Society of Actuaries in Ireland

50 Shades of “de Grey”
International Drivers of Longevity Outliers

Dr. Chris Reynolds FIA
Cillian Ryan FSAI

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Disclaimer

The views expressed in this presentation are those of the presenters and not necessarily of the Society of Actuaries in Ireland

Today's Topic

Survival

&

Mortality

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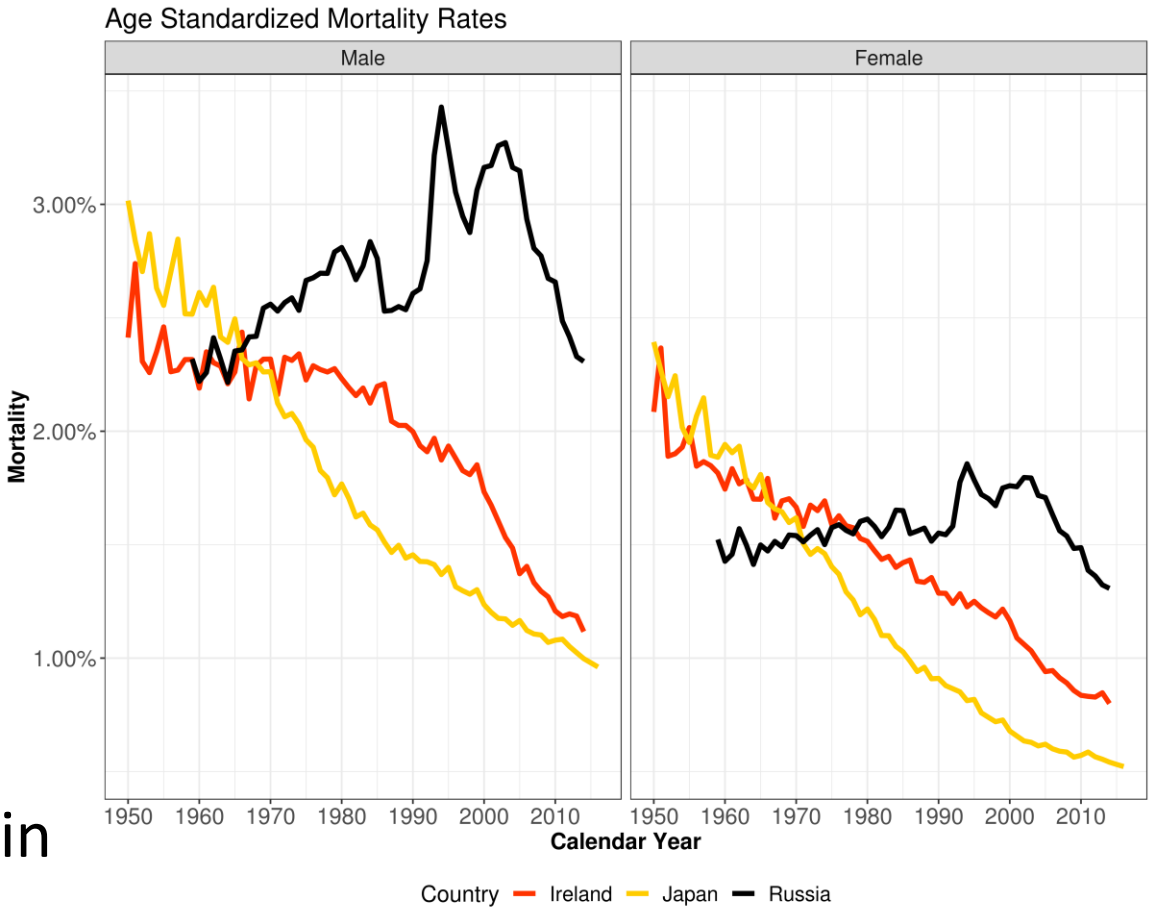
Living Forever : The Oldest Old

What we know

- Mortality gains – in most countries
- Historical gains in life expectancy have been attributed to a reduction in early-life mortality
- More recent data, however, show evidence for a decline in late-life mortality



Source: mortality.org

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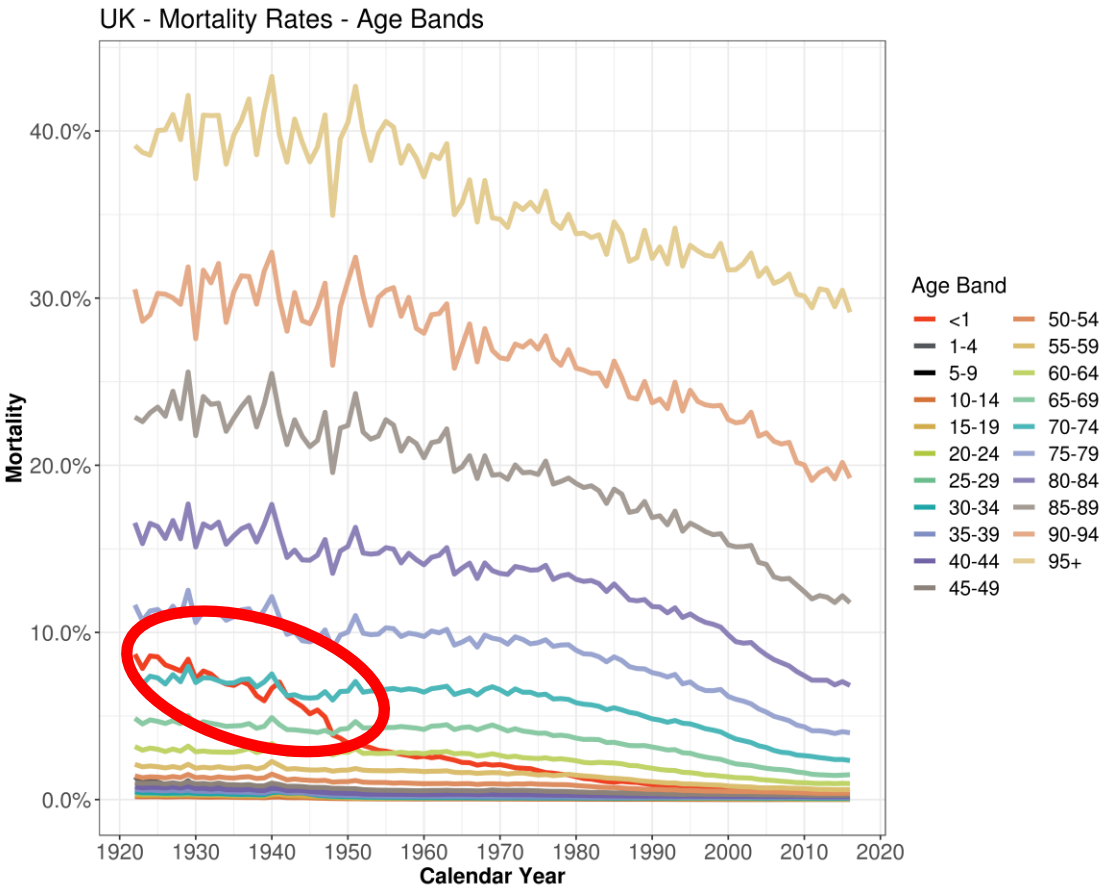

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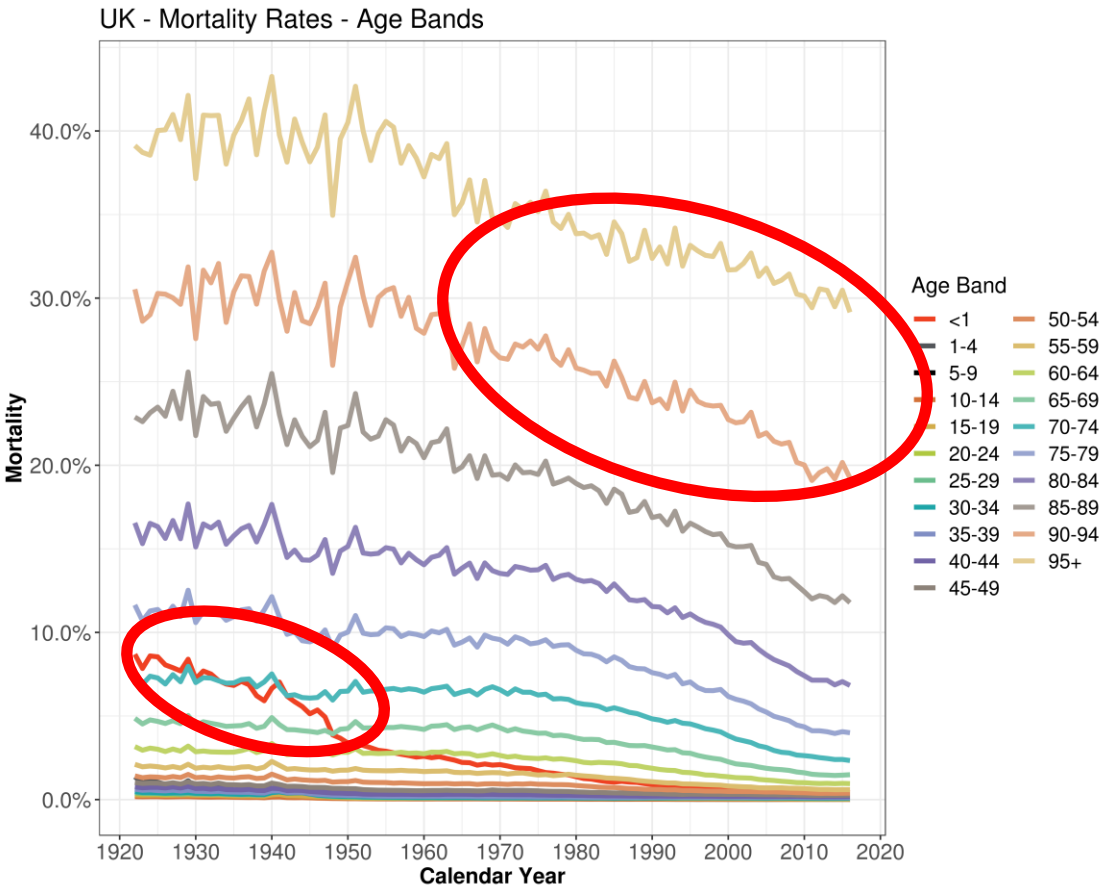

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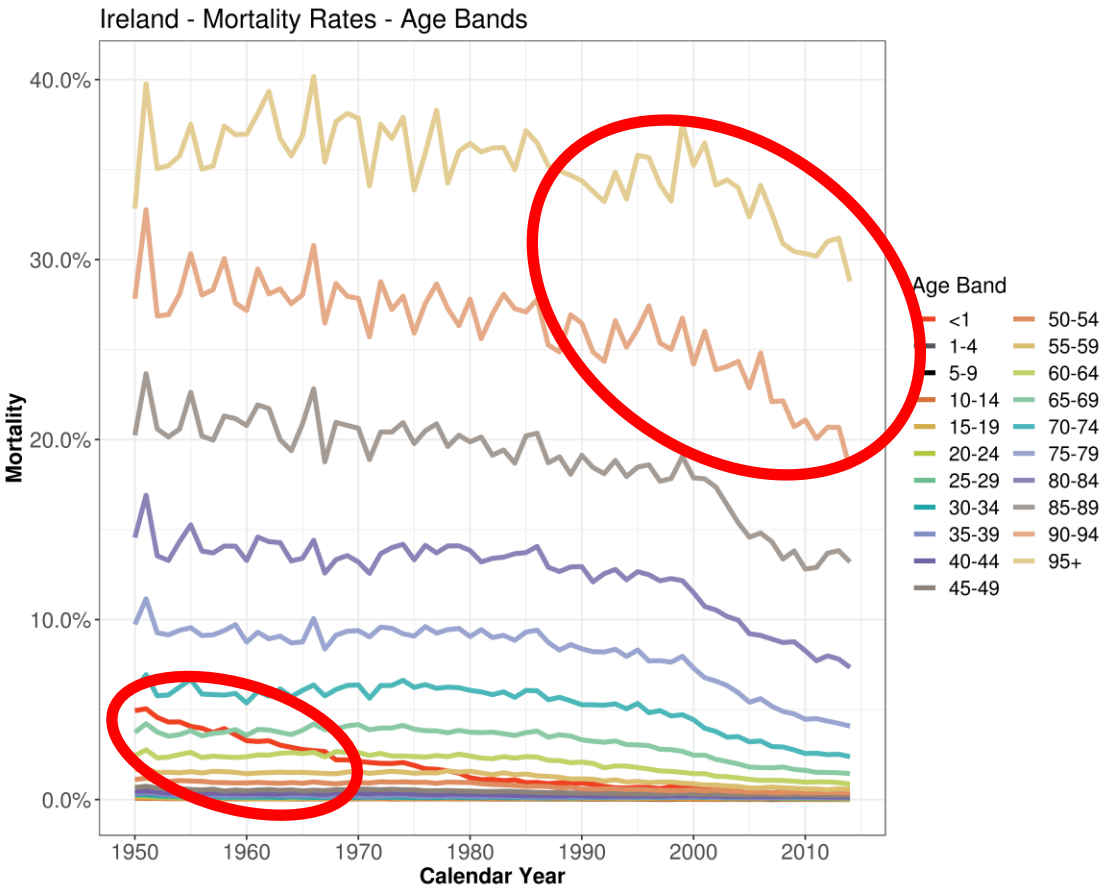

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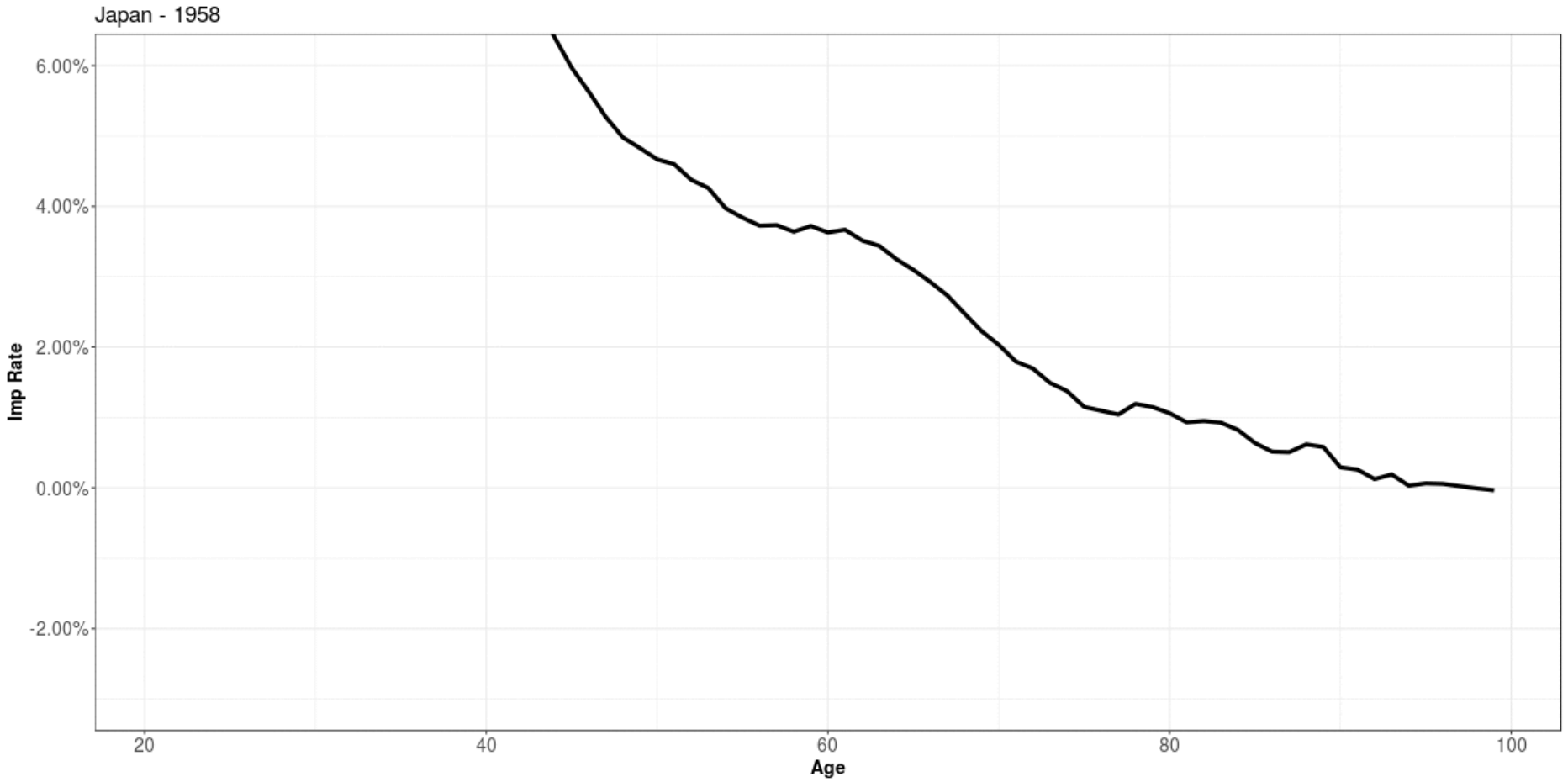
Mortality Improvements

Japan - Females



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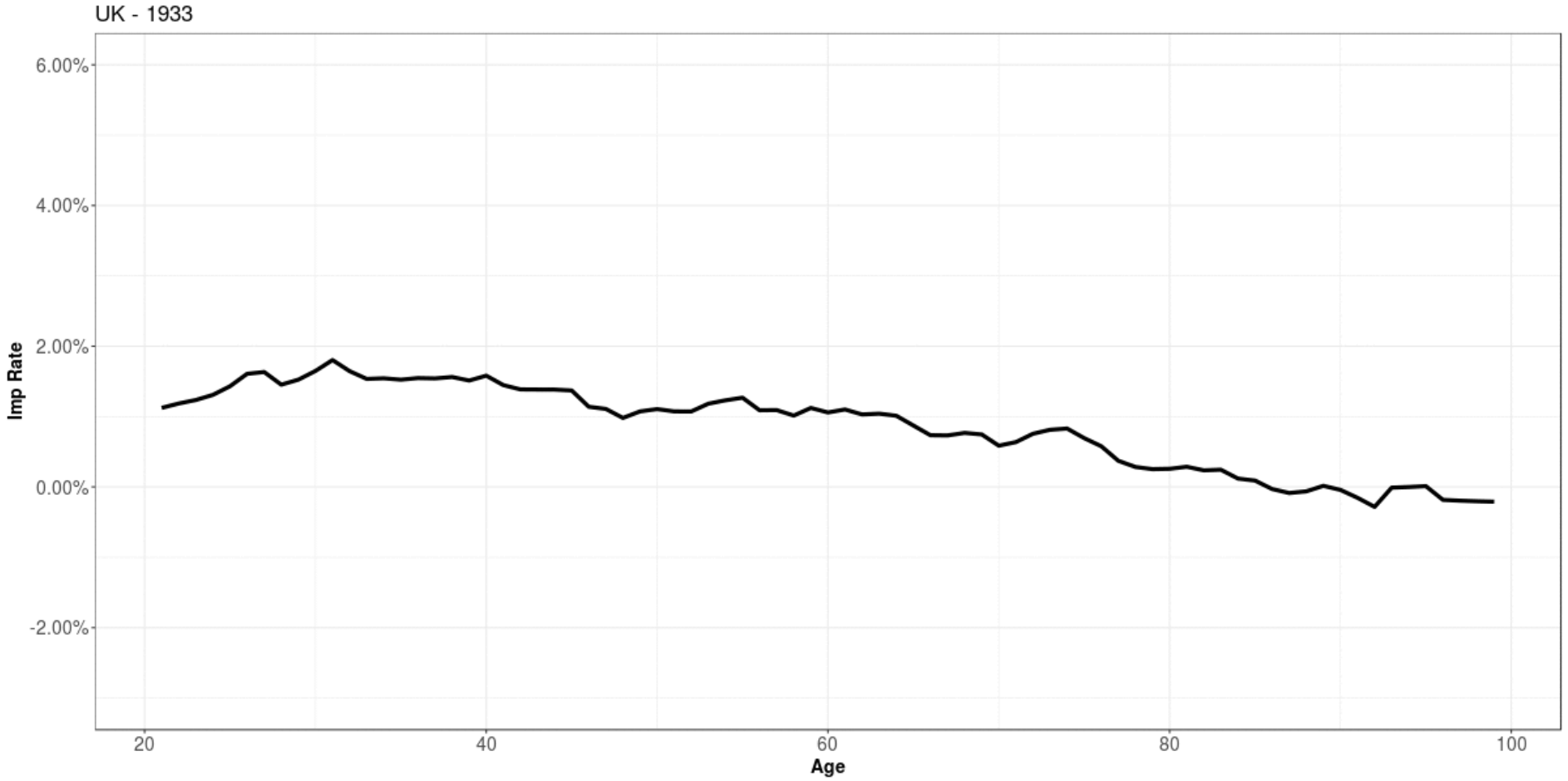
Mortality Improvements

