Recent developments in longevity, internationally

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Chair, IAA Mortality Working Group

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This presentation covers published and unpublished material from a variety of sources and countries. The findings do not necessarily reflect the position of the authors’ employers or of the IAA.

With thanks to:
Steven Baxter, Sophie Sanders, Marine Habart, Jon Palin, Richard Willets, Magali Barbieri, Assia Billig, Al Klein, Sam Gutterman, Dale Hall, Madhavi Bajecal, Michael Sherris, Rikard Bergstrom, David Raymont, Lars Pralle, Jari Niittuinperä, Luis Alfonso Jiménez Muñoz, Hans de Mik and many others
Agenda

• US and UK are seeing improvements slowing down. Where else?
• Possible causes and drivers
• Is this a trend or a blip? Similarities internationally?
• What are actuaries doing about it?
• Questions
US and UK are seeing improvements slowing down

• "So what"?

• estimated Aggregate Deficit in UK Pension Funds: £780 billion on a full buyout basis

• small changes to longevity assumptions can make big differences to reserves
Past 70 years – the world

In most parts of the world with the notable exception of Eastern Europe, the last 70 years have seen gradual but significant improvements in life expectancy.

Period life expectancy at birth 2001 to 2016

Source: Eurostat
Period life expectancy at age 65 2001 to 2016

Source: Eurostat
A word about our methodology

We wanted to compare the trend of recent improvements (2011 until “now”) against the trend from 2001-2011
UK Period life expectancy Trends

Period life expectancy at birth, Males, UK

Methodology:

Compare Trend [2011-most recent year] against Trend 2001-2011

Next: the details
Methodology for comparisons – data sources

• Compare progress in different countries when we have different data sources, different final years for data
• Main data source is the Human Mortality Database (HMD)
• However, data available for some countries to 2016, others to 2015 (the “bad” year) and some only to 2014
• For the latter cases data from national statistical offices (NSO) was used, if available
• In some cases HMD data was extended with data from NSOs, where not too different from HMD results
Methodology for comparisons

• Wishing to compare annual improvement rates against a common base we chose to use the period [2011-most recent year] against a base of [2001-2011].
• Method fits trend lines to 2001-11 and 2011 onwards using linear regression.
• In the selection of high-income countries in Europe we considered population size and availability of recent data.
  – Comparing rate of increase in longevity:
  – Green = increase Red = decrease
US and UK are seeing longevity improvements slowing down. Where else?
## Period life expectancy at birth: Months gained per year elapsed

### Average trend annual increase in period life expectancy at birth

<table>
<thead>
<tr>
<th>Country</th>
<th>Last Year</th>
<th>Male 2011+</th>
<th>Male 2001-11</th>
<th>Female 2011+</th>
<th>Female 2001-11</th>
<th>Difference Male</th>
<th>Difference Female</th>
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<tbody>
<tr>
<td>Australia</td>
<td>2016</td>
<td>1.7</td>
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<td>2.4</td>
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<td>-0.6</td>
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<tr>
<td>Canada</td>
<td>2013/15</td>
<td>1.6</td>
<td>2.9</td>
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<td>2.1</td>
<td>-1.4</td>
<td>-0.9</td>
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<tr>
<td>Czech Republic</td>
<td>2016</td>
<td>3.6</td>
<td>3.5</td>
<td>3.0</td>
<td>3.0</td>
<td>0.1</td>
<td>0.0</td>
</tr>
<tr>
<td>Denmark</td>
<td>2015</td>
<td>3.0</td>
<td>3.5</td>
<td>2.8</td>
<td>2.9</td>
<td>-0.4</td>
<td>-0.1</td>
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<td>-1.7</td>
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<td>-1.2</td>
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<td>Sweden</td>
<td>2016</td>
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<td>1.9</td>
<td>-0.8</td>
<td>-0.6</td>
</tr>
<tr>
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<td>-2.8</td>
<td>-2.4</td>
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<tr>
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<td>2015</td>
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<td>2.8</td>
<td>0.4</td>
<td>2.2</td>
<td>-2.6</td>
<td>-1.8</td>
</tr>
</tbody>
</table>

**Data source**

- HMD
- NSO
- HMD+NSO

**Legend**

- Green = better
- Red = worse
### Period life expectancy at age 65: Months gained per year elapsed

Average trend annual increase in period life expectancy at age 65

<table>
<thead>
<tr>
<th>Country</th>
<th>Last Year</th>
<th>Male</th>
<th>Female</th>
<th>Difference</th>
</tr>
</thead>
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<td>1.0</td>
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<td>0.7</td>
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<td>0.8</td>
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</tbody>
</table>

Data source:

- HMD
- NSO
- HMD+NSO

Green = better  
Red = worse
Selected high-income countries

Where are there signs of a fallback – and why?

