



# Drivers of U.S. Mortality Improvement

## Expert Panel Forum Report





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### Background on the Society of Actuaries Longevity Initiative

In 2012, the Society of Actuaries (SOA) Board established a task force emphasizing longevity as a key social issue and the need for actuaries, particularly SOA members, to be better positioned to manage mortality/longevity as a risk. As a result, the Longevity Advisory Group (LAG) was formed to further education and research into longevity issues. The LAG, a nine-member group of volunteers, has engaged in a variety of projects and activities to spur more education and research, including the following:

- Conducted a series of webcasts on longevity topics/issues
- Sponsored research projects on components of historical improvements in U.S. mortality
- Created a “shark tank–like” contest—“Workable Innovations for Longer Living (WILL)” — held at the SOA Annual Meeting in Nashville on October 15, 2018
- Conducted searches for additional data gathering sources
- Investigated developing a consistent mortality improvement framework
  - A survey of practitioners utilizing mortality modeling techniques indicated there was no real consensus of a consistent framework.
  - Modeling mortality improvement varies by line of business.

### Discussion of Drivers of U.S. Mortality

It is not the intent of the LAG to create a single set of mortality improvement rates to be used in all applications and all circumstances. Experts from inside and outside the insurance/retirement industry were invited to participate in a daylong Expert Panel Forum discussion to provide input about drivers of U.S. mortality improvement for the short and long term. The issues addressed included:

- What are going to be the key drivers of U.S. mortality?
- How will key drivers of mortality interact?
- How might factors discussed change mortality rates for different age groups, most noticeably below and above age 65?

As evidenced by continuing experience studies conducted by the SOA, academic researchers and individual companies, longevity in the United States has continually improved over the past 100 years. According to the Social Security Administration, in 1910 a 65-year-old male was expected to live to age 76 and a 65-year-old female to age 77; in 2010 a 65-year-old male was expected to live to age 82 and a 65-year-old female to age 85. Most would agree mortality improvement will continue into the future, but will the improvement continue at the same rate or even faster? Or will mortality improvement eventually flatten out or perhaps drop?

Views on mortality improvement expressed at the forum seemed to fall into the “limitations camp” of researchers as expressed in a January 2014 *Pension Section News* article, “in projecting mortality improvement researchers tend to fall into two extremes with little middle ground. At one extreme, many see a practically unlimited human lifespan, arguing the potential to be reduced by human intervention. At the other extreme, some researchers believe that there is a biological limit to human lifespan. Although they predict that life expectancy will continue to lengthen for some time into the future through medical advances and other factors, these researchers believe the inevitable processes of aging and damage accumulation will create a limit to the average lifespan.” Forum participants fell into the latter camp.

In this discussion, it is worthwhile to provide a few definitions. *Life span of humans*—and for that matter any species—is the oldest age ever achieved by a member of the species. Thus, human life span was defined by Jeanne Calment, who died at the age of 122 and 167 days in 1997. *Average life expectancy*, on the other hand, is the average of death for a particular birth year cohort or age group.

## Top Drivers of U.S. Mortality

When asked to identify the most important drivers affecting U.S. mortality during the next 10 years, the group’s top choices were:

- Individual behavior issues,
- Socioeconomic status (SES) inequality,
- Social policy (access to health care and other health-related interventions, such as smoking policies and policies that have an impact on violence and traffic accidents in particular), and
- Environmental issues.

Several of the same factors but in different order were chosen as the most important drivers affecting U.S. mortality past the next 10 years:

- Socioeconomic status (SES) inequality,
- Individual behavior issues,
- Genetics/pathways affecting aging,
- Social policy (access to health care), and
- Environmental issues.