UK - Females



Source: mortality.org

Madame Jeanne-Louise Calment

Mar 10, 1876
First telephone call

20

40

60

113

122

1875

1997

Jan 28, 1887
Eiffel Tower construction started

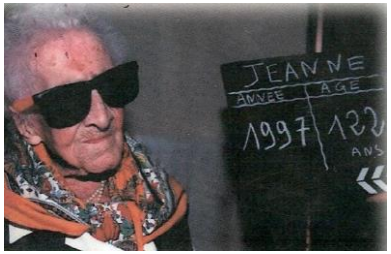
Oct 1, 1908
Ford Model T enters production

May 6, 1935
Silver Jubilee celebrations for King George V

Jan 1, 1996
Google is invented

Source: http://www.grg.org/jcalmentgallery.htm

Madame Jeanne-Louise Calment



- **Good genes** - mother lived until 86, father lived until 93
- **Wealth** - married a wealthy man
- **Exercise** - Spent much time playing tennis, swimming and cycling. Cycled until she was 100 years old.
- **Relaxing** - Learned to play the piano and enjoyed the opera

- **Smoking** – smoked from 21 until 116
- **Diet** – Ate ~1kg of chocolate per week. Drank port wine as part of her daily diet.

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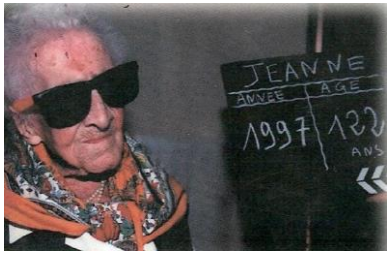
Madame Jeanne-Louise Calment



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Or was it all an elaborate tax fraud?

Source: http://www.grg.org/jcalmentgallery.htm

Even Older?

- “The world’s oldest man has been named as Indonesian Mbah Gotho, who is 145 years old, with documentation that says he was born in 1870.”
- Has official documentation which shows his age
- If documents can be independently verified will go down in the record books

Source: http://www.telegraph.co.uk/news/2016/08/27/longest-lived-human-says-he-is-ready-for-death-at-145

Competing Camps

No Limits	Limits
• Human life expectancy steadily increased since the 19th century	• Past is not necessarily a guide to the future
• Increasing reports of supercentenarians	• Limited scope for future improvements
• Lifespans of animals can be extended through genetic or dietary modifications	• Increase in life expectancy & maximum human lifespan will eventually stop

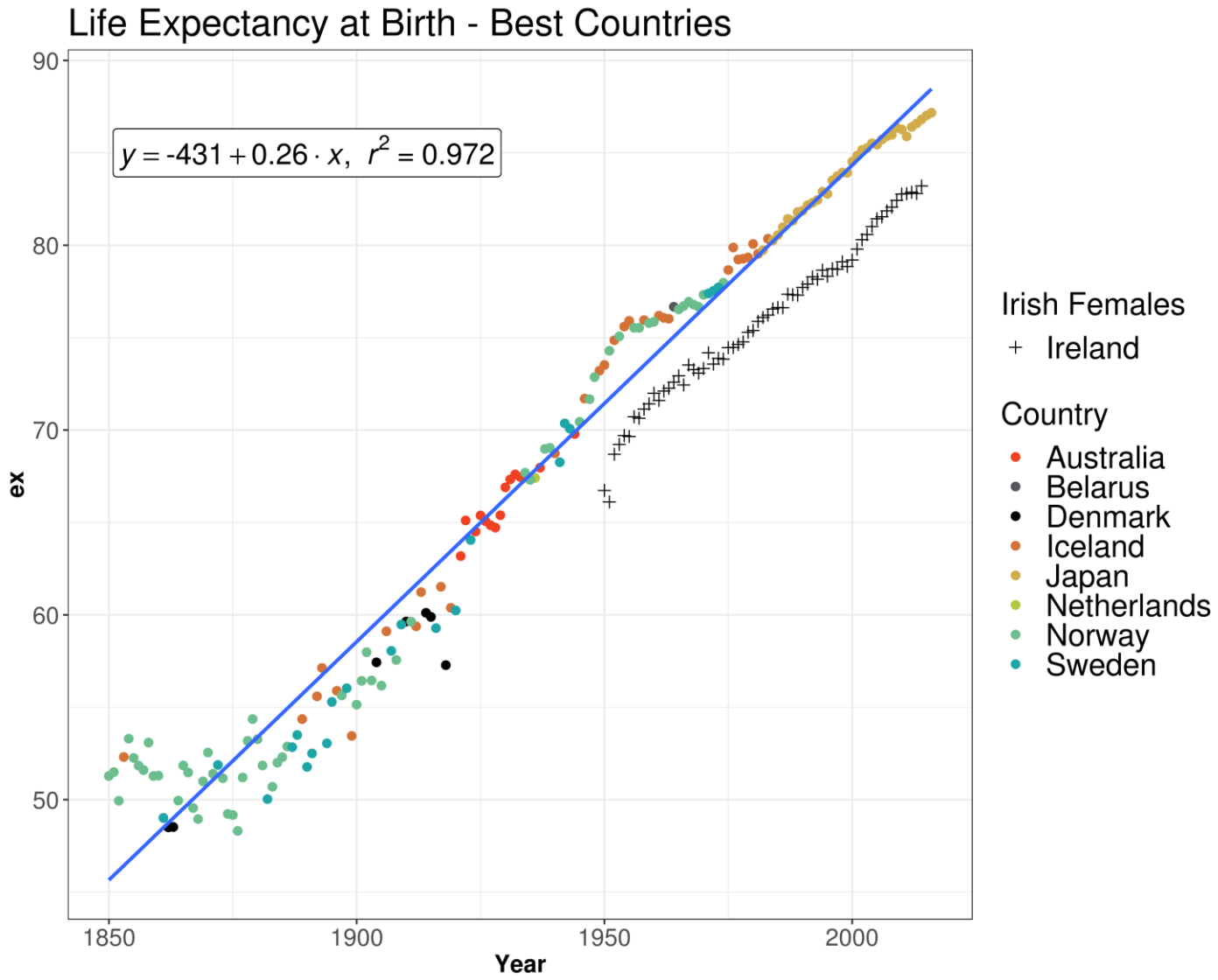
Limits on Life Expectancy?

Oeppen and Vaupel:

1. Experts have repeatedly asserted that life expectancy is approaching a ceiling – these experts have repeatedly been proven wrong
2. The apparent levelling off of life expectancy in various countries is an artefact of laggards catching up and leaders falling behind
3. If life expectancy were close to a maximum, then the increase in the record expectation of life should be slowing – it is not.

Source: Oeppen and Vaupel, Broken Limits to Life Expectancy, Science – Vol 296 – 10 May 2002

Life Expectancy at Birth



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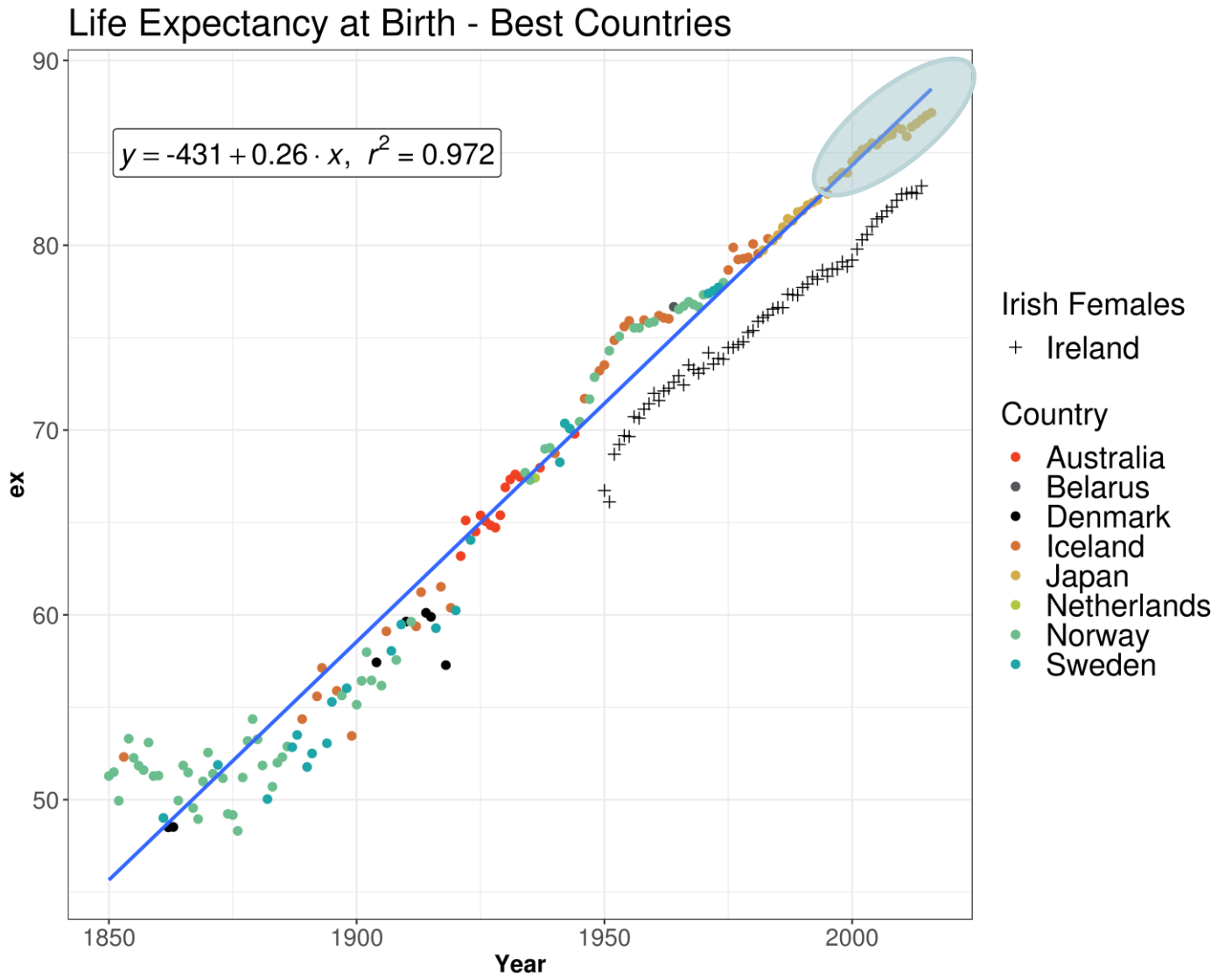

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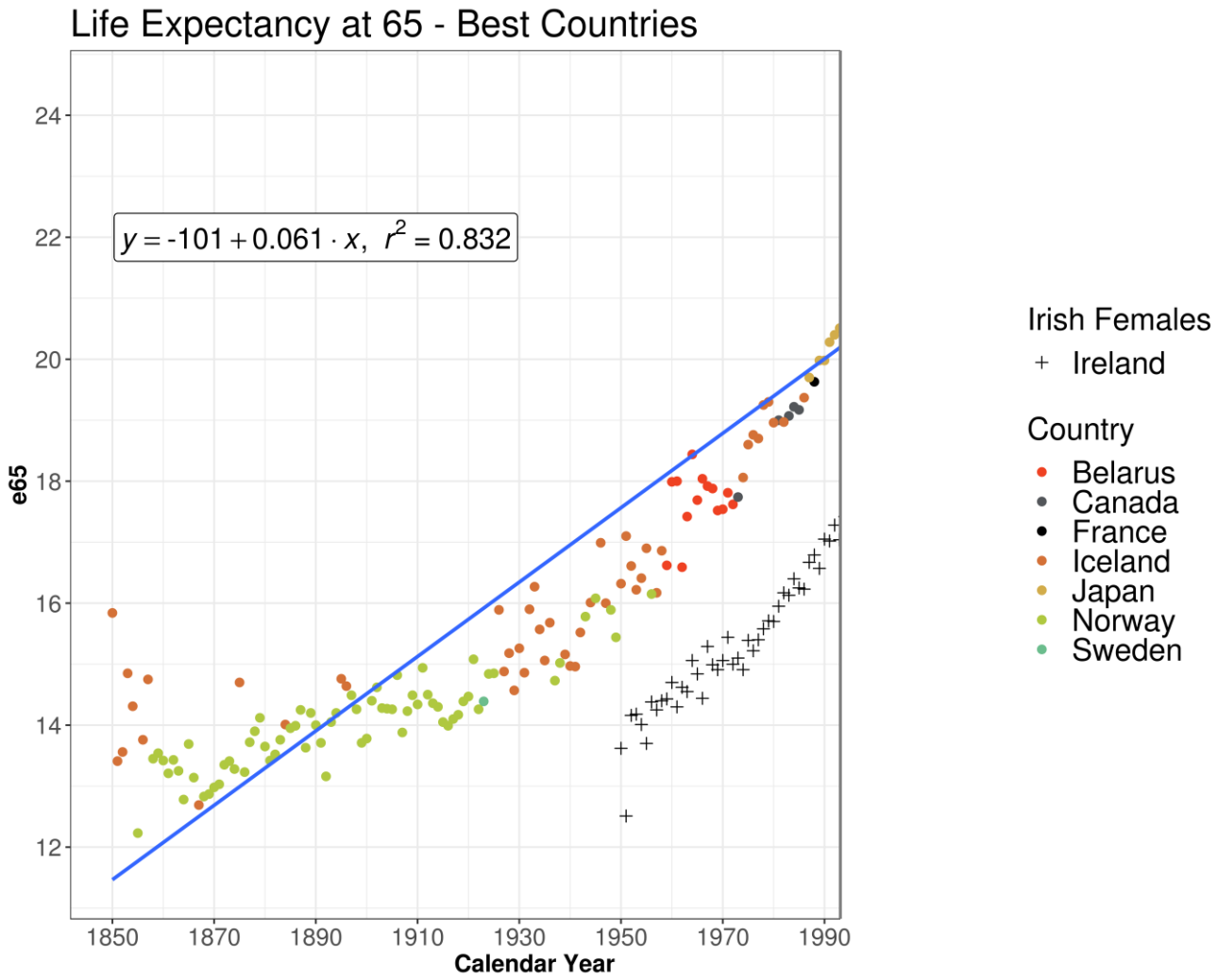
Life Expectancy at 65



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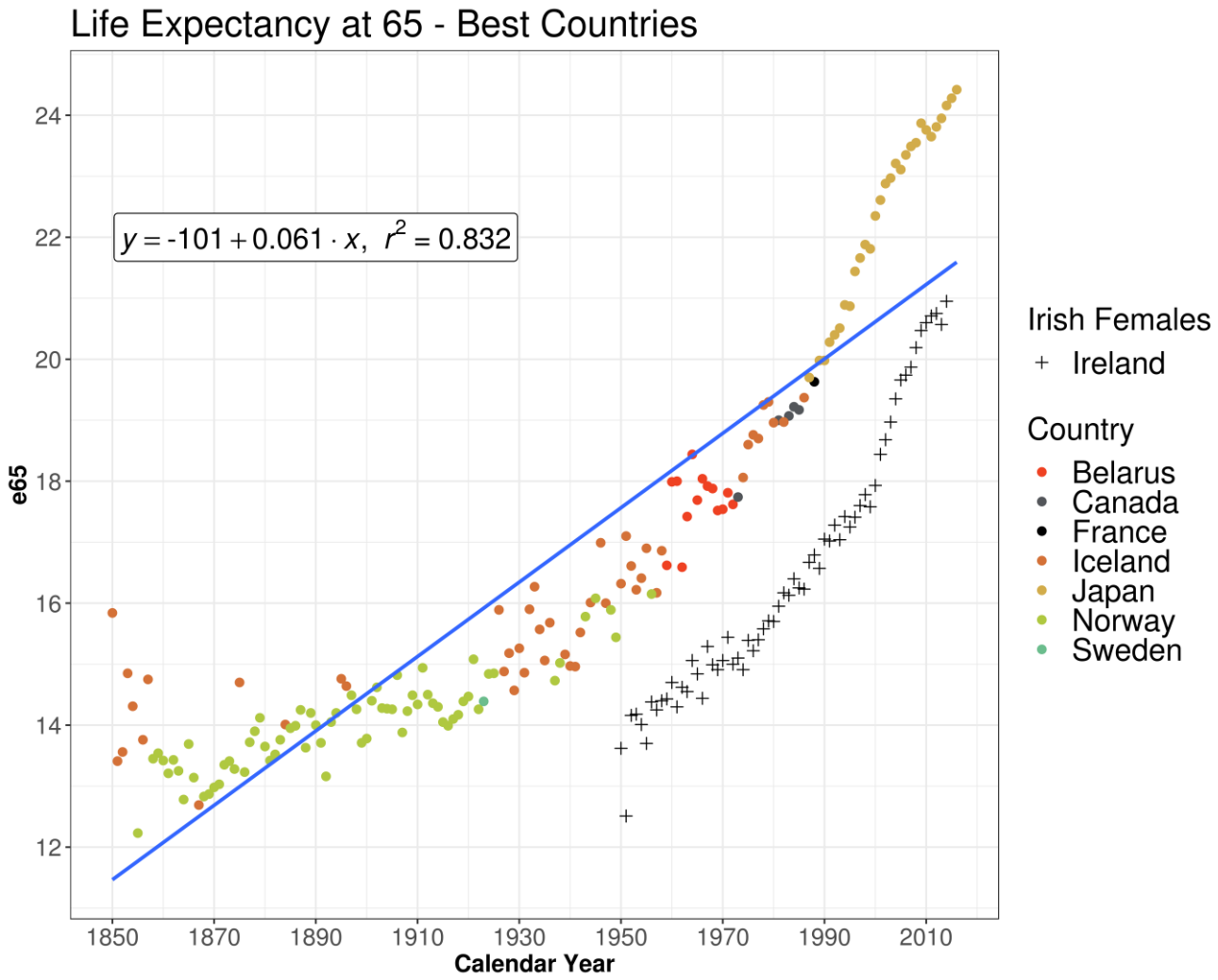