- US
- UK
- Other European countries
- Canada
- Australia
- Japan
US Period life expectancy at birth

Period life expectency at birth, Males, USA

\[ y = 0.2325x + 73.946 \]
\[ R^2 = 0.9879 \]

Period life expectency at birth, Females, USA

\[ y = 0.186x + 79.276 \]
\[ R^2 = 0.9853 \]


Extension to 2016 done by applying difference between 2015 and 2016 figures from NHSC to HMD data used for analysis

Next: What age groups caused the slow-down?
US increase in partial life expectancy by 5-year age bands, for 5-year periods ending 1986 to 2011 and 4-year to 2015

USA, Male five year change

USA, Female five year change

Next: UK
UK: Period life expectancy at birth 2001 to 2016

Period life expectancy at birth, Males, UK

\[ y = 0.3121x + 75.26 \quad R^2 = 0.9921 \]
\[ y = 0.0765x + 78.017 \quad R^2 = 0.6733 \]

Standardised number of deaths

Period life expectancy at birth, Females, UK

\[ y = 0.2349x + 80.032 \quad R^2 = 0.9768 \]
\[ y = 0.0328x + 82.354 \quad R^2 = 0.2385 \]

Next: What age groups caused the slow-down?
UK increase in partial life expectancy by 5-year age bands, for 5-year periods ending 1986 to 2016

UK Male 5 year change

UK Female 5 year change

Next: other European countries - Austria
Austria Period life expectancy growth fell in 2012 for females, in 2015 and is recovering better for males than for females.
France: Period life expectancy at birth from 2001

Period life expectancy at birth, Males, France

\[ y = 0.2974x + 75.195 \]
\[ R^2 = 0.9738 \]

Period life expectancy at birth, Females, France

\[ y = 0.2058x + 82.725 \]
\[ R^2 = 0.9215 \]

See also Espérance de vie à divers âges en 2017 Données annuelles de 1994 à 2017, Insee
https://www.insee.fr/fr/statistiques/2416631#Tableau-Donnes  Courtesy Marine Habart

Next: Germany
Germany Period life expectancy at birth

Males, Germany

\[ y = 0.2558x + 75.011 \]
\[ R^2 = 0.9758 \]

Females, Germany

\[ y = 0.1629x + 81.093 \]
\[ R^2 = 0.9467 \]
The Netherlands: Period life expectancy at birth

Period life expectancy at birth, Males, Netherlands

\[ y = 0.351x + 75.397 \]
\[ R^2 = 0.9895 \]

Period life expectancy at birth, Females, Netherlands

\[ y = 0.2397x + 80.386 \]
\[ R^2 = 0.9711 \]


Next: Spain
Spain Period life expectancy at birth

Males, Spain

\[ y = 0.3247x + 75.664 \]

\[ R^2 = 0.9777 \]

Females, Spain

\[ y = 0.2279x + 82.608 \]

\[ R^2 = 0.9572 \]

Next: Sweden
Sweden: Period life expectancy at birth

Period life expectancy at birth, Males, Sweden

\[ y = 0.2256x + 77.31 \]
\[ R^2 = 0.9941 \]

Period life expectancy at birth, Females, Sweden

\[ y = 0.1595x + 81.897 \]
\[ R^2 = 0.9831 \]

Source for 2017: [http://www.statistikdatabasen.scb.se/pxweb/en/ssd/START__BE__BE0101__BE0101I/LivslangdEttariga/?rxid=984223ab-5d2a-4259-a8eb-6bb54a495f6e](http://www.statistikdatabasen.scb.se/pxweb/en/ssd/START__BE__BE0101__BE0101I/LivslangdEttariga/?rxid=984223ab-5d2a-4259-a8eb-6bb54a495f6e) Courtesy Rikard Bergstrom

Next: European countries combined
European countries Period life expectancy growth 2011-2016

Source Eurostat Courtesy Steven Baxter, Club Vita
Canada Period life expectancy at birth

Period life expectancy at birth, Males

Period life expectancy at birth, Females


Next: Canada Old Age Security experience
Canada Old Age Security (OAS) Program
Average Annual Increase in Life Expectancy of OAS Beneficiaries (in months)


Next: Australia
Australia Period life expectancy

Males, Australia

Females, Australia

Next: Japan
Japan period life expectancy

Males

y = 0.1596x + 77.895
R² = 0.9462

Females

y = 0.1287x + 84.87
R² = 0.8415

Next: summary
Where are there signs of a fallback – and why?