## Aging Is the Biggest Driver of Mortality

We age. While some people live well beyond their birth cohort life expectancy, there is currently an observed limit to human life span. The goal is not perhaps to lengthen life span indefinitely (there is no magic pill) but to lengthen healthy living. Behavior issues are the big drivers of mortality. Most people can live to their mid-80s by following healthy behaviors (such as not

smoking, eating well, exercising, maintaining a healthy weight, and avoiding stress). To the extent structural differences in equality (SES) affect behavior issues, we will continue to see structural differences in mortality rates. There may be some improvements on the margins (such as understanding the pathways of aging leading to medical interventions), but these are unlikely to be advanced enough to have an impact for at least another 20 years, and even then they will only affect mortality for certain individuals and groups— not population-level changes.

We've achieved much of the mortality improvement we've seen in recent decades from medical advances. One forum participant noted, "We've gotten the easy stuff solved on cardiovascular." Can the 75% decline in coronary artery disease be replicated? There would have to be a huge alignment of factors:

- All blood pressures would need to be below 120.
- All cholesterol levels would have to be below 180.
- Factors driving cardiovascular disease also drive cancers.
- Healthy weights (including a body mass index of <25) would need to be maintained.
- Tobacco use would have to be eliminated.
- Regular and frequent exercise would need to be common.

The ceiling is biology. There will always be peak performers (that is, Olympians) in sports who can run a mile in less than four minutes. The same is true for aging, with an extreme few being able to approach the current 122-year limit of life span.

The question of what we're capable of achieving in terms of current average life expectancy can be answered by examining the life expectancy of a group of studied Seventh Day Adventists. These individuals live a very healthy lifestyle (regular exercise, vegetarian diet, abstention from alcohol and tobacco), but they are heterogeneous with regard to where they live and their ethnicities. Data indicate life expectancy for this group at birth is age 86 for males and 89 for females, an eight- to nine-year advantage over non-Adventist Americans basically due to lifestyle choices.

How far can we push average life expectancy? It may not be much beyond what the Seventh Day Adventists achieve. Individual behaviors, SES, social policy, and environment may allow the average person to live to the mid-80s. The greatest potential for significantly reducing mortality is for the age group 50 to 70 years. Even eliminating all deaths before age 50 results in only 3.5 years of life expectancy. Subgroups of people with healthy behaviors still die in their 50s and 60s. These individuals may have genetic coding predisposing them to early deaths. Others dying in this age range exhibit "harmful" behaviors:

- Obesity and/or poor diet
- Smoking and drug abuse
- Consumption of alcohol
- Inactivity
- Exposure to violence

Low life expectancy is often geographically associated with harmful behaviors. If we optimize lifestyle and cannot control genetics, the only things left to prolong healthy life span are

improvements in medical care (as for Alzheimer's) and environmental factors (such as social and environmental interventions). Recently published studies suggest global warming and pollution could have major direct and indirect effects on health in the medium to long term.

Healthy behaviors among those of higher income and education levels largely drive differences in population mortality. To the extent we do not see improvements in public health (through social policy)—including positive changes in environments, better access to health care and efforts to improve health behaviors—then disparities in mortality between lower, middle and upper socioeconomic status groups will likely continue. A combination of education and income contribute to the acquired healthy behaviors for these individuals in selecting where and how they live (for instance, environmental factors).

While there is room for mortality improvement, how much social policy is needed to improve mortality if it does not always come with offsets in morbidity compression? Will governments be willing to endorse (“pay for”) social policies to achieve mortality improvements and wait for long-term effects to take place? Some social policy has been powerful (for example, smoking bans have lowered lung cancer rates; traffic regulations have reduced vehicle accidents). However, the differences in political emphasis on public policy in the United States lead many to believe no relevant public policy will (can) be enacted.

Increasing disparity between rich and poor will lead to social disruption, and inequitable distribution could have negative consequences. Notwithstanding, the higher income/higher educated group will benefit first from any new technologies. Over time the costs will fall, and access will become widespread.

Improved understanding of the genome and other aspects of the biology of aging, as well as improved medical treatments, may lead to some improvements on the margins, but these will likely only affect mortality for certain individuals and groups in the short to medium term and not create population-level changes. If there are population-level changes, it will take a long time to flow down. Individuals living to extreme old ages (beyond 105 years) have a combination of favorable genes. It is pretty clear from genetics performed to date no single genetic variant may be modified to shut off aging. Aging is a complicated process—a combination of many detrimental and protective forces.