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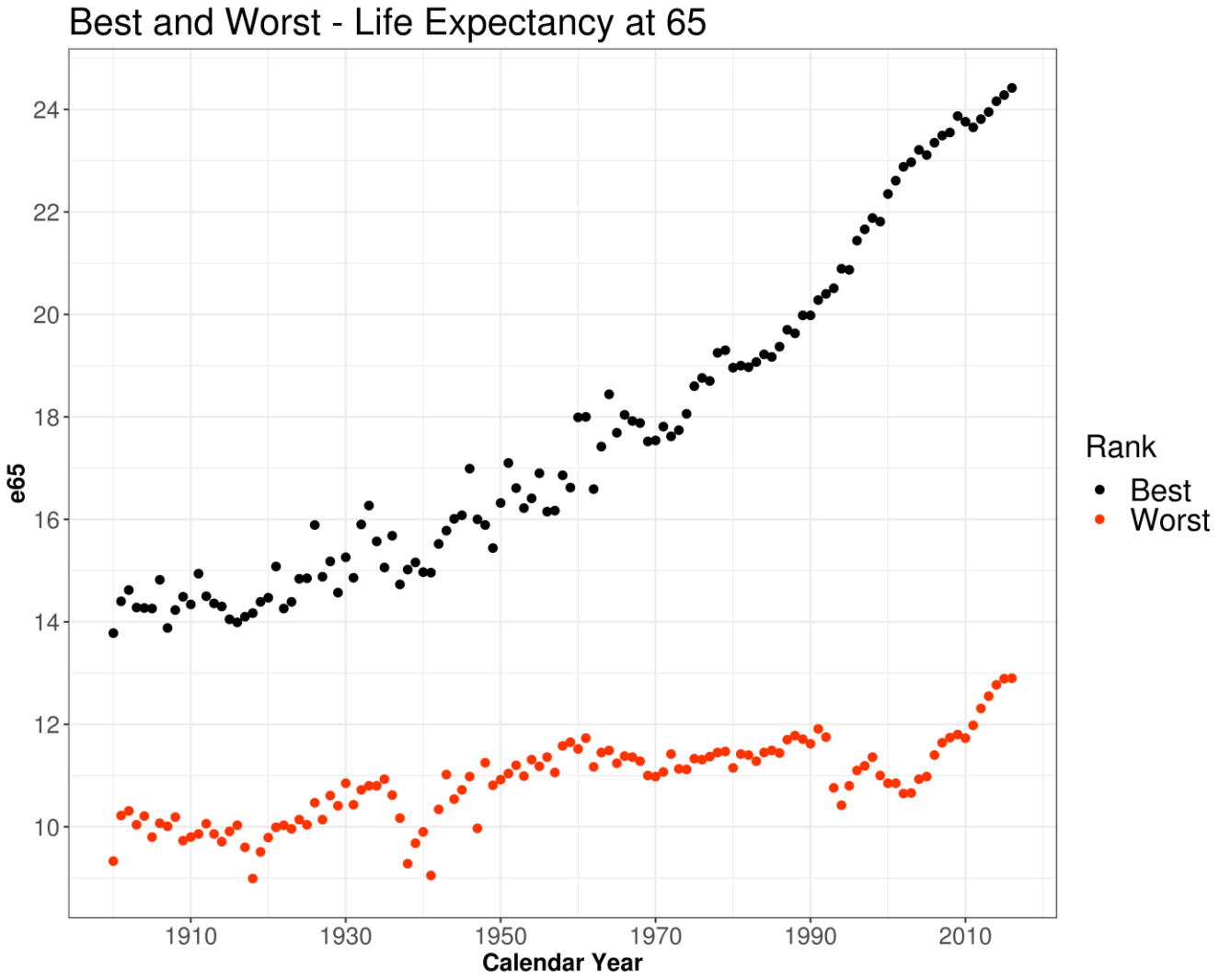
Gap Between Best and Worst



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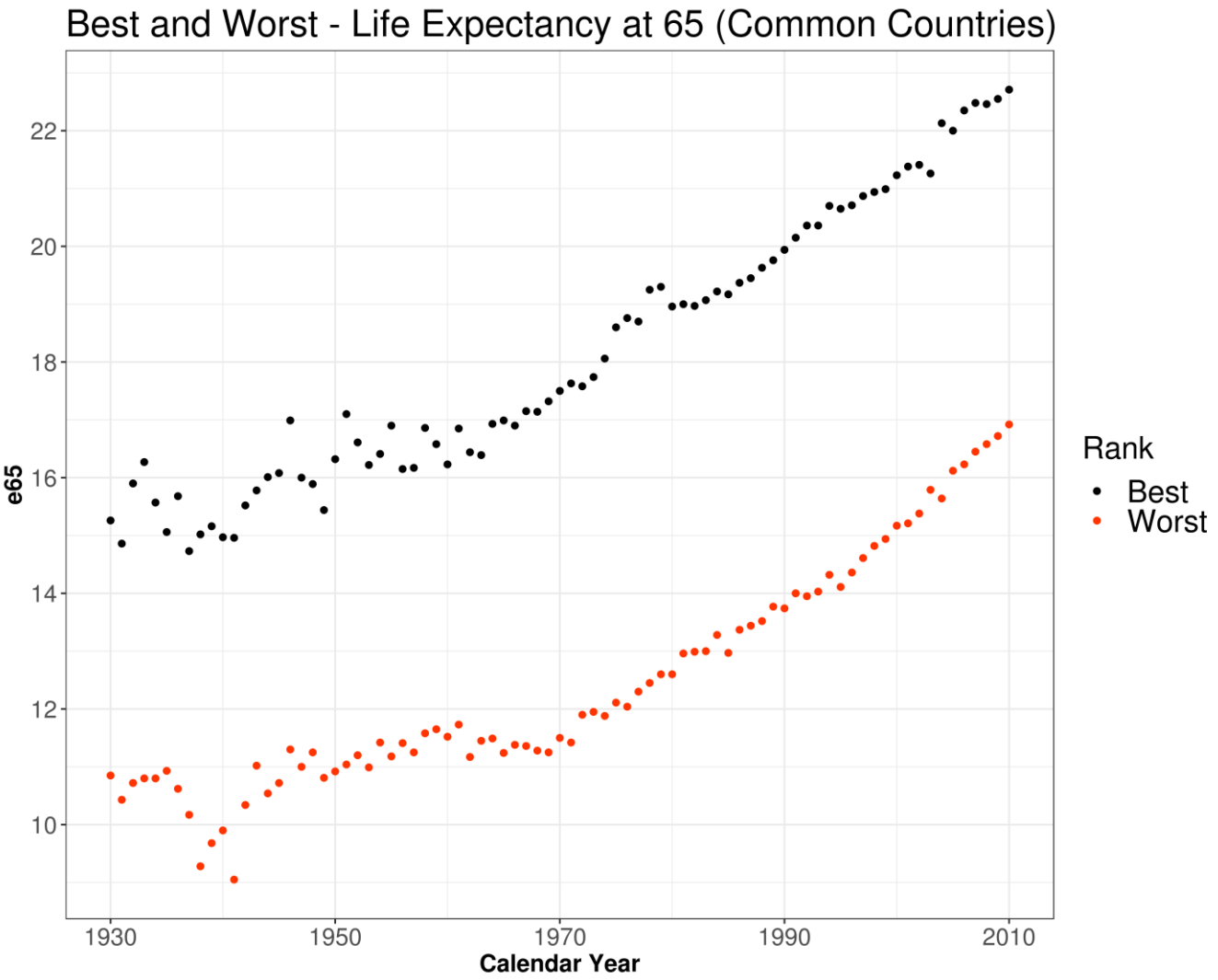

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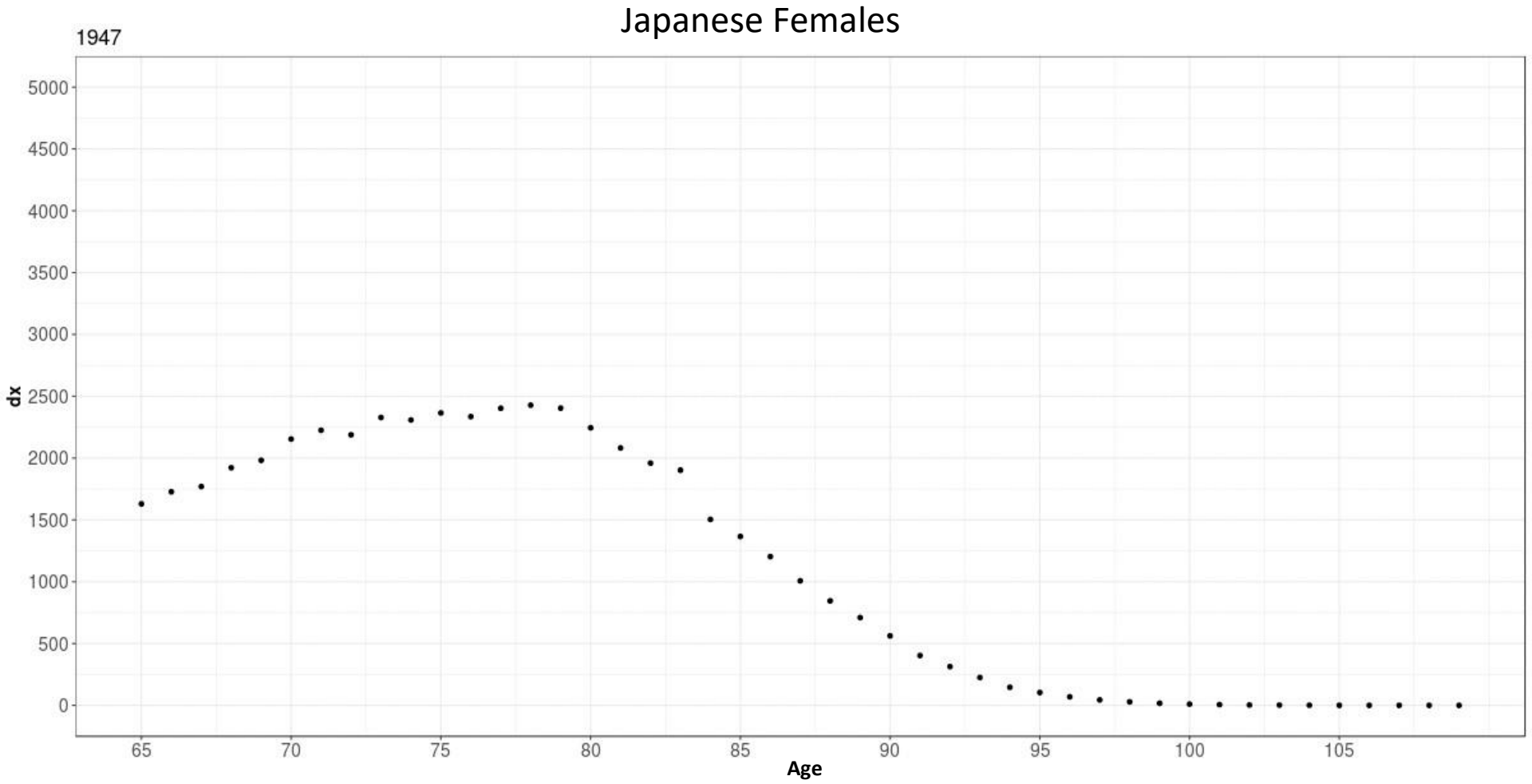
Modal Age of Death



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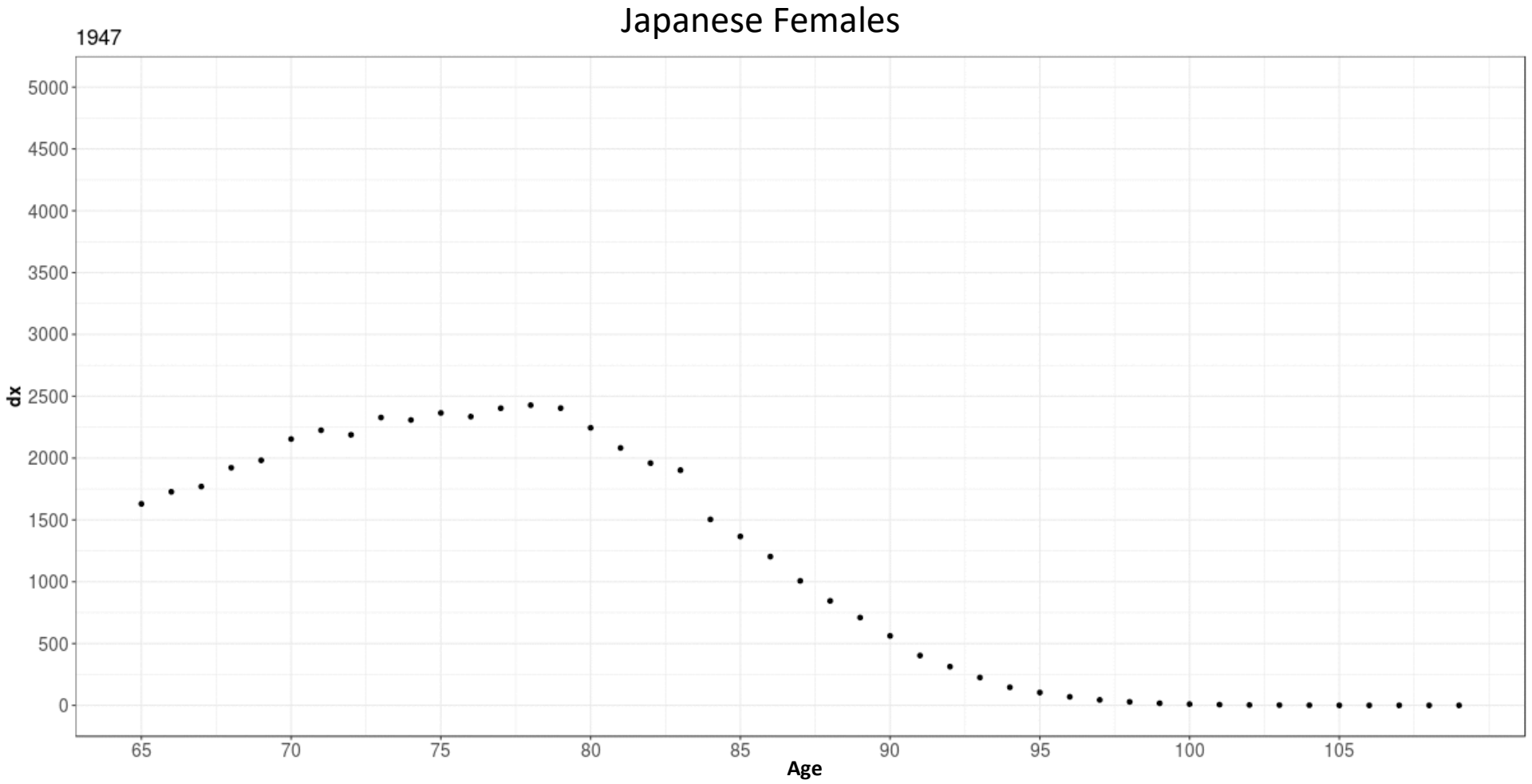

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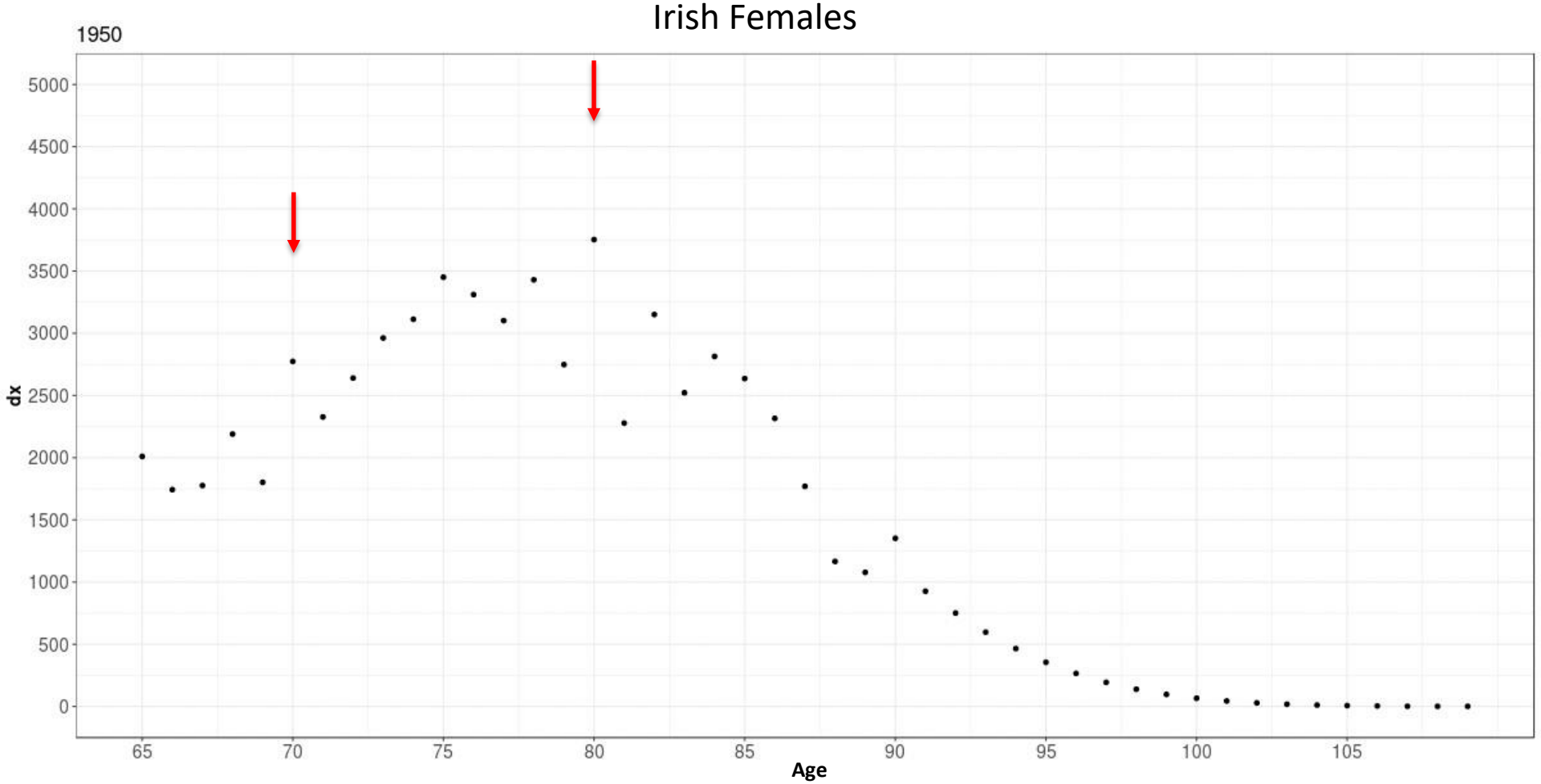

