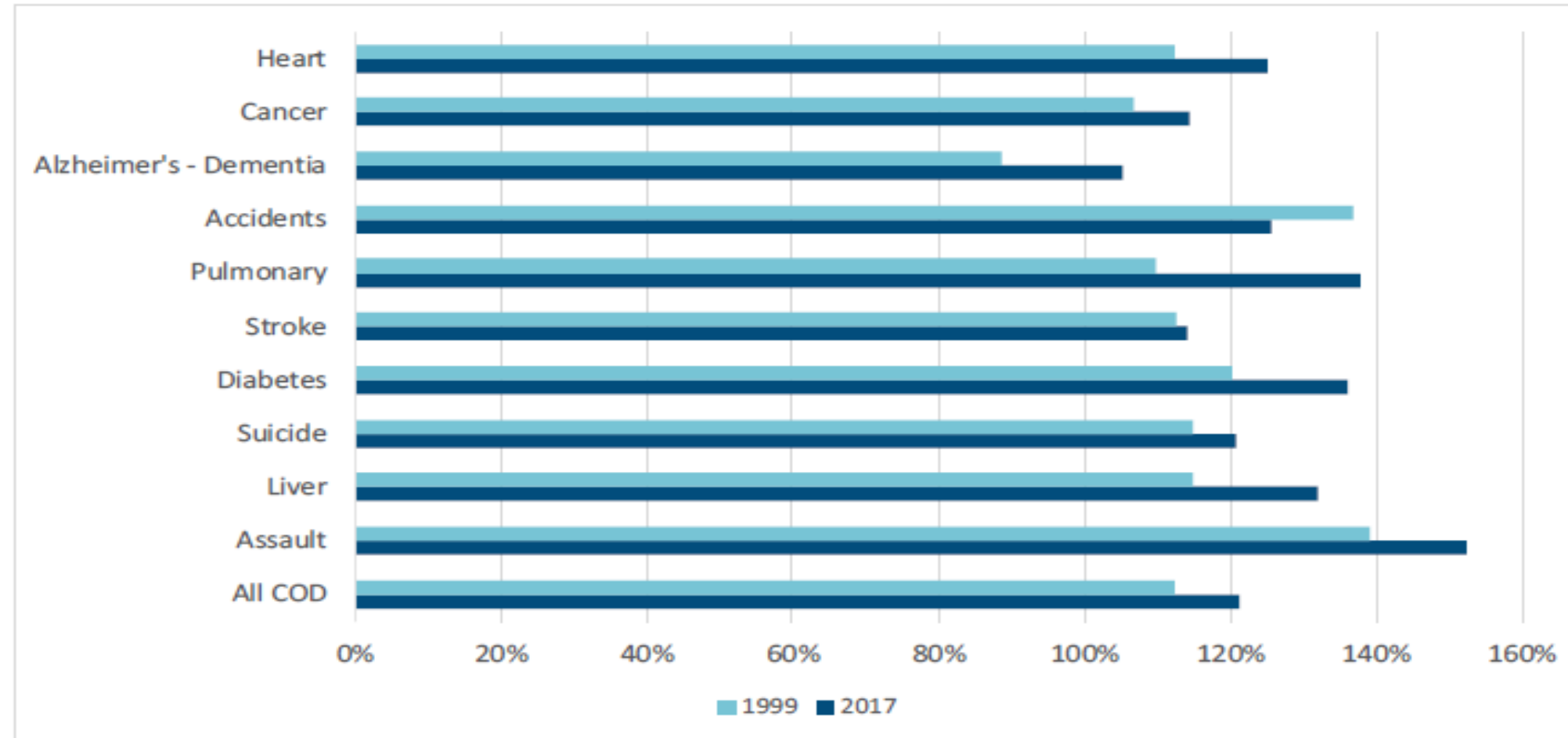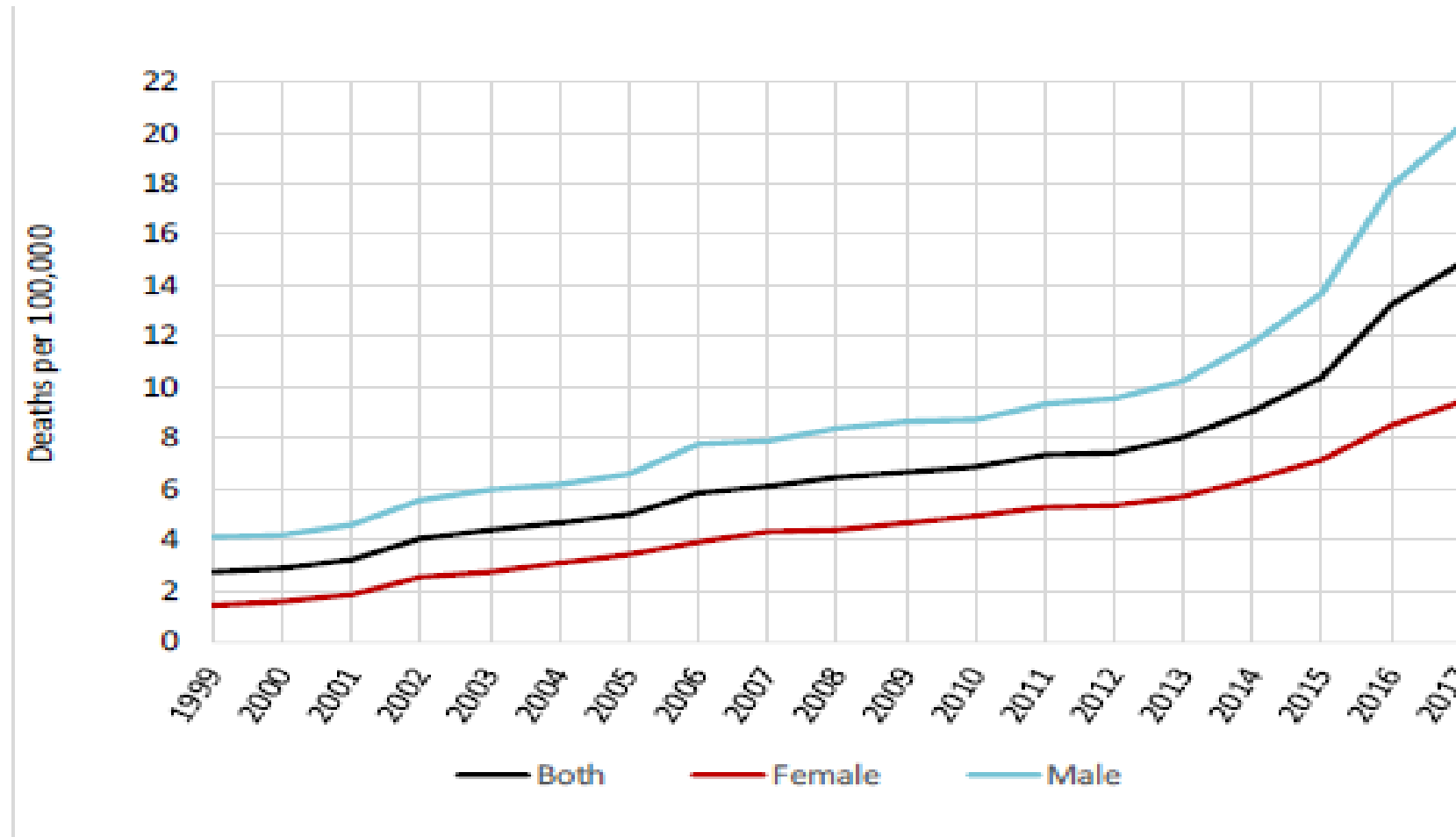Murphy SL, Xu JQ, Kochanek KD, Arias E. Mortality in the United States, 2017. NCHS Data Brief, no 328. Hyattsville, MD: National Center for Health Statistics. 2018.