Although there is no magic pill, will populations take pills? There is no evidence people continue behaviors unless there are noticeable benefits in a short period of time. Precision medicine will not have a big impact in the next 10 years. Society needs less expensive ways to improve morbidity, and that is not via precision medicine, which so far only creates high-cost treatment. Also, initially this will be something for the “wealthy” and not have a population-level effect. People with higher levels of education may be more willing to do the “pill a day” routine for senescence (the process by which cells irreversibly stop dividing and enter a state of permanent growth arrest without undergoing cell death). Senescence can positively be affected by behavior (for example, exercise).

Looking at the super old is not helpful. Living into one's mid-80s is about health behaviors. Between the 80s and past 100 an individual's genetics (in addition to behaviors) tend to play an important part. A socially active 90-year-old is more likely to live to age 100 (or beyond). Living into one's 90s or past age 100 may require “super” genetics. The trick of getting beyond age 105 (1 per 250,000)

is rare, not because of one or two or three genes, but because the combination of a lot of individually weak genes have a strong effect as a group. This is difficult to replicate.

It is unlikely mortality improvements experienced in the past (particularly for the age 65+ cohorts) will continue. A change in life expectancy of one year per decade may not be a realistic achievement. However, a one-year extension of life will have a huge financial/economic impact on society, the cost of insurance, pensions and annuities. What is a government's motivation to fund research or promote social policy for longer life spans if there is a burden on the population to pay for the research? Individuals with the means to fund research will benefit from it. The first person to live to age 200 (if humanly possible) is not alive today; that goal will take considerable income and genetic manipulation to achieve.

Mortality improvements experienced to date are more likely due to the following:

- The effects of declining smoking rates working their way through the population; and
- The rising level of education, which may also be driving the widening mortality gap (those who do not have a high school education today are a more select population and, as such, may be healthier on average than those without a high school education 30 years ago).

The single most discriminating factor in terms of health is education. In areas with very little health care, people with higher education benefit faster once they have access to health care in that region (geographically). They know to take advantage of the opportunities provided to them.

The future is unknown. We know what has increased mortality in the past, but we don't know what will drive future mortality changes.

- Will differences between social economic levels of the population affect the outcomes?
- Obesity is a wild card. Will we have the discipline to change the food supply?
  - We will need to fight against the food and entertainment industries who profit from "unhealthy" foods.
  - The Food and Drug Administration has banned artificial trans fats in the U.S. food supply.
  - The effort to ban sugared drinks was not successful. Should another attempt be made?
  - Other policy measures (such as instituting a sugar tax, removing the "generally regarded as safe" status from sugar and salt, changing the farm bill subsidies) to improve the food supply could have important effects on the healthiness of Americans.
  - Nutritional labeling on packaged food has had some effect on behavior, but more standardization is needed.
  - The problem of competing signals on public policy needs to be addressed (think of passing through the junk food aisles to retrieve a statin prescription from the pharmacy).
  - It is still less expensive to purchase a "supersize" drink meal than a smaller, healthier meal at fast-food restaurants.
- Immigration is having an effect on the heterogeneity of the age 65+ population. This is the least diverse segment of the U.S. population. Immigration laws changed in the 1970s. First-generation immigrants tend to have better mortality than native-born citizens, albeit with



some variations depending on the place of origin. But immigrants now tend to be somewhat less healthy than previous generations because they are coming from countries with poorer health behaviors (including high obesity and high smoking rates).

- The environmental effects of climate change could bring more tropical and infectious diseases, as well as catastrophic events, to new populations.
- Is the opioid situation getting better or worse? Right now, it is clearly getting worse, but the increase in mortality due to drug poisoning seems to be decelerating. Prescription patterns are different across countries. In the United States doctors prescribe more pills than necessary to treat ailments. There is pressure on the medical industry to change prescribing patterns, including not prescribing for minor impairments. *But* the U.S. black market is being flooded with fentanyl, in a way fentanyl is much more lethal than prescription opioids. Social policy needs to initiate educational campaigns about the dangers of drugs in general. initiating education campaign.