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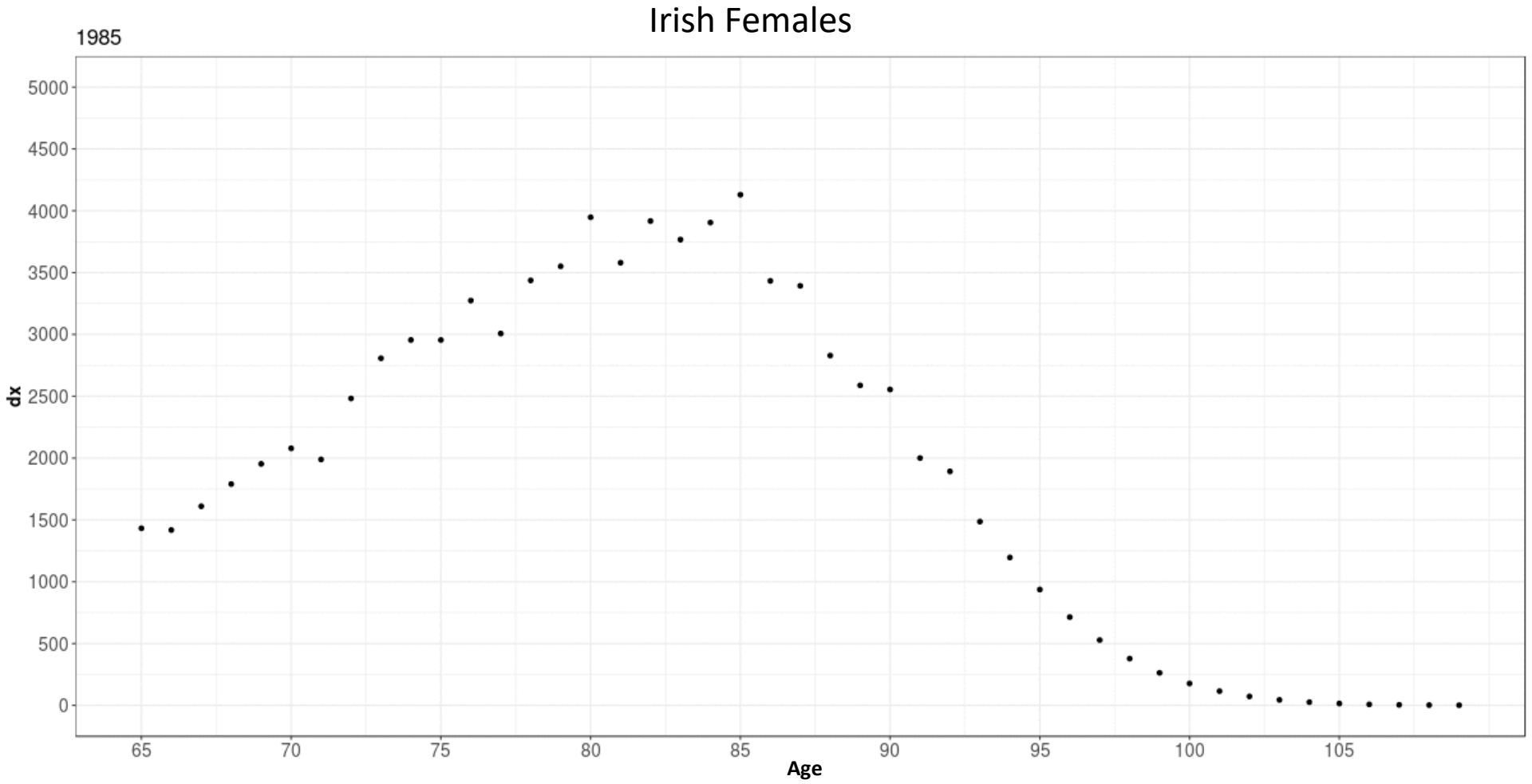

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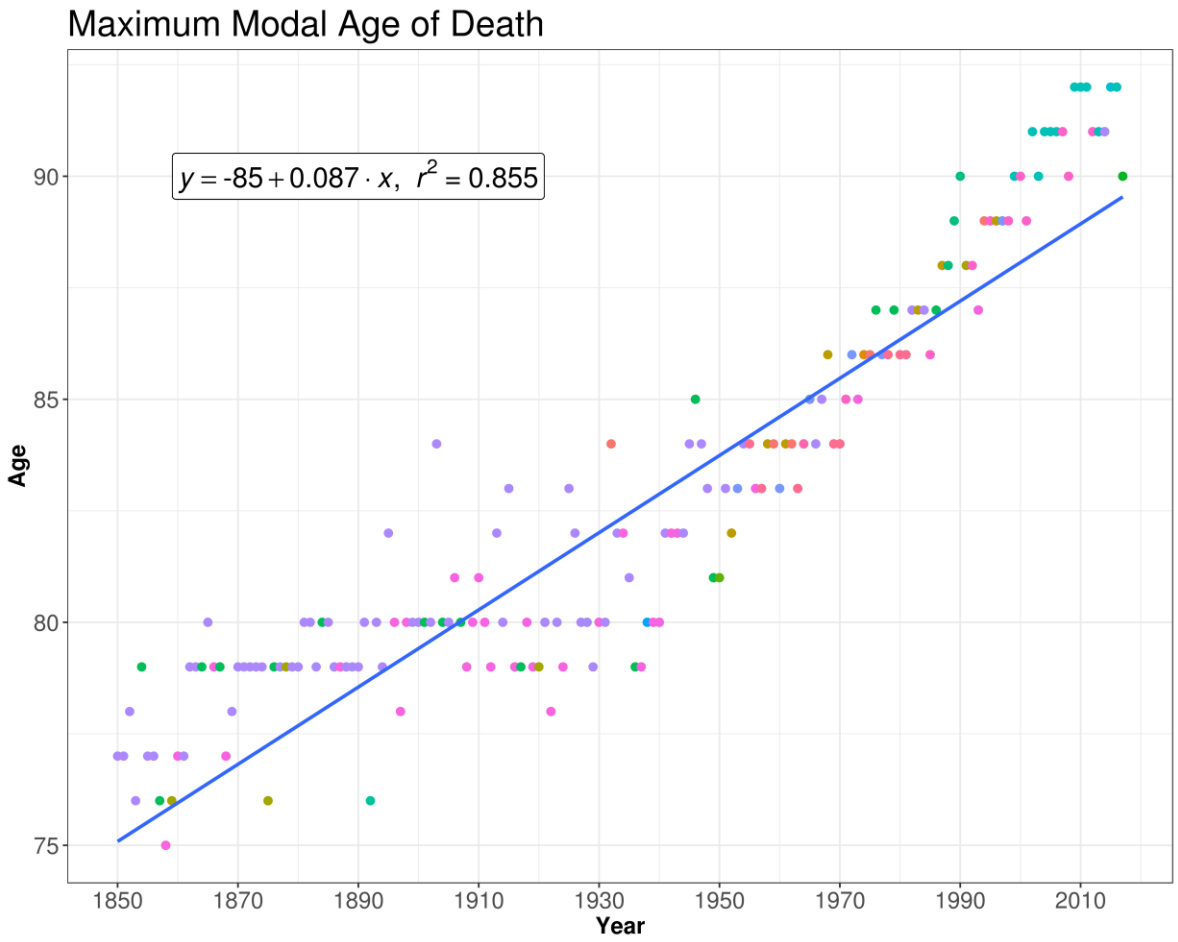
Modal Age of Death

- Calculate modal age of death for each country and year
- For each year take the **maximum** modal age across all countries



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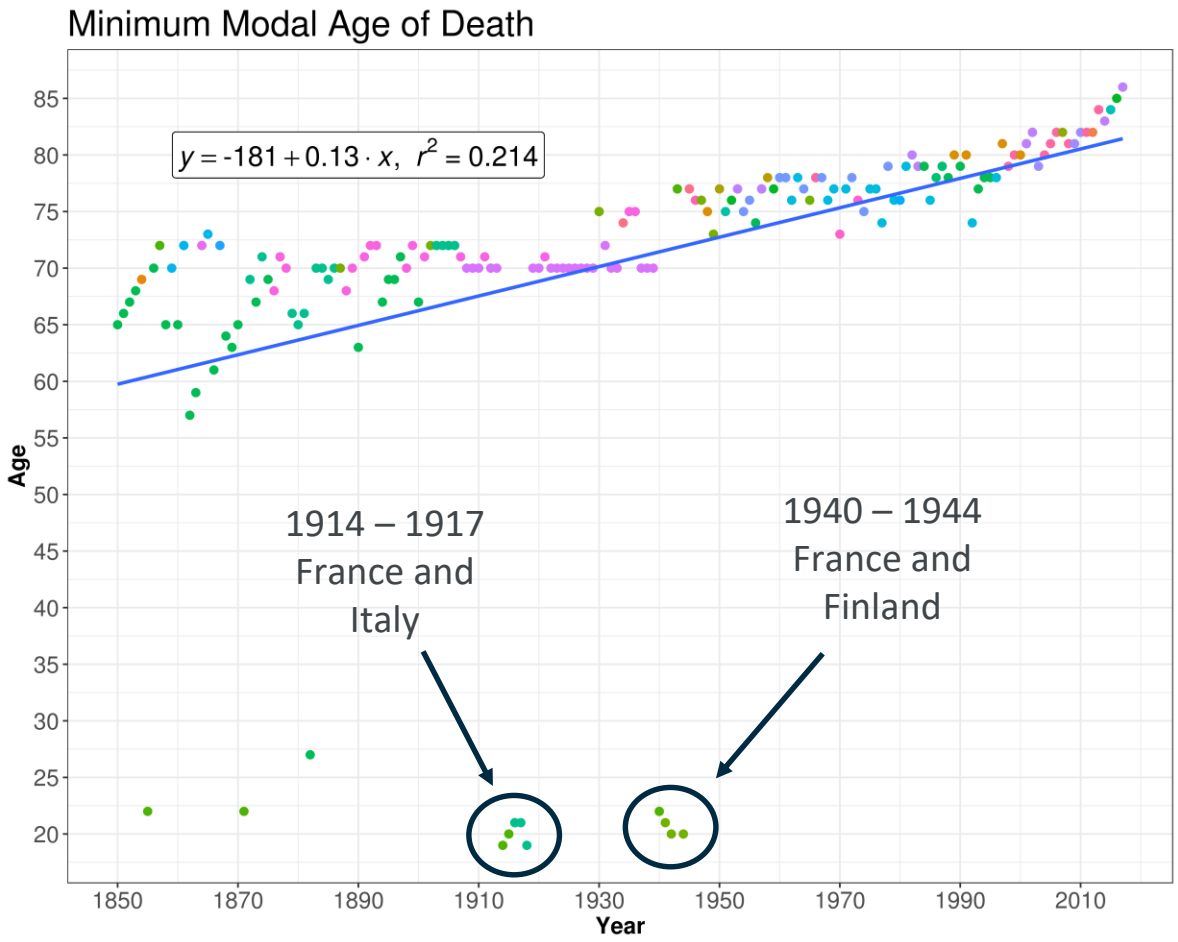

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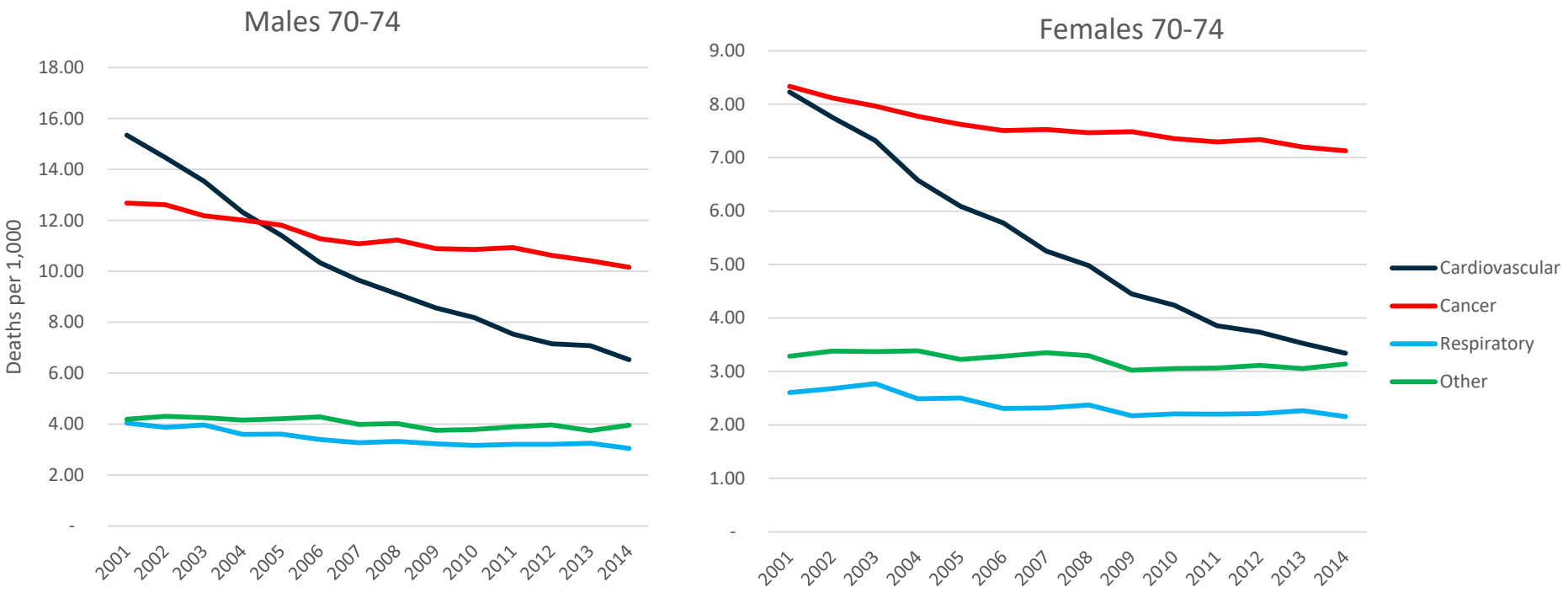
Mortality by Cause

Mortality rates by cause – England & Wales



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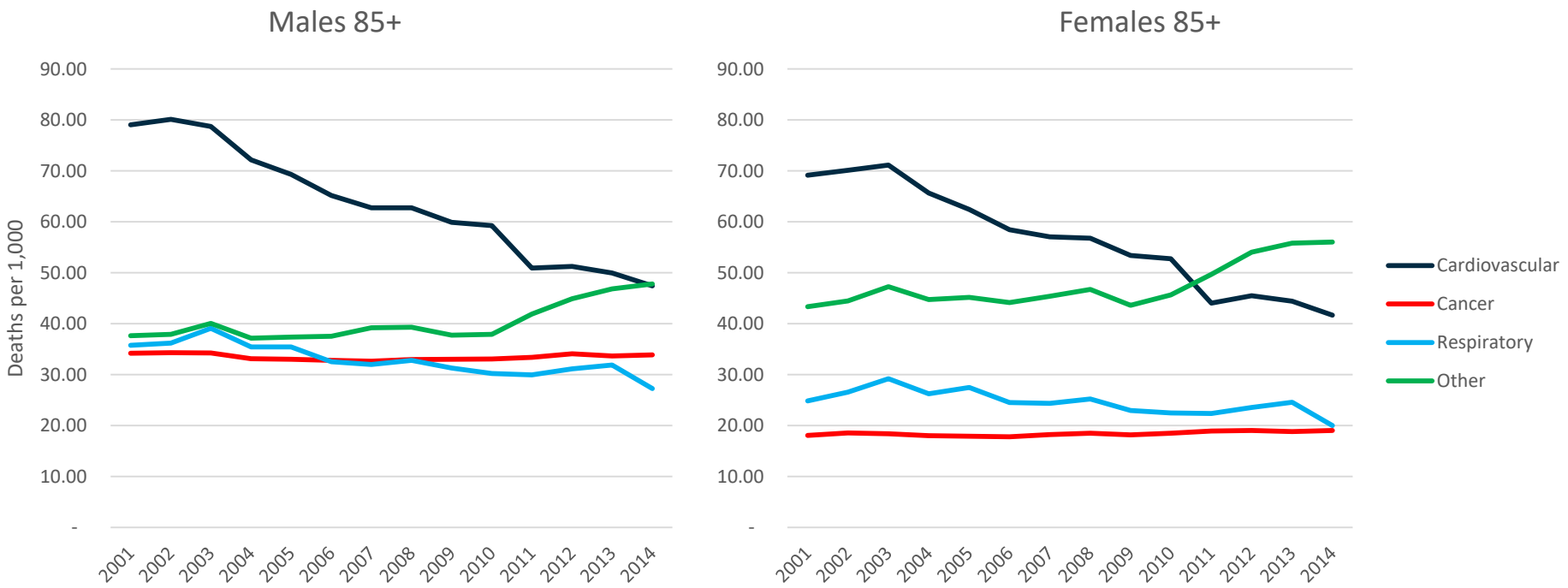

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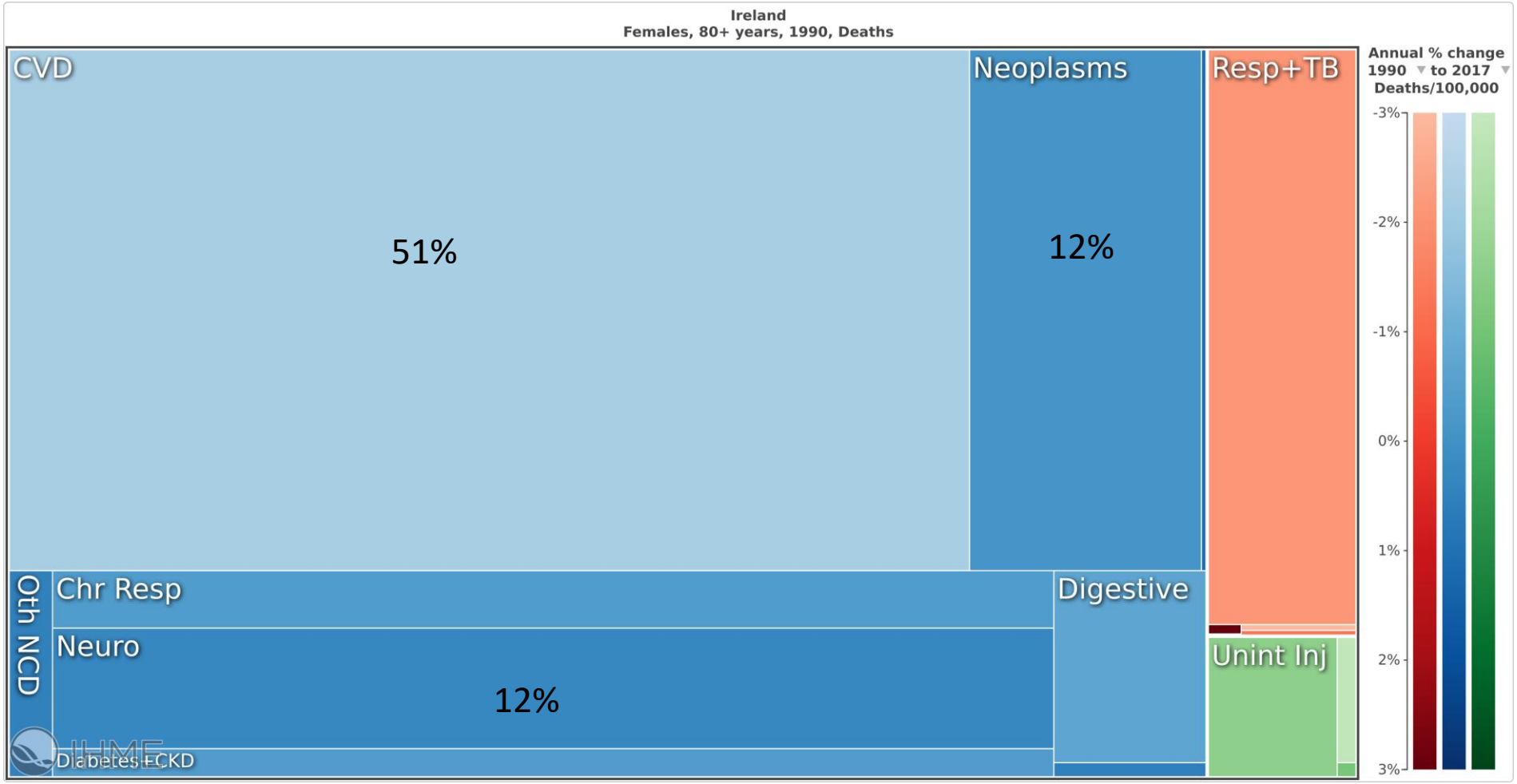
Mortality by cause – Ireland – 1990