- US
- UK
- Other European countries
- Canada
- Australia
- Japan – the exception

Now, what about causes and drivers? –
Possible causes and drivers

Looking for major causes and drivers that might have contributed to the recent changes

How about your country/experience? Are there the same influences?
Groupings, Causes and drivers

Seasonal factors (eg winter mortality)

Causes of death

“working age” causes (15-64)
- cardiovascular/circulatory/stroke
- dementia

Drivers: behaviours - smoking – obesity

Socio-economic groups and deprivation

Austerity

Next: seasonal mortality
Scandinavian countries normally experience lower excess winter mortality...

... and southern countries (Spain, Portugal) often higher!

Source: EuroMOMO

Next: young age mortality US
US Standardised deaths indexed to 100k in 2001

Flat period then substantial increase in deaths age 15 - 64

Females

Predominantly “External causes” and Opioids

Next: opioids
US Opioids: Age adjusted mortality 1999-2016 Deaths per 100,000

Overall mortality rate (both genders) due to opioid drug overdose increased 27.4% in 2016.


Next: US Cause of Death
US top 5 causes of death (all ages)

Cardiovascular/circulatory/Stroke

Substantial improvements (reduced by 1/3) now slowing

Source: NHCS
As the death rate from cardiovascular disease fell, rates from other diseases, such as dementia rose. Dementia might soon overtake coronary heart disease as the single leading cause of death in Australia (ABS 2016).

There are close associations between dementia and cardiovascular disease—cardiovascular disease itself is a major cause of dementia, and it is often listed as an associated cause when dementia is the underlying cause of death.”

Source: Trends in cardiovascular deaths, Australian Institute of Health and Welfare Bulletin 141 • September 2017  

Next: E&W cause of death
E&W Age standardised mortality rates for top five leading causes of death M, F (per million population)

Source: Deaths registered in England and Wales (series DR): 2016
US Alzheimer’s/Dementia, age adjusted mortality 1999-2016

![Graph showing US Alzheimer’s/Dementia mortality rates from 1999 to 2016 for both genders and age groups.]

### Annual Improvement

<table>
<thead>
<tr>
<th></th>
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<tr>
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<td>0.0%</td>
<td>1.8%</td>
</tr>
<tr>
<td>Female</td>
<td>-5.1%</td>
<td>-0.3%</td>
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</tr>
<tr>
<td>Male</td>
<td>-4.6%</td>
<td>0.4%</td>
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### Age Group

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<td>65 - 74</td>
<td>-3.6%</td>
<td>0.0%</td>
<td>-1.5%</td>
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<td>75 - 84</td>
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<tr>
<td>85+</td>
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<td>-0.4%</td>
<td>1.7%</td>
</tr>
</tbody>
</table>

*Includes both genders

**Less than 10 deaths. See section 3.


Next: trend or blip?
Summarising Causes.

Is this a trend or a blip? Similarities internationally?

How about your country/experience? Are there the same influences?
Groupings, Causes and drivers  *summary so far*

Seasonal factors (eg winter mortality)  
Blip? - 3 years in past 4 (Europe)

Causes of death

- “working age” causes (15-64) US  
  Blip? Opioids Hard to reverse
- cardiovascular/circulatory/stroke  
  Blip? Only if the decline in improvements reversed
- Dementia  
  Mixed

NB Considerable variations between countries

Drivers: behaviours - smoking – obesity

Socio-economic groups and deprivation

Austerity

Next: Drivers
Drivers

- Behaviours
- Smoking
- Obesity
- Socio-economic factors
- Austerity

WHAT’S HAPPENING TO U.S. MORTALITY RATES? Chen et al, Center for retirement research, Boston College.