The future is not all bleak; there is room for some optimism—especially when we look at the continuous improvements experienced by many other high-income countries. We can control the health effects of obesity—there are effective treatments to control diabetes and obesity. If we can control blood pressure, cholesterol and blood sugar, then being obese may not be (as) lethal.

Aging research today is focused on delaying morbidity. Mortality compression is a consequence of delayed morbidity; but it is not worth having lots of people live to be age 115 if they are all sick for an increasing number of years. The trick is to push the first age-related disease to later in life, but that might not change when the “cascade” begins. On average it takes 60 years for an individual to succumb to the first age-related disease, then three years to succumb to the second, and one year to succumb to the third. Although it may not be possible to change the trajectory of diseases, it may be possible to delay the onset of the morbid chain to later ages.

Even if you can eliminate one disease, there is a likelihood of dying from another. But there may be a spillover effect from treating one disease to treating another. For example, if you understand why people die from cancer, improving treatment may improve outcomes for cardiovascular disease.

What has been demonstrated from the forum discussion so far?

- At best a population may achieve living to age 86 for males and to age 89 for females, given appropriate lifestyle factors.
- At least in the next 10 years, medicine alone is not likely to improve mortality.
  - If it does, the wealthier will benefit the most because our health care/public health system is not established to distribute it.
  - If medical advances take the form of gene-level treatment for specific illnesses, treatment will not affect wide groups of the population.
- There are unknowns—new cohorts are very different from prior cohorts.

Last but not least, what should we consider when creating a consistent framework for modeling mortality improvement?

- “By disease” models are not helpful.
- Cause of death reporting is not fully accurate (for example, a patient with Alzheimer’s who dies in her sleep is coded as having died of cardiovascular disease).
- Seventh Day Adventists have at-birth life expectancies of age 86 for males and age 89 for females.
  - What are optimization effects of better behaviors?
    1. On a population level it will be tricky to get everyone to follow healthier behaviors.
    2. In the last 10 years major mortality improvement was seen in upper income populations that were educated about and had access to better health care.
    3. Achieving life expectancies of 87 or 88 years for even the healthiest subgroups of the population may be the best we can expect in the next 10 years.
- The United States has improved mortality at older ages (> late 80s) but not for those in their 70s and 80s. Though even at older ages, U.S. mortality gains have become slower than in those of most other high-income countries.
- A review of National Center for Health Statistics data to understand the current health status of younger cohorts does not paint a pretty picture. People in their 40s, 50s, and 60s already have multiple health problems.
- The composition of the national population is changing, and we are seeing generation effects in ethnic populations. For example, the Hispanic population in the United States will increase, but we do not know if first-generation immigrants from Latin America will maintain their traditional health advantage.
- A 1%/year mortality improvement is historically appropriate as a *pension* assumption. Employees covered by pension plans will have better mortality than the general population because employers offer health insurance and employees are better educated.
  - An alternative is to review the health status of cohorts; for instance, look at the health status of 50-year-olds today to figure out what mortality rates may be for 60-year-olds in 10 years.
  - Behaviors exhibited by the majority of 55-year-olds are not healthy. Will experience improve, or will survivors of this cohort continue to be unhealthy?
- It is hard to construct differentiated mortality improvement models. We need to keep models simple unless there is strong evidence to do otherwise.
- National Health and Nutrition Examination Survey data are best for measuring the prevalence of risk factors in the U.S. population as the program does not rely on self-reporting (like other nationally representative surveys such as the National Health Interview Survey).

What are the next steps? There is more to consider regarding creating a consistent framework to model mortality improvement. We do not have strong data on all the factors. Going forward involves three steps:

1. Review existing models used for mortality improvement—CMI, the SOA’s Retirement Plans Experience Committee (RPEC)—to understand their methodology and development.
2. Review what we have to work with—what are the drivers we know?