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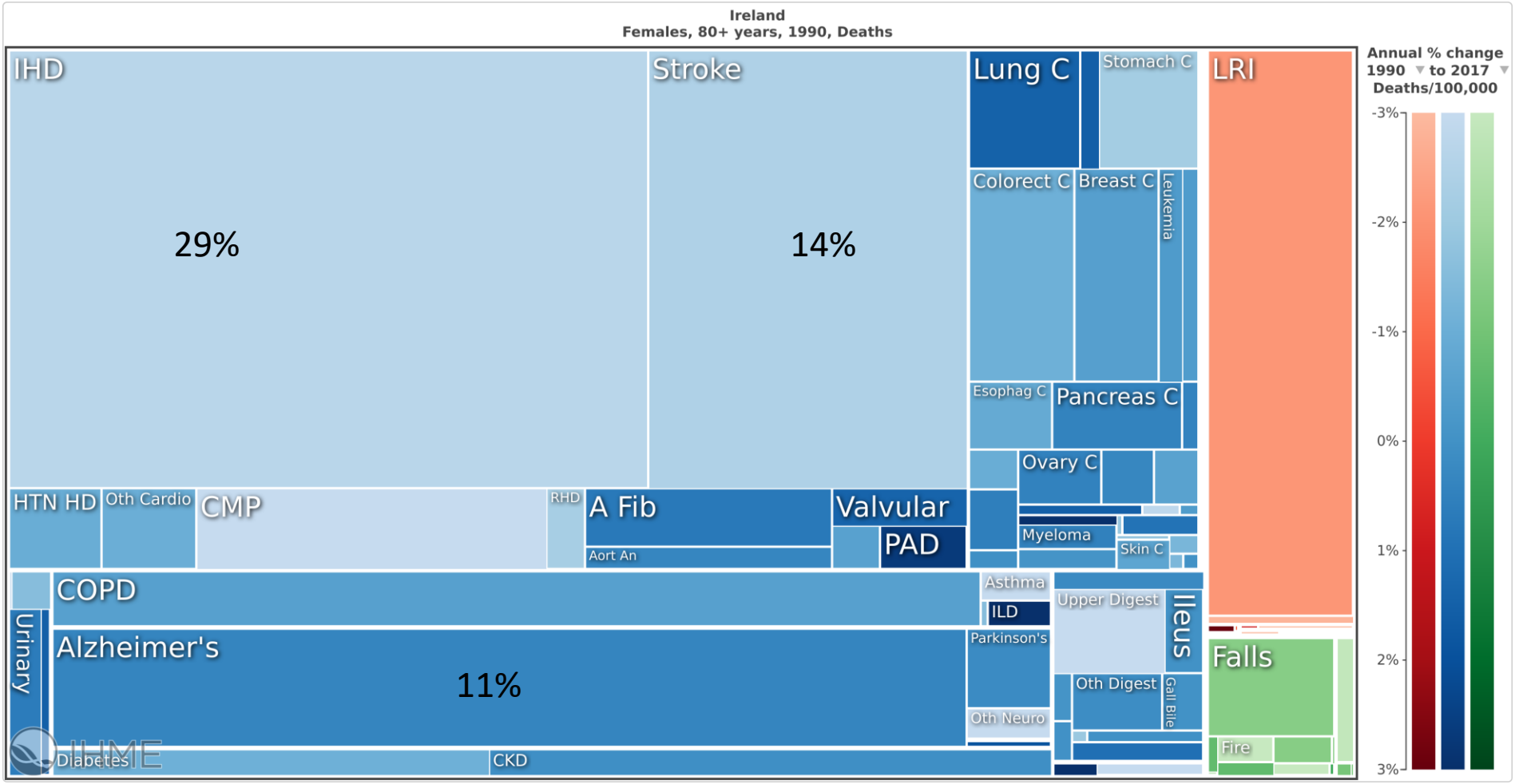

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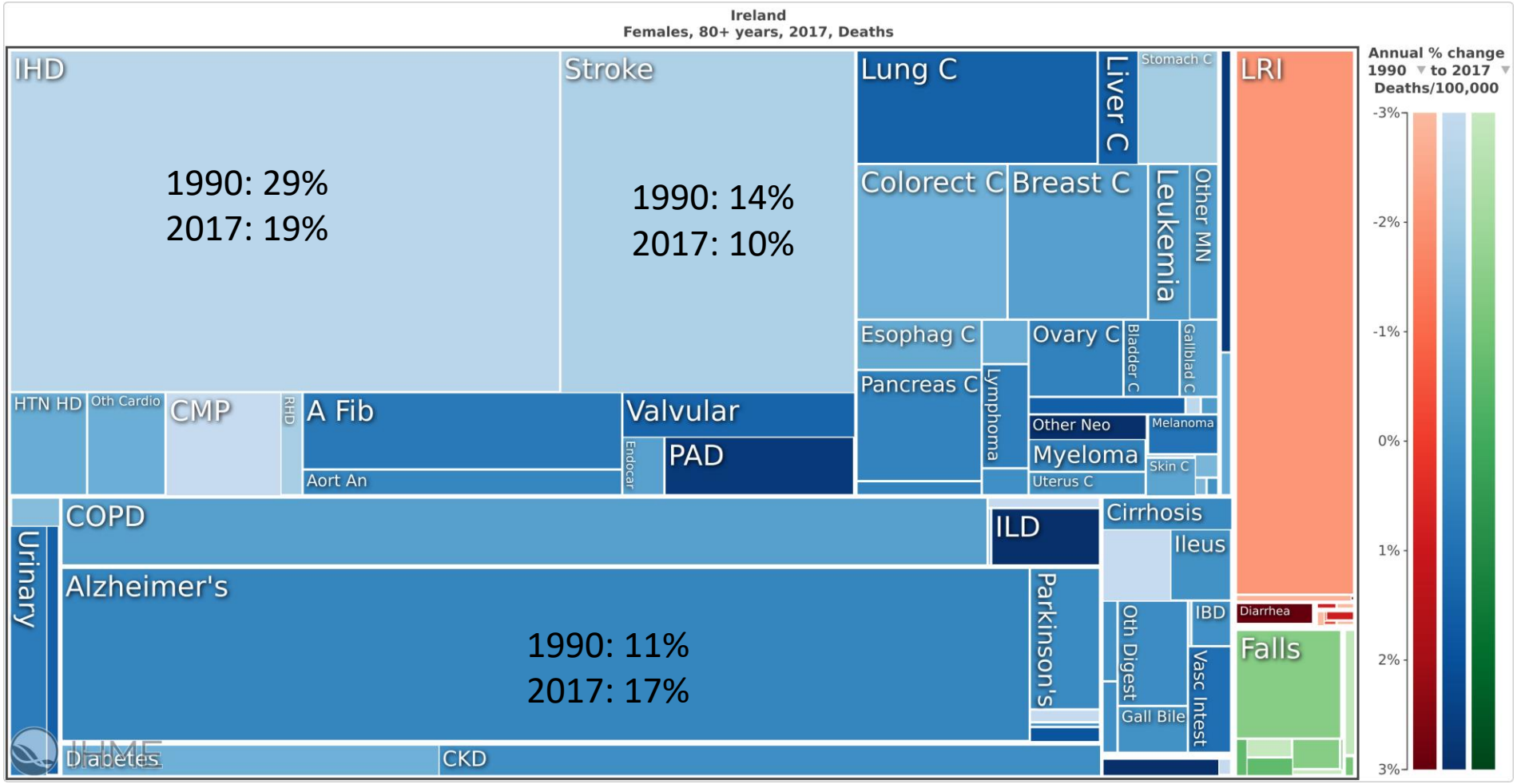
Mortality by cause – Ireland – 2017



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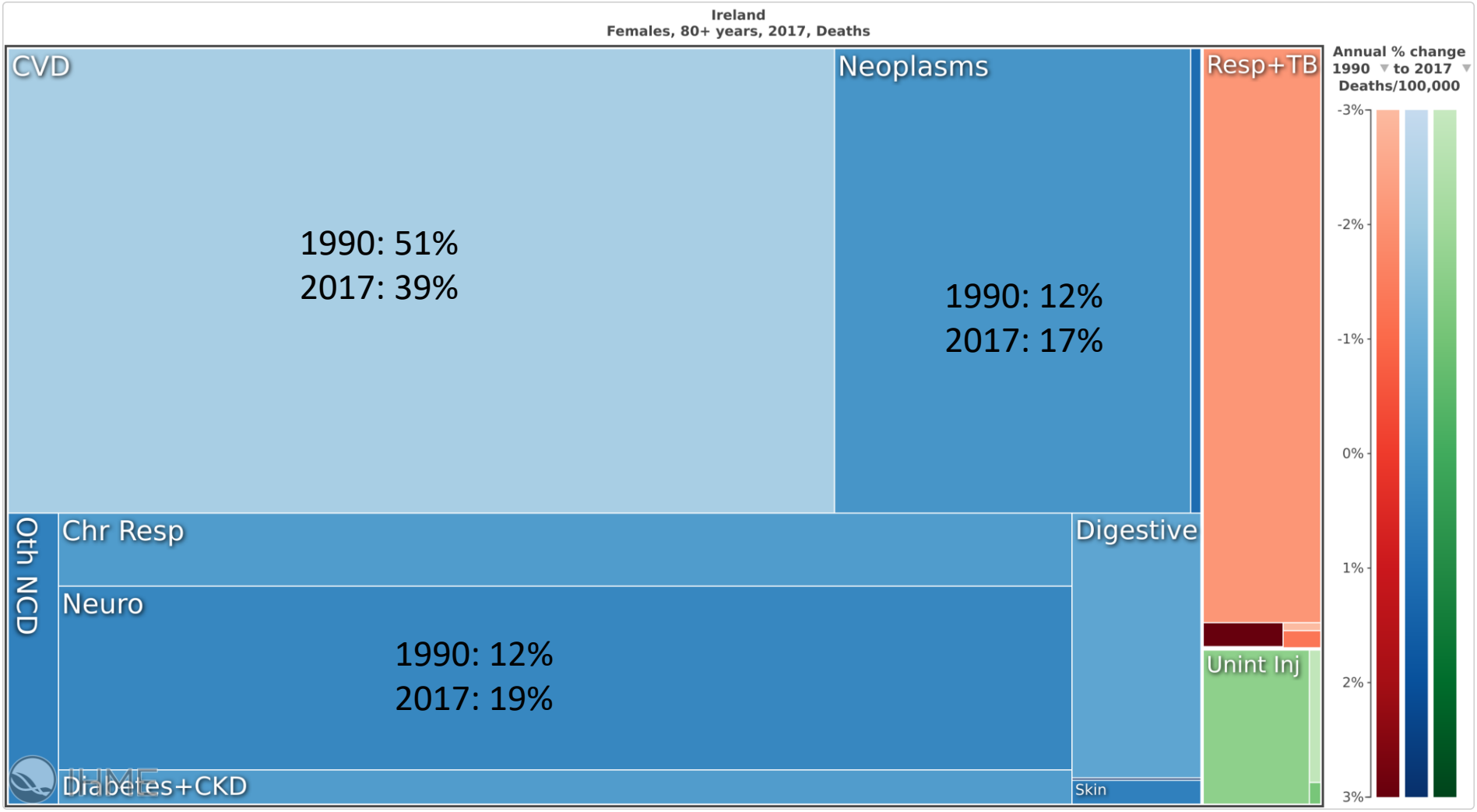

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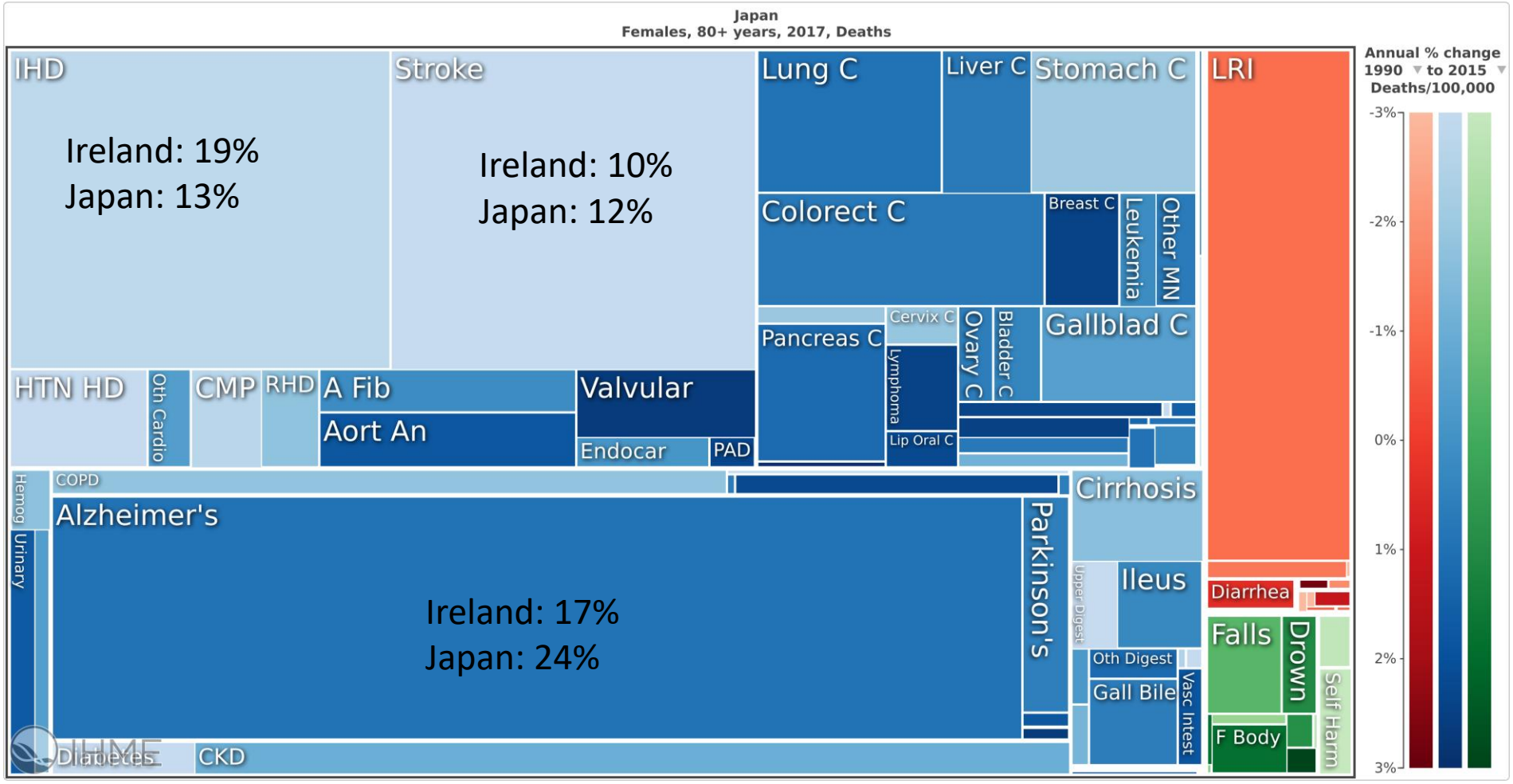
Mortality by cause – Japan – 2017



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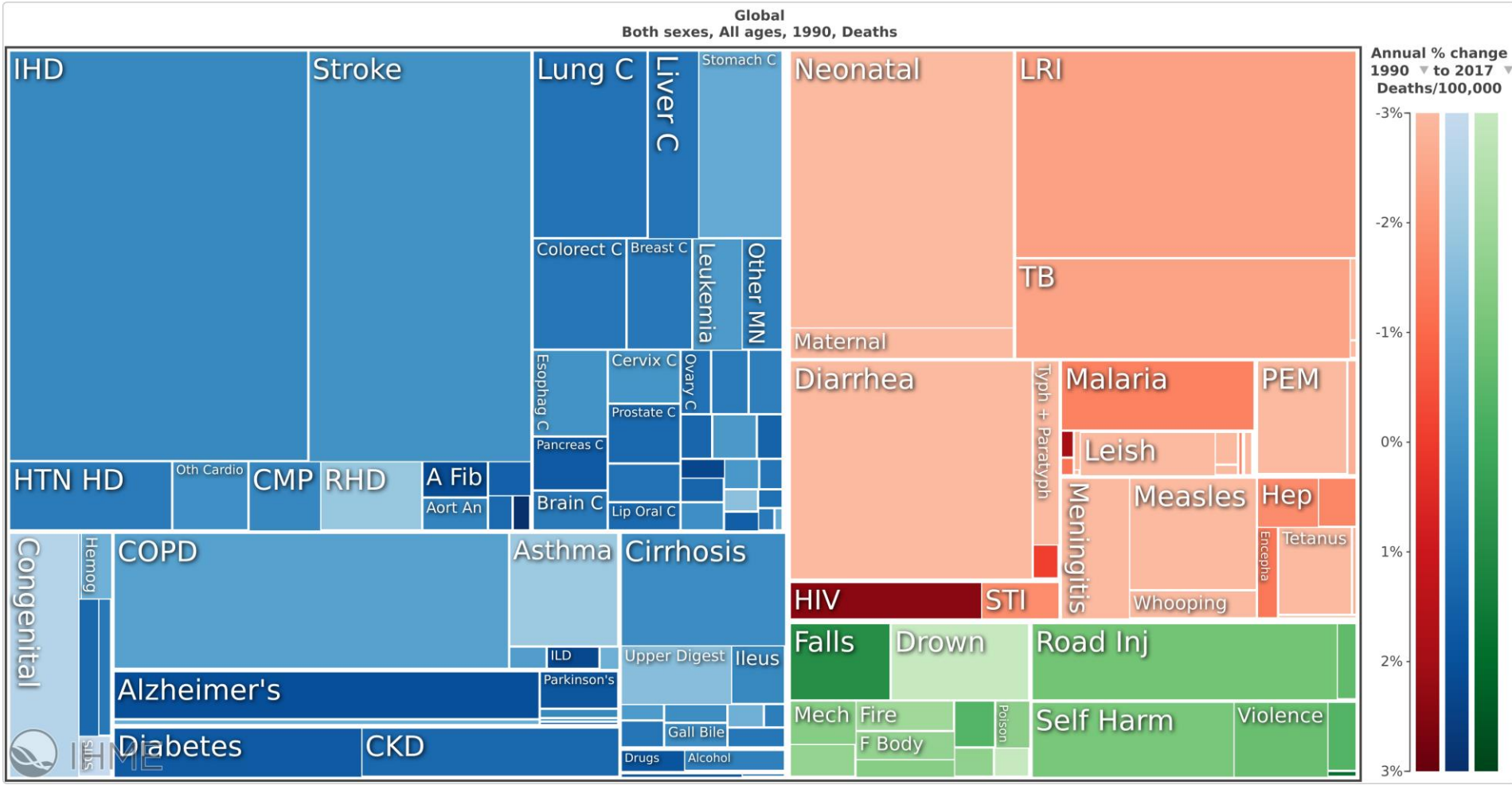
Mortality by cause – Global, all ages – 1990