Next: Socio-economic groups and deprivation: US
Drivers: behaviours - smoking – obesity

Look at the big ones for clues on trends or blip

- **Behaviours** account for up to 50% of all deaths. What effects recently? US deaths from drug and alcohol poisoning, suicide, and chronic liver disease and cirrhosis

- **Smoking**: Is the effect of past generations quitting smoking now fading out?

- **Obesity** is the effect increasing?

Behavioral factors cause 35 percent of all premature deaths (before 80) in the United States (and other preventable causes another 13%)

Source: Up to Half of U.S. Premature Deaths Are Preventable; Behavioral Factors Key: Mather and Scommegna 2015
https://www.prb.org/us-premature-deaths/

Next: white non-Hispanics US
US Behaviors: white non-Hispanics 45-54 deaths

The change in all-cause mortality for white non-Hispanics 45–54 is largely accounted for by an increasing death rate from external causes.


Next: it’s all age groups
All 5-y age groups between 30–34 and 60–64 have witnessed marked and similar increases in mortality from the sum of drug and alcohol poisoning, suicide, and chronic liver disease and cirrhosis over the period 1999–2013. Case and Deaton

Behaviours: Smoking and dietary risk factors England

Using the GBD model, Behavioural factors account for around 45% of all deaths

Source: Health profile for England, Chapter 2: major causes of death and how they have changed July 2017
Behaviours: risk factors age 15-49 England

- **Behavioural risk factors**
  - Alcohol & drug use
  - Dietary risks
  - Tobacco smoke
  - Low physical activity

- **Metabolic risk factors**
  - High body mass index
  - High systolic blood pressure
  - High total cholesterol
  - High fasting plasma glucose

- **Environmental risk factors**
  - Air pollution
  - Occupational risks

Source: Health profile for England, Chapter 2: major causes of death and how they have changed July 2017

Behavioural factors account for around 50% of deaths age 15-49

Next: Socio-economic groups and deprivation: US
Drivers: socio-economic factors - austerity

- Socio-economic factors: US, UK, France – Socio-economic gap increasing
- Austerity: Europe, US

WHAT'S HAPPENING TO U.S. MORTALITY RATES? Chen et al, Center for retirement research, Boston College.

Next: Socio-economic groups and deprivation: US
England: Socio-economic gap. Progression of death rates for those aged 60-89 of each socioeconomic circumstances quintile – mortality given as a percentage of that in 2001

Life expectancy: is the socioeconomic gap narrowing? Longevity Science Panel Feb 2018
http://www.longevitypanel.co.uk/_files/LSP_Report.pdf

It’s mainly about money

“Of the many factors including income, education, crime, health, housing, environment and unemployment, income deprivation is the strongest independent predictor of mortality rates”

Next: Austerity
Austerity – mixed messages

EUROPE: “The slowing down of improvements in life expectancy, correlated to the level of austerity, raises uncomfortable questions as to whether we are beginning to transition from the era of consistently improving population health to a new age characterised by an instability in population health largely dictated by the social and political determinants of health.”

“While income inequality has increased in both the United States and France, inequality in mortality in France remained remarkably low and stable”

Source: Mortality (in)equailty in France and the United States, J Currie et al National Bureau of Economic Research, Cambridge, MA
What are actuaries doing about it?

Projections
US OASDI: Successive projected period life expectancies in 2025

Projected period life expectancy at birth in 2025

Projected period life expectancy at age 65 in 2025

Source: USA Federal Old-age and Survivors insurance and federal Disability insurance trust funds (OASDI)

Next: UK ONS
UK Office for National Statistics: period life expectancy projections age 65 from 2010 to 2016

Next: How does it compare with trend observed?

Source: Office for National Statistics
UK: Historical and projected period life expectancy at birth

Period life expectancy at birth, Males, UK

- 2012-based: $y = 0.3121x + 75.26$, $R^2 = 0.9921$
- 2014-based: $y = 0.0765x + 78.017$, $R^2 = 0.6733$

Period life expectancy at birth, Females, UK

- 2012-based: $y = 0.2349x + 80.032$, $R^2 = 0.9768$
- 2014-based: $y = 0.0328x + 82.354$, $R^2 = 0.2385$
The CMI Model – Life expectancy age 65

CMI life expectancy projections have been reduced in successive iterations of the model – age 65 shown

Source: CMI WP 97
Austria: projected life expectancy at birth for 2030

Period life expectancy at birth, Males, Austria

\[ y = 0.1976x + 77.887 \]
\[ R^2 = 0.8475 \]