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Opioid Epidemic

AGE-ADJUSTED MORTALITY 1999-2017

"US Population Mortality Observations - Updated with 2017 Experience" , Society of Actuaries, January 2019
https://www.soa.org/Files/resources/research-report/2019/us-population-mortality-observations.pdf
Rudd RA, Seth P, David F, Scholl, L. Increases in drug and opioid overdose deaths—United States, 2000–2015. MMWR Early Release 2016;64:1378–82. CrossRefPubMed

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Life Expectancy Updates

U.S. Statutory Reserves Have Conservatism Built In (~85th Percentile)

2018 Cohort Life Expectancies (Complete)						
	Females			Males		
Projection Scale →	MP-2017	MP-2018	% Change	MP-2017	MP-2018	% Change
Age						
25	64.39	64.23	-0.26%	61.78	61.49	-0.47%
35	53.63	53.48	-0.28%	51.10	50.86	-0.46%
45	42.95	42.83	-0.29%	40.48	40.30	-0.44%
55	32.47	32.35	-0.36%	30.12	29.97	-0.50%
65	22.68	22.61	-0.33%	20.71	20.60	-0.51%
75	14.34	14.29	-0.34%	12.89	12.84	-0.40%
85	7.68	7.66	-0.25%	6.75	6.73	-0.34%

Based on these assumptions, age-65 cohort life expectancy decreased slightly less than one month for females and slightly more than one month for males.