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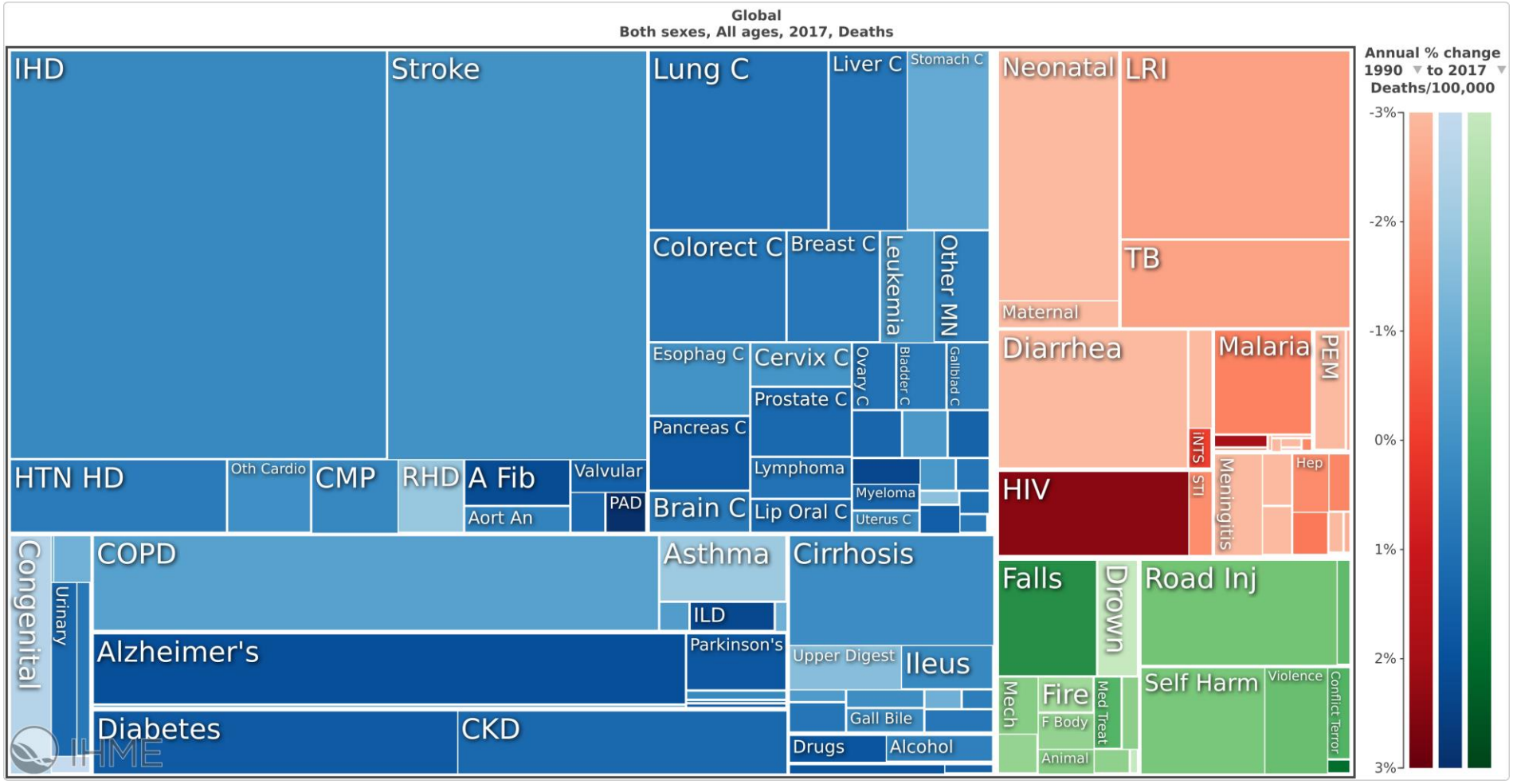

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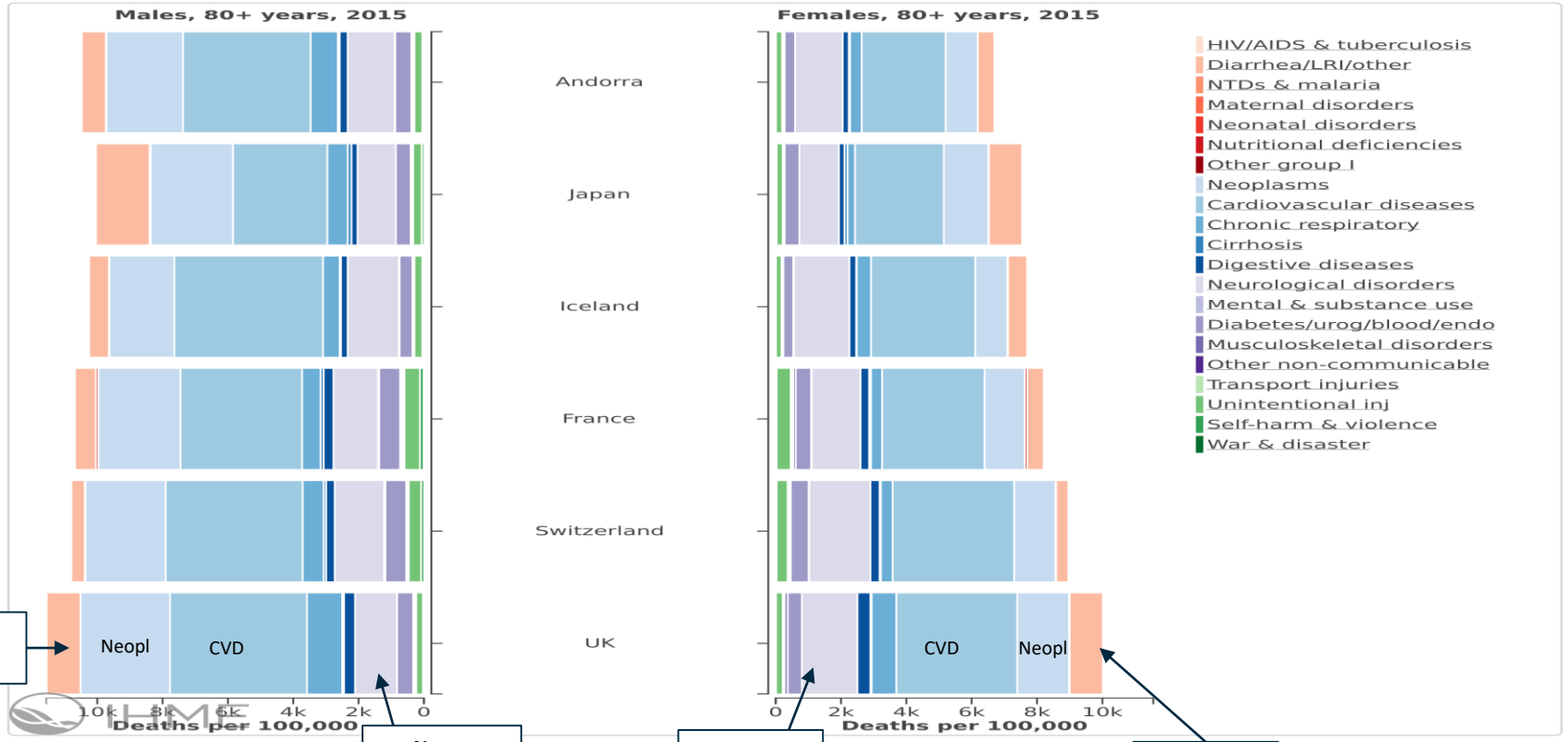
Mortality by cause

Top 5 Countries – deaths per 100,000 – 80+



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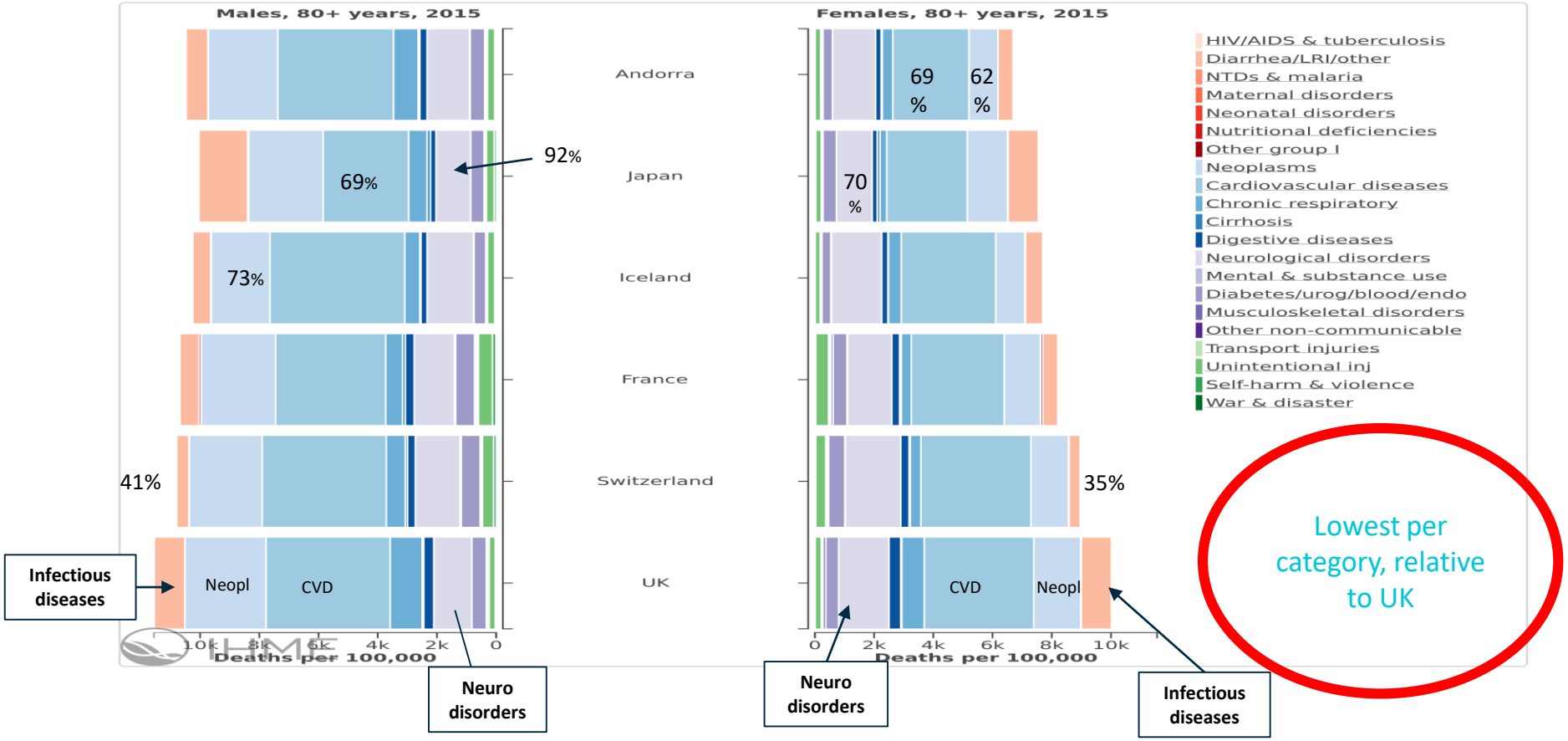

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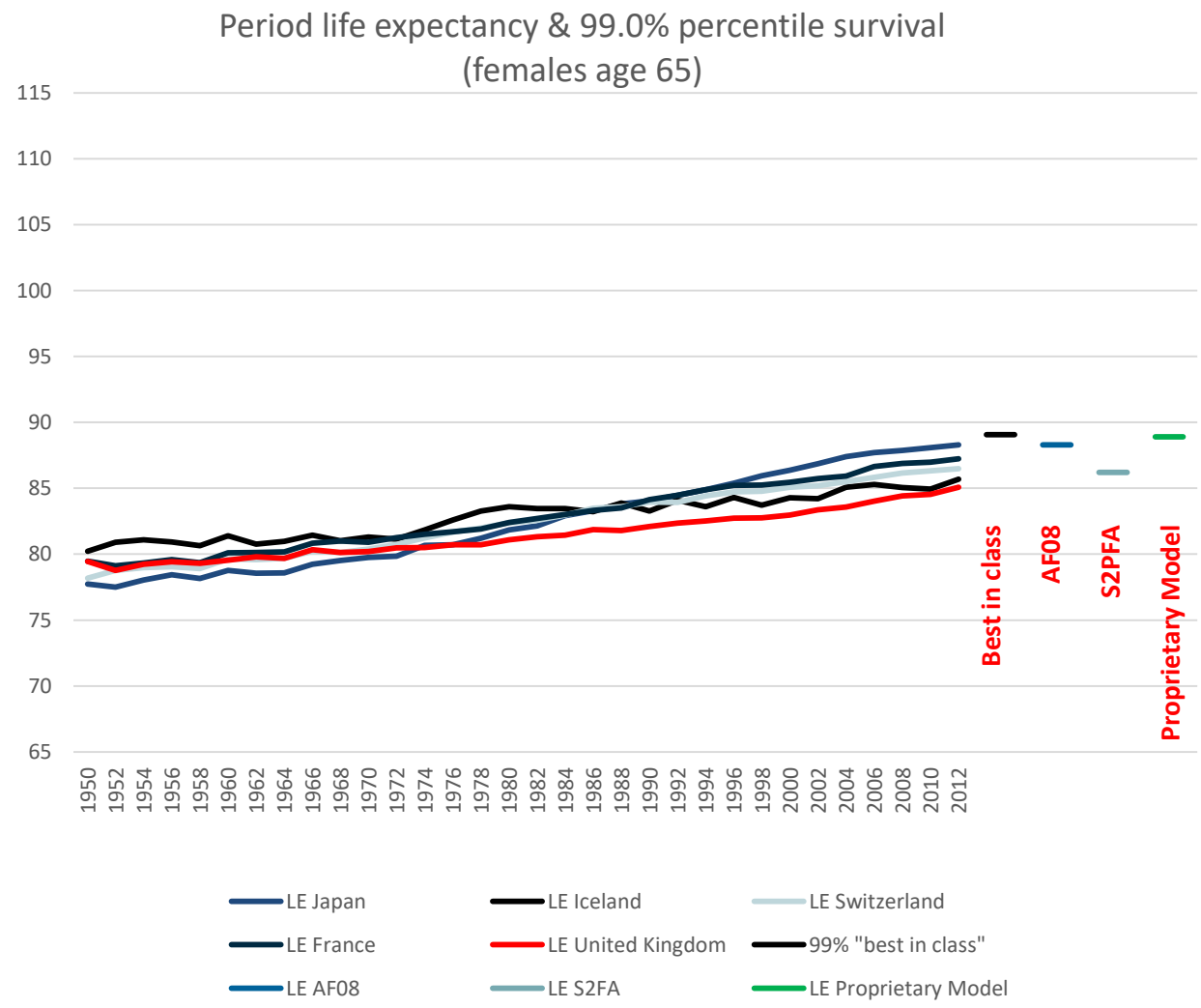
Life Expectancy & “best in class” by cause

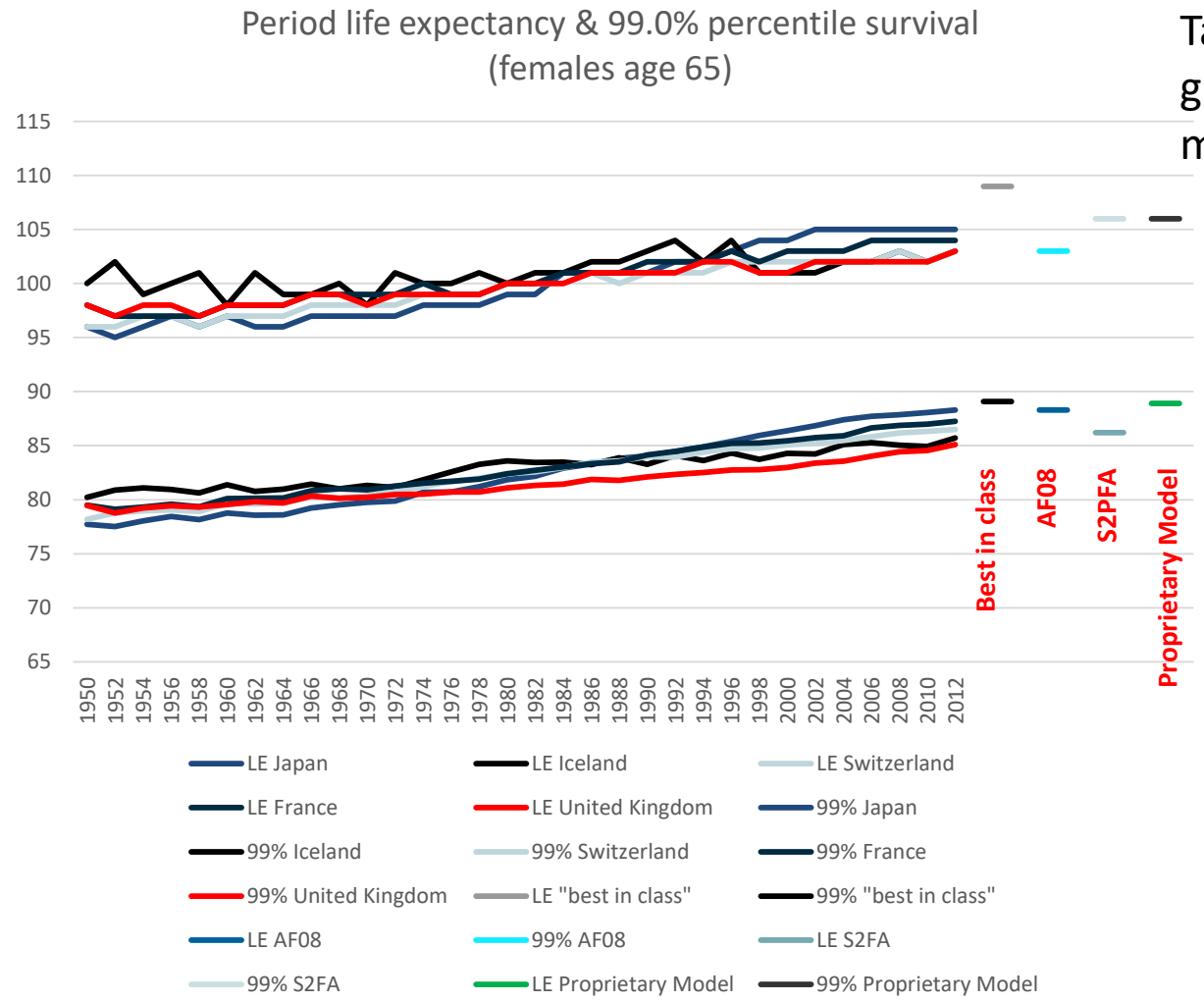


Take best in class for each group and apply to UK mortality for “Top 4” causes

- Total impact is 30% reduction in mortality
- Potential for life expectancy at 65 to increase to 88.5 – based on current best in class
- Life expectancy consistent with current life expectancy for subsets of UK

