Recent developments in mortality research

Brian Ridsdale

Chair, IAA Mortality Working Group (MWG)

Tues 23 May 2017, Helsinki

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Subjects to cover

- About the IAA Mortality Working Group (MWG)
- Recent developments in mortality and longevity
  - Seminar, Current Developments in Aging and Mortality – Budapest (MWG and Population Issues WG)
  - Older ages (80 plus): 3
  - Approaches to inequality: 3
  - Other:
- Discussion