Period life expectancy at birth, Females, Austria

\[ y = 0.1062x + 83.221 \]
\[ R^2 = 0.7221 \]

2015-2100 projections
France: projected life expectancy at birth for 2030

Period life expectancy at birth, Males, France

\[ y = 0.18x + 78.259 \]
\[ R^2 = 0.877 \]

Period life expectancy at birth, Females, France

\[ y = 0.0696x + 84.87 \]
\[ R^2 = 0.5278 \]

Trend line extrapolated to 2030 and the projected period life expectancy for males and females in 2030 from the latest population projections for France (2031-2070) is also shown. Source: INSEE
Sweden population: Projected period life expectancies in 2025

Projected period life expectancy at birth in 2030, Sweden

Projected period life expectancy at age 65 in 2030, Sweden

Next: vs trend line
Sweden: projected life expectancy at birth for 2030

Period life expectancy at birth, Males, Sweden

\[ y = 0.1543x + 79.629 \]
\[ R^2 = 0.9643 \]

Period life expectancy at birth, Females, Sweden

\[ y = 0.0964x + 83.5 \]
\[ R^2 = 0.7914 \]

2018-2060 projections

Next: Canada Projections
Canada Pension Plan: Successive projected period life expectancies in 2025

Projected period life expectancy at birth in 2025, CPP Reports

Projected period life expectancy at age 65 in 2025, CPP Reports


Next: Australia Projections
Australia: with projected life expectancy at birth for 2025/6

Period life expectancy at birth, Males, Australia

\[ y = 0.1384x + 79.993 \]
\[ R^2 = 0.7946 \]

Period life expectancy at birth, Females, Australia

\[ y = 0.1039x + 84.222 \]
\[ R^2 = 0.7273 \]

Projected year here is 2025/6; data not readily available for 2030. These are from the 2011-2060 projections so reasonably old – can’t find more recent projections

Next: Japan
Japan: with projected life expectancy at birth for 2030

Period life expectancy at birth, Males, Japan

\[ y = 0.3014x + 79.237 \]

\[ R^2 = 0.9813 \]

Period life expectancy at birth, Females, Japan

\[ y = 0.2411x + 85.769 \]

\[ R^2 = 0.9547 \]

2017 – 2115 projections.

Next: Conclusions
Conclusions

Longevity improvements have slowed down in most countries
Underlying causes unlikely to disappear
• Excess winter mortality
• “External causes”
• Opioids
• Cardiovascular/circulatory/stroke gains slackening
• Dementia and Alzheimer’s - mixed
• Poverty and the widening socio-economic gap
• Austerity

Impact on insured and pensioner populations differ:
    different subsets of the population
    exposure by “amounts” higher for higher socio-economic groups

Next: MWG
Conclusions

Longevity improvements have slowed down in most countries

Underlying causes unlikely to disappear

• Excess winter mortality
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Impact on insured and pensioner populations differ:
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  exposure by “amounts” higher for higher socio-economic groups

My views only

Please bring your views to the Discussion Session at the end (after Assia’s paper)
Half-yearly Updates with all papers presented at our meetings

References to hundreds of relevant papers

Country reports
Mortality Working Group

If you are interested in Longevity and Mortality do join us as an Interested Person

You’ll get Half-yearly Updates and Event Information

Free of charge

Just email: iaamwg@actuaries.org
Comments and questions?

www.actuaries.org/mortality
Thank you
ONS Office for National Statistics (UK)
ASMR Age-Standardised Mortality Rate
E & W England and Wales
NHS UK National Health Service, providing medical care to 100% of the population

“Medical treatment covering all requirements will be provided for all citizens by a national health service”. Sir William Beveridge (1942)

NHCS US National Center for Health Statistics
EOL “Life expectancy” = Period life expectancy
(unless specifically mentioned)
We have chosen here to focus on life expectancy at birth, as “recent” EOLs at other ages are often not available

European Standard Population: Used to prepare age-standardised deaths on the same basis
Sources are hyperlinked from the relevant slide
About the speaker

- **Brian Ridsdale** BSc, FFA, CEng, MBCS
- Chair, IAA Mortality Working Group
- Member IFoA Mortality Research Steering Cttee

- Director, Solent Credit Union
- Past Chair, CMI
- Past Trustee, Christian Aid
- Past Vice President, Faculty of Actuaries UK
- Past General Manager, Zurich Life UK