3. What data are available, or how do we collect new data on the new drivers?

## Forum Participants

<b>Invited Expert</b>	<b>Title and Affiliation</b>
Mary Bahna-Nolan, FSA, MAAA, CERA	Vice President, Head of Life R & D, SCOR Global Life
Magali Barbieri, PhD	Full Researcher, Department of Demography, University of California, Berkeley; Associate Director, Human Mortality Database (HMD)
Tom Gordon, FIA	Head of Aon Demographic Horizon Team
Mark Huffman, MD, MPH	Associate Professor, Preventative Medicine and Medicine Cardiology, Northwestern University Feinberg School of Medicine
Brian Ivanovic, MD	Head of Swiss Re North America Applied Research and Development
Nathan LeBrasseur, PT, PhD	Consultant, Associate Professor, Co-Chair, Research Department of Physical Medicine and Rehabilitation, Mayo Clinic
Neil Mehta, PhD, MA, M Sc	Assistant Professor, Health Management and Policy, University of Michigan
S. Jay Olshansky, PhD	Professor, School of Public Health, University of Illinois, Chicago; Research Associate, Center on Aging, University of Chicago and London School of Hygiene and Tropical Medicine; Chief Scientist, Lapetus Solutions, Inc.
Tom Perls, MD, MPH, FACP, AGSF, FGSA	Professor Medicine and Geriatrics, Director/Founder New England Centenarian Study, Principal Investigator Life Long Family Study, Boston University School of Medicine
<b>Longevity Advisory Group Member</b>	<b>Title and Affiliation</b>
Jean-Marc Fix, FSA, MAAA	Vice President, Actuarial Research and Development, Gen Re
Sam Gutterman, FSA, FCAS, MAAA, CERA, FCA, HonFIA	Retired Consulting Actuary, PWC
Tom Jones, ASA, MAAA	Vice President, Head of Pension Risk Transfer Funded Transaction and Structured Settlement Pricing Team, Prudential Insurance Company of America
Allen M. Klein, FSA, MAAA	Principal and Consulting Actuary, Milliman
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## About The Society of Actuaries

The Society of Actuaries (SOA), formed in 1949, is one of the largest actuarial professional organizations in the world dedicated to serving 32,000 actuarial members and the public in the United States, Canada and worldwide. In line with the SOA Vision Statement, actuaries act as business leaders who develop and use mathematical models to measure and manage risk in support of financial security for individuals, organizations and the public.

The SOA supports actuaries and advances knowledge through research and education. As part of its work, the SOA seeks to inform public policy development and public understanding through research. The SOA aspires to be a trusted source of objective, data-driven research and analysis with an actuarial perspective for its members, industry, policymakers and the public. This distinct perspective comes from the SOA as an association of actuaries, who have a rigorous formal education and direct experience as practitioners as they perform applied research. The SOA also welcomes the opportunity to partner with other organizations in our work where appropriate.

The SOA has a history of working with public policymakers and regulators in developing historical experience studies and projection techniques as well as individual reports on health care, retirement and other topics. The SOA's research is intended to aid the work of policymakers and regulators and follow certain core principles:

**Objectivity:** The SOA's research informs and provides analysis that can be relied upon by other individuals or organizations involved in public policy discussions. The SOA does not take advocacy positions or lobby specific policy proposals.

**Quality:** The SOA aspires to the highest ethical and quality standards in all of its research and analysis. Our research process is overseen by experienced actuaries and nonactuaries from a range of industry sectors and organizations. A rigorous peer-review process ensures the quality and integrity of our work.

**Relevance:** The SOA provides timely research on public policy issues. Our research advances actuarial knowledge while providing critical insights on key policy issues, and thereby provides value to stakeholders and decision makers.

**Quantification:** The SOA leverages the diverse skill sets of actuaries to provide research and findings that are driven by the best available data and methods. Actuaries use detailed modeling to analyze financial risk and provide distinct insight and quantification. Further, actuarial standards require transparency and the disclosure of the assumptions and analytic approach underlying the work.

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