Source: HMD / CMI & Own Calculations

Life Expectancy & top percentile survival



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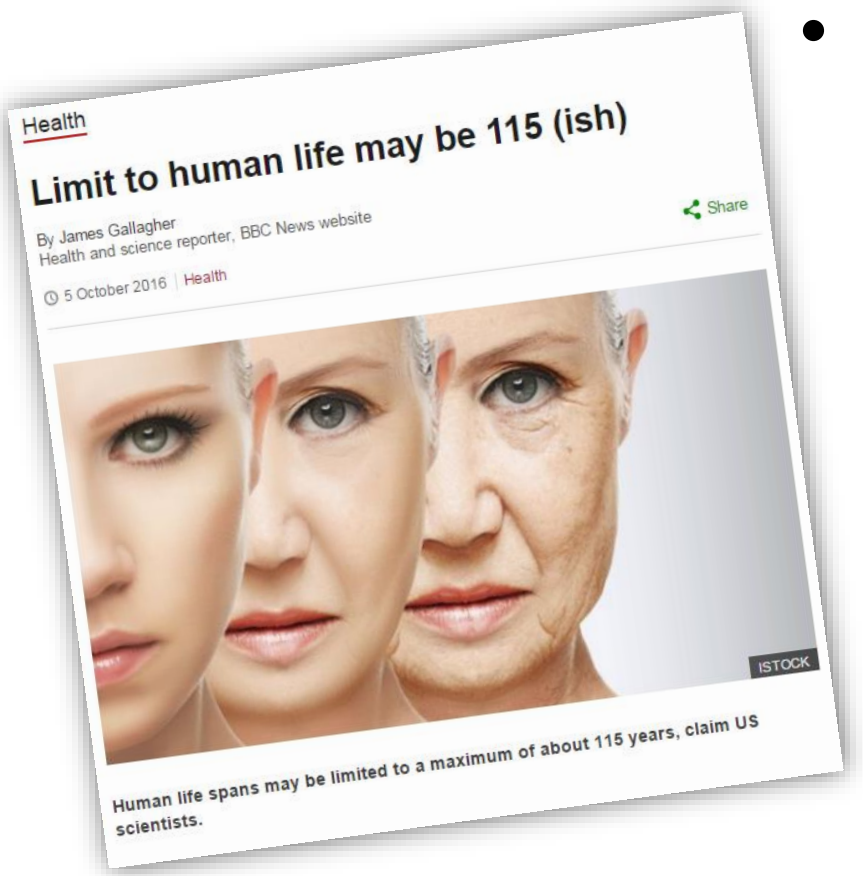
- Total impact is 30% reduction in mortality
- Potential for life expectancy at 65 to increase to 88.5 – based on current best in class
- Life expectancy consistent with current life expectancy for subsets of UK
- Potential for large gain in top percentile survival?

Source: HMD / CMI & Own Calculations

Limits of Human Lifespan

The Answer's 115



- "For the first time in history we've been able to see this, it looks like the maximum life span - this ceiling, this barrier - is about 115."

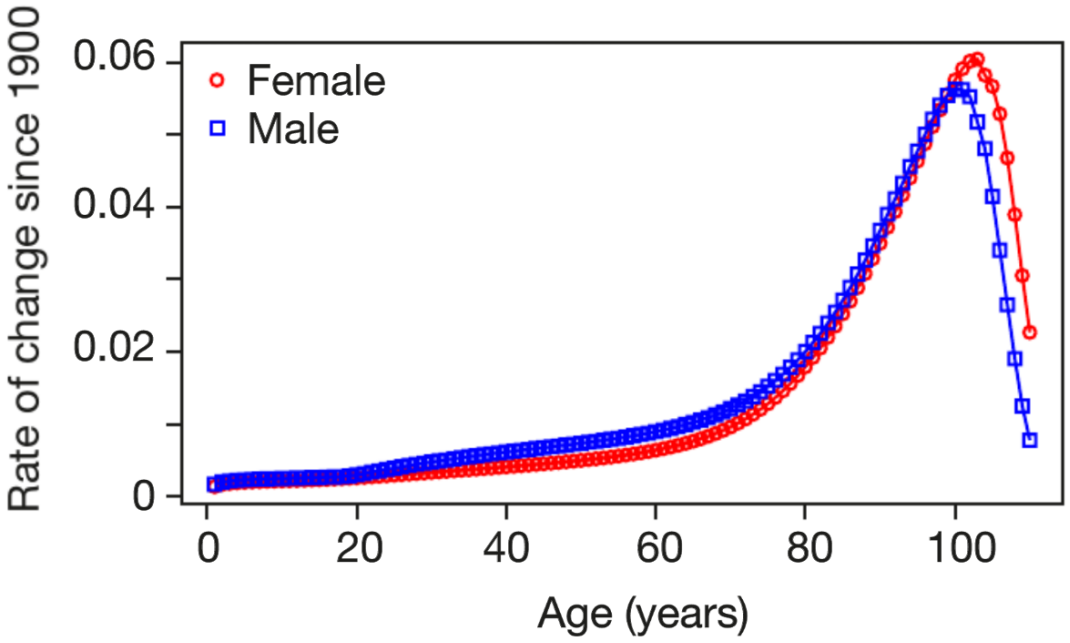
Nice headline … *but what did the paper show?*

Source: http://www.bbc.com/news/health-37552116 (5th October 2016)

Dong et al – Evidence for a Limit to Human Lifespan

Drop Off

Rate of improvement in survival peaks and then declines for very old ages



- Used data from the Human Mortality Database
- Regression of the fraction of people surviving to old age since 1900

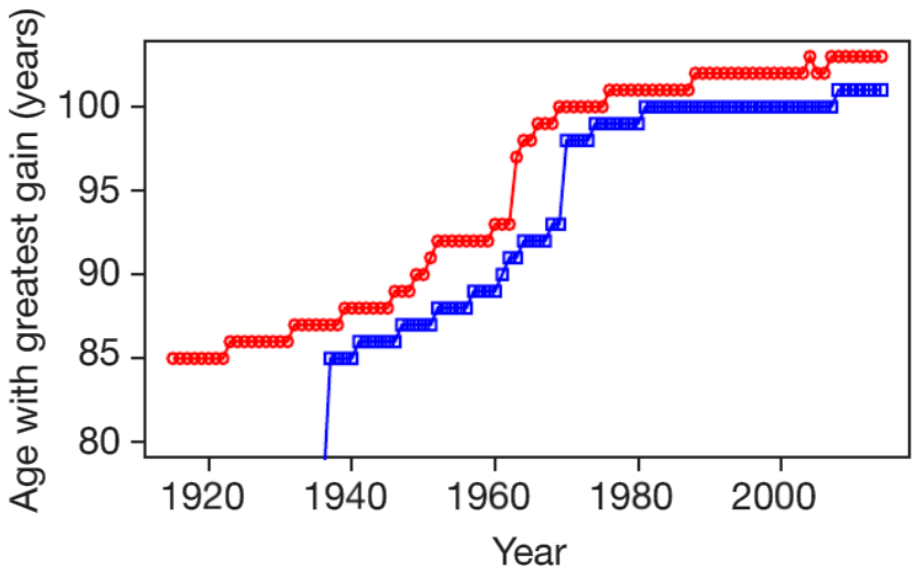
  $\log(l(x, t)) = a_x + b_x t$
- Chart is essentially $y(x) = b_x$

Source: Evidence for a limit to human lifespan, Dong, Milholland & Vijg - Nature doi:10.1038/nature.2016.20750

Dong et al – Evidence for a Limit to Human Lifespan

Survival Plateau

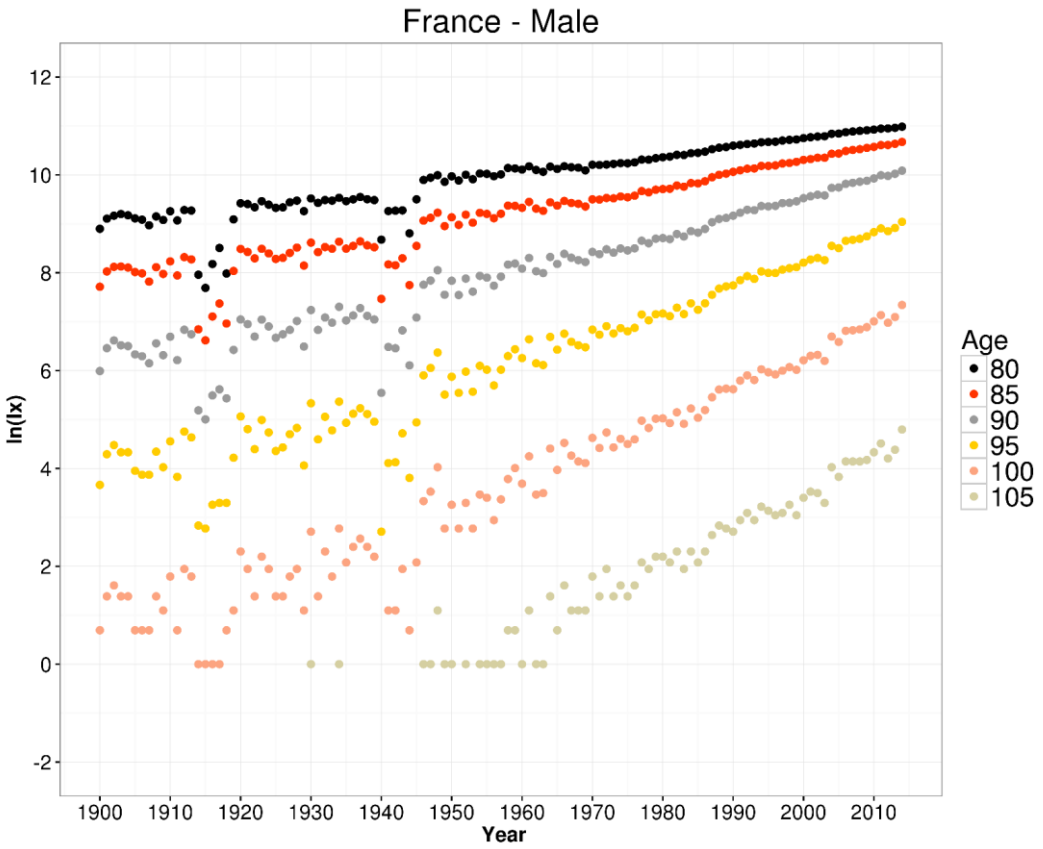
The age that experienced the greatest annual increase in survival stopped significant increasing after 1980



- If no upper limit on lifespan ⇨ biggest increase in survival should be experienced by ever-older age groups.
- Found that age with greatest improvement in survival got steadily higher since the early 20th century then started to plateau at about 99 in 1980.

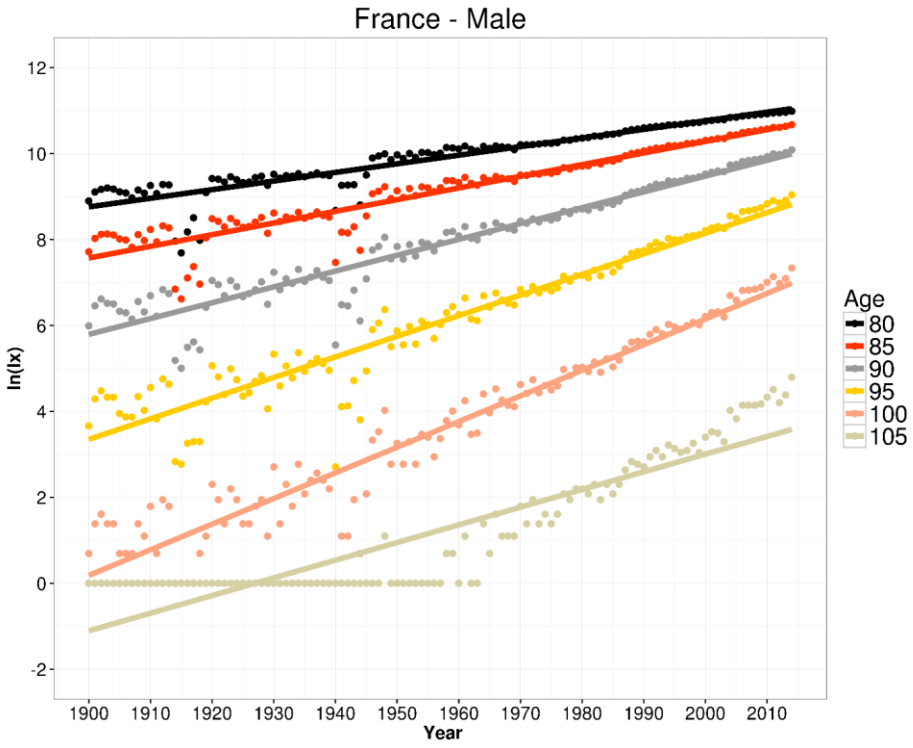
Source: Evidence for a limit to human lifespan, Dong, Milholland & Vijg - Nature doi:10.1038/nature.2016.20750

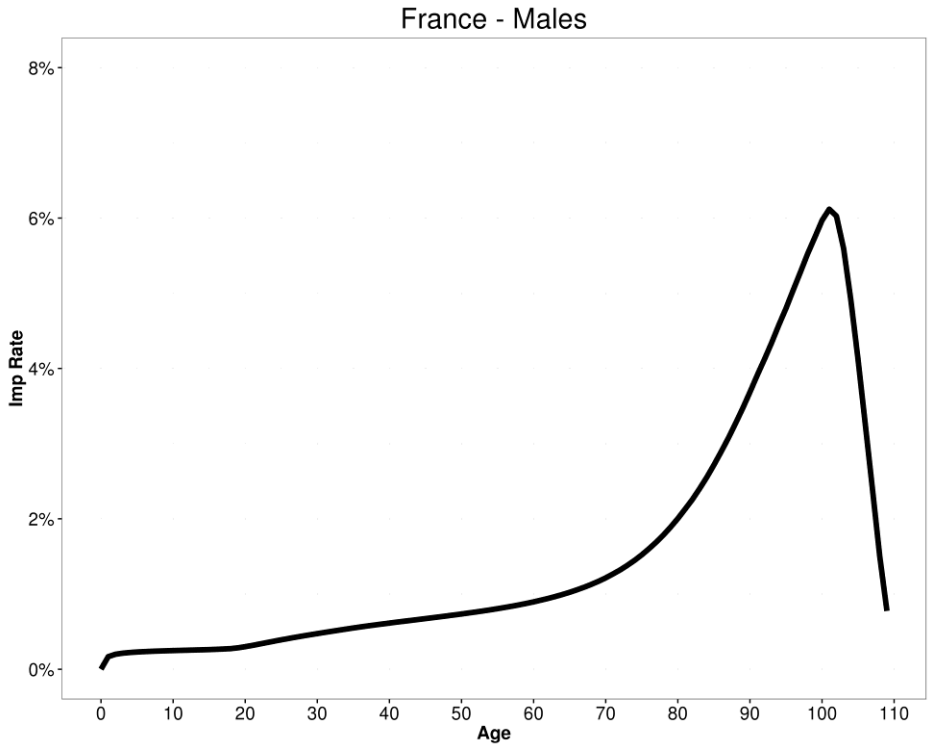
Survival Improvement Rate Drop-off?



Source: mortality.org (own calculations)

Survival Improvement Rate Drop-off?





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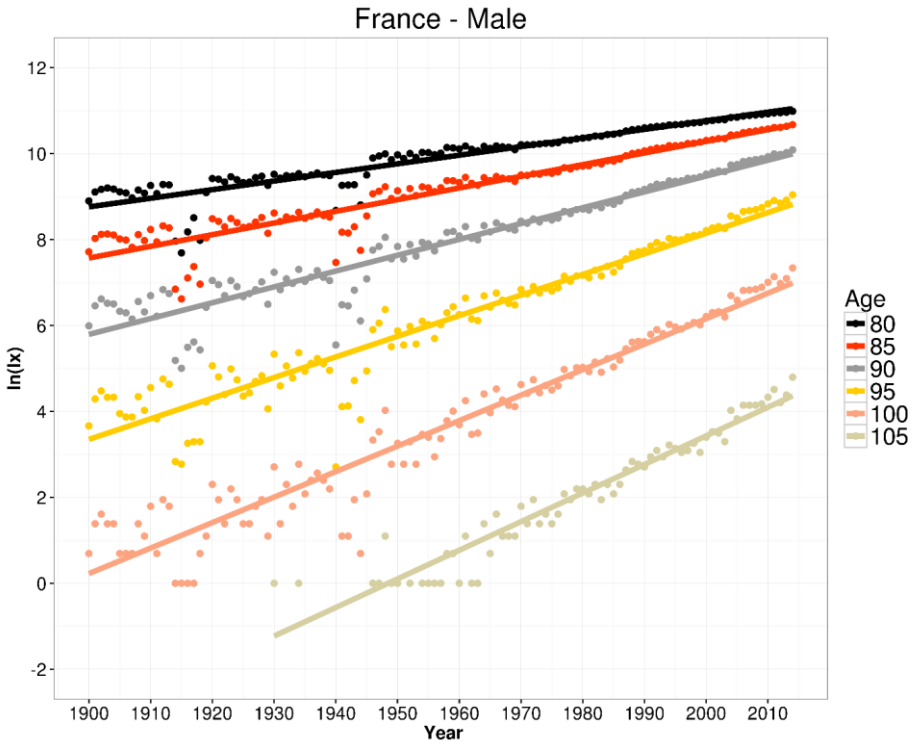

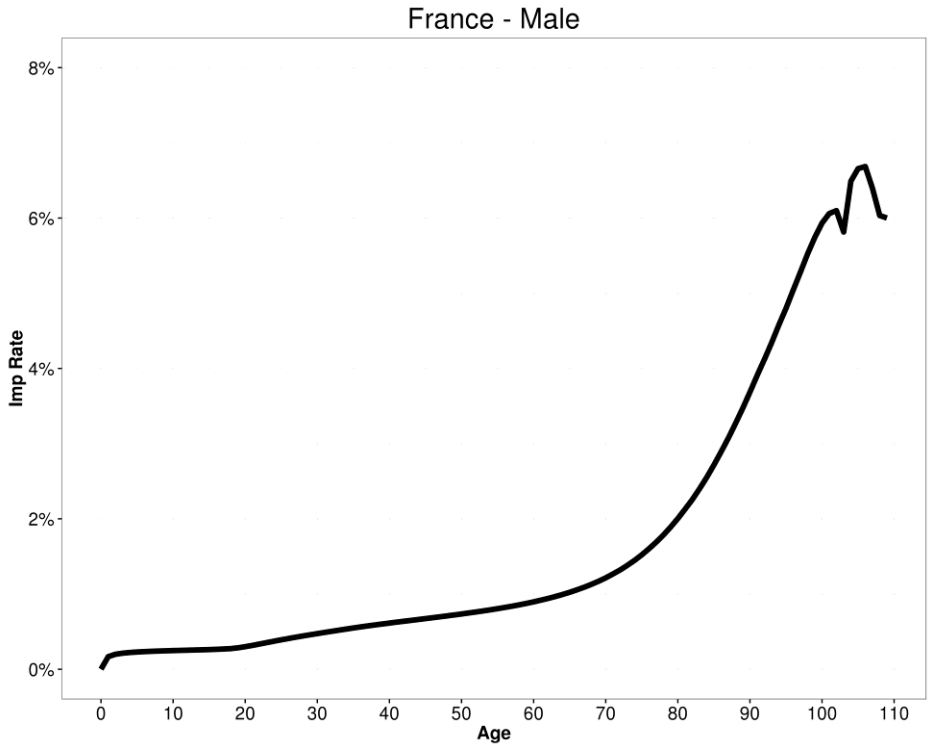

Source: mortality.org (own calculations)

What does Aubrey say?

Source: https://www.flickr.com/photos/shareconference/6838320854/

What is Ageing?

- Ageing is a consequence of physics, not biology
- It is the life-long accumulation of “damage” to the body that occurs as an intrinsic side-effect of the body’s normal operation
- The body can tolerate some damage, but too much of it causes disease and disability

Source: sens research foundation

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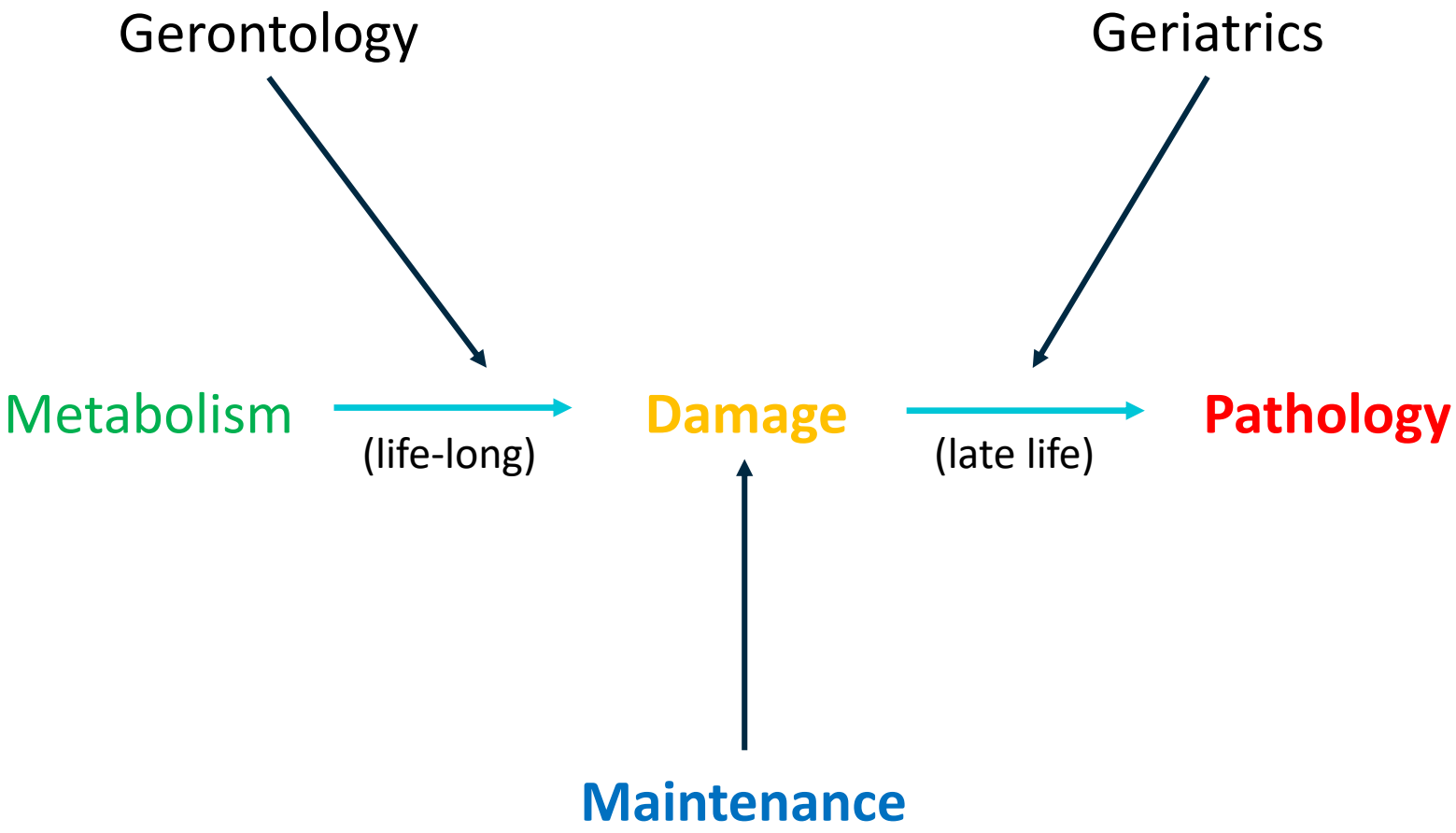
Source: sens research foundation

What is Ageing?



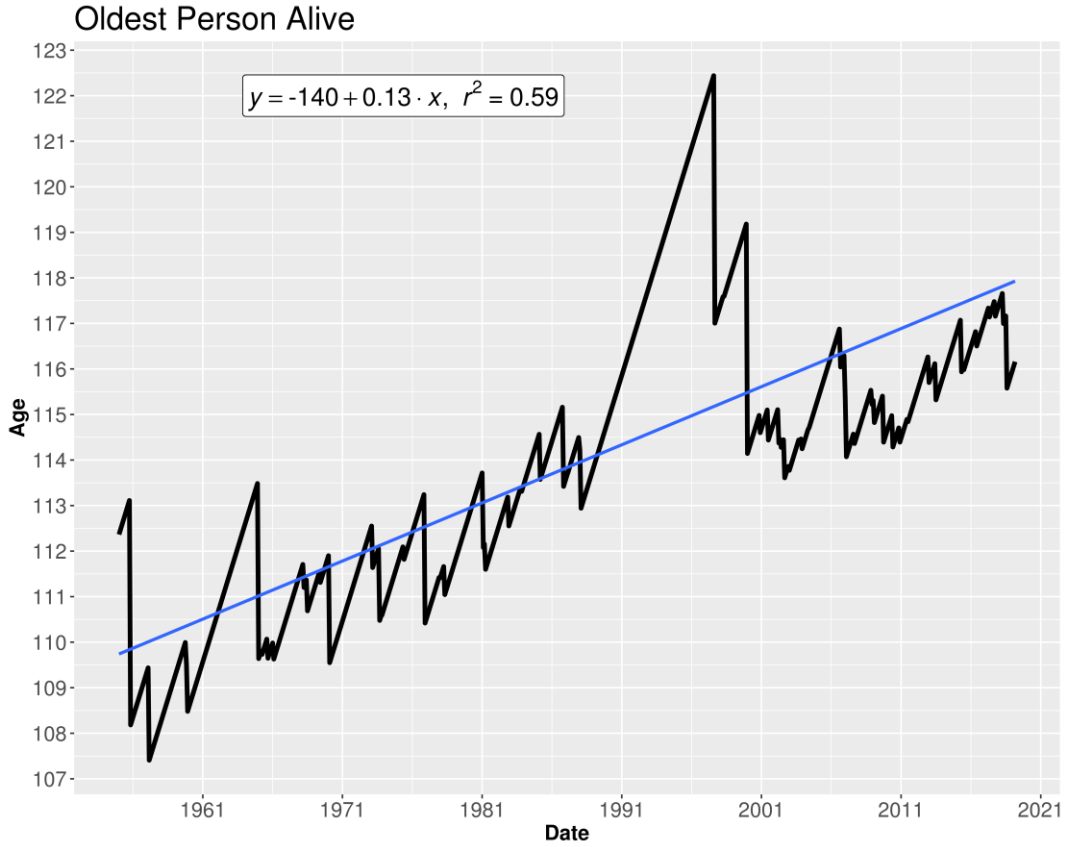
Source: sens research foundation

Seven Deadly Things

Ageing Damage	Rejuvenation Biotechnology
Cell loss, cells atrophy	Replace, using stem cells
Division-obsessed cells	Resist, using telomere control
Death-resistant cells	Remove, using suicide genes etc.
Mitochondrial mutations	Resist, using backup copies
Intracellular waste products	Remove, using foreign enzymes
Extracellular waste products	Remove, using immune system
Extracellular matrix stiffening	Repair, using crosslink-breakers

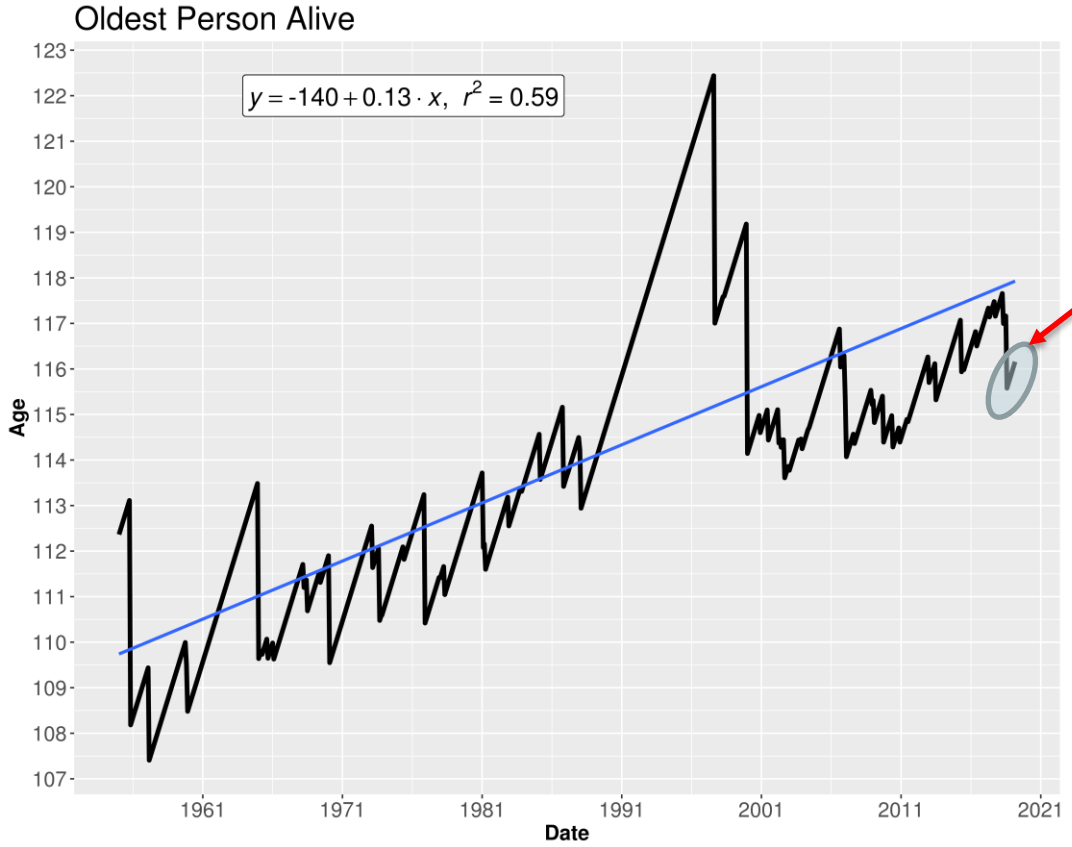
Source: sens research foundation

Oldest living person?



Source: Gerontology Research Group (http://www.grg.org/Adams/C.HTM)

Oldest living person?

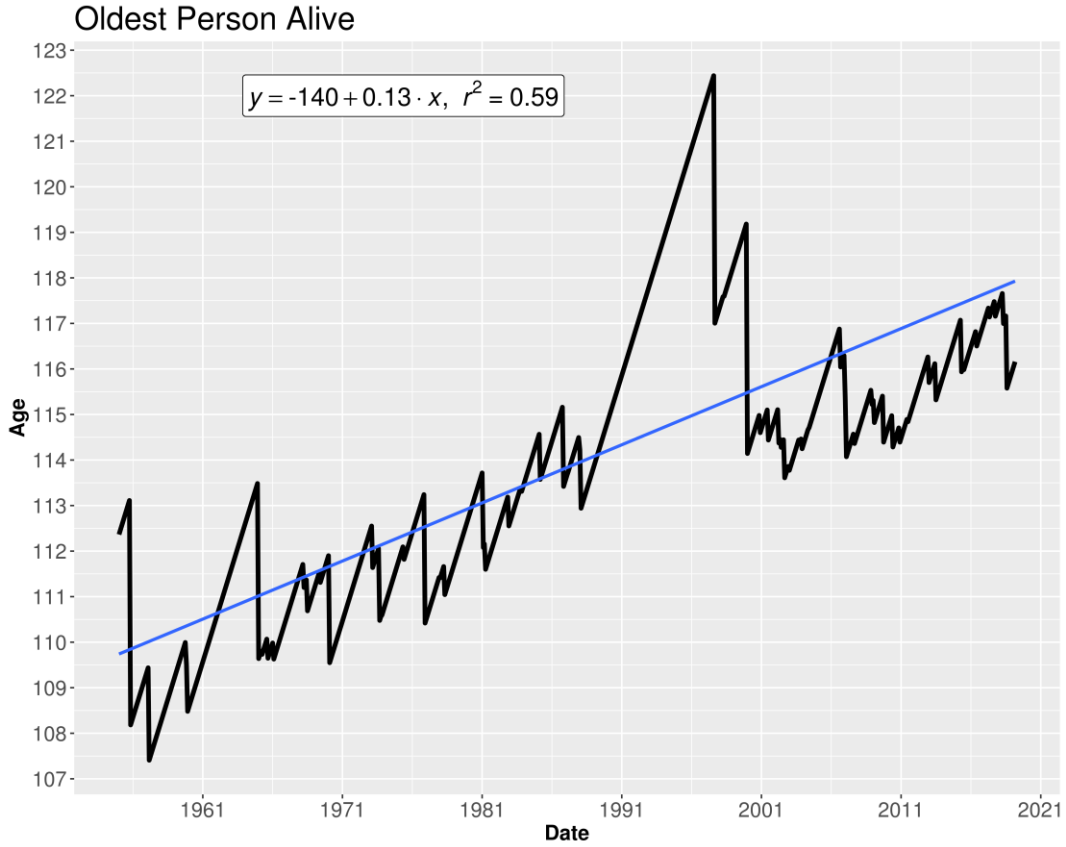


Kane Tanaka

Source: https://www.bbc.com/news/av/world-47508518/oldest-living-person-very-grateful-for-award

Source: Gerontology Research Group (http://www.grg.org/Adams/C.HTM)

Oldest living person?

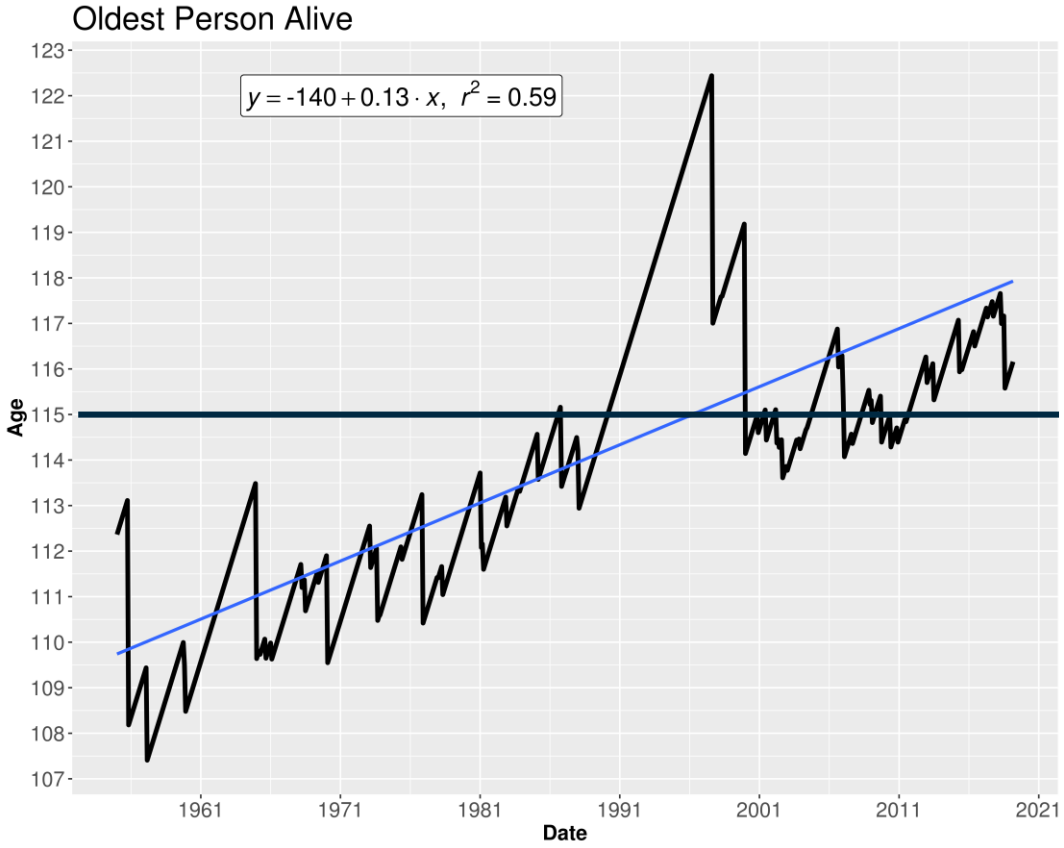


Increasing at 0.13 years per calendar year

Will reach 1000 in year 9000 ?

Source: Gerontology Research Group (http://www.grg.org/Adams/C.HTM)

Oldest living person?



A realistic limit?

Source: Gerontology Research Group (http://www.grg.org/Adams/C.HTM)

Acciaroli – Early Findings

- Diet – Rosemary & Anchovies
- Environment – Unpolluted
- Stress – a stress-free life
- Active – spending time outdoors
  - Swimming
  - Gardening

Source: By Ciaurlec - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=16214368

Acciaroli – Early Findings

- Diet – Rosemary & Anchovies
- Environment – Unpolluted
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- Active – spending time outdoors
  - Swimming
  - Gardening
  - Sex

Society of Actuaries in Ireland

50 Shades of “de Grey”
International Drivers of Longevity Outliers

Q&A