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Eliminating Certain Causes of Death

Life Expectancy Related to Fighting Disease (U.S.)
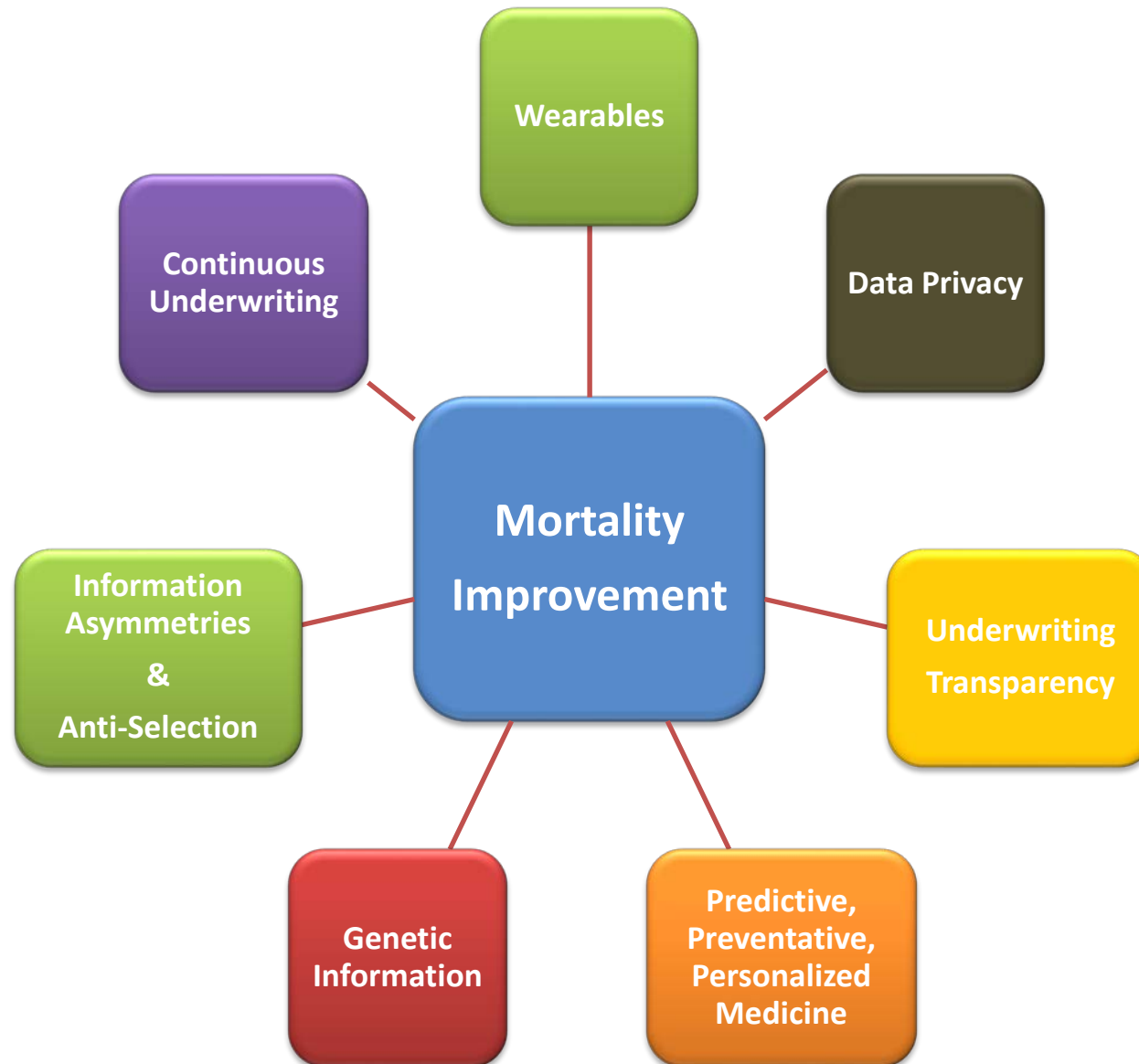
At Birth…
31% chance of dying from **heart disease** (or 41% from a "major cardiovascular" disease)
22% chance of dying from **cancer**

Age	Curing Heart Disease	Curing Cancer
55-60	25.6 => 30.9 **(+5.3)**	25.6 => 28.4 **(+2.8)**
60-65	21.6 => 26.7 **(+5.1)**	21.6 => 24.1 **(+2.5)**
65-70	17.8 => 22.8 **(+5.0)**	17.8 => 19.9 **(+2.1)**
70-75	14.3 => 19.1 **(+4.8)**	14.3 =>16.0**(+1.7)**
75-80	11.1 => 15.7 **(+4.6)**	11.1 => 12.4 **(+1.3)**
80-85	8.4 => 12.7 **(+4.3)**	8.4 => 9.3 **(+0.9)**

Future Mortality Improvement

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The Art of Modeling

Extrapolation, Simulation, and Alternative Approaches

1 How Complex Should Your Model Be?

(Group vs. Individual Level, Multi-Decrement Cause of Death, Improvement Timelines)

2 Experience Takes Years to Emerge

(Human Lives are Long Compared to Animal Studies)

3 Alternative Views of the Future

(Improvement Plateau vs. Medical Breakthroughs)

4 Simulations & Scenario Testing Can Offer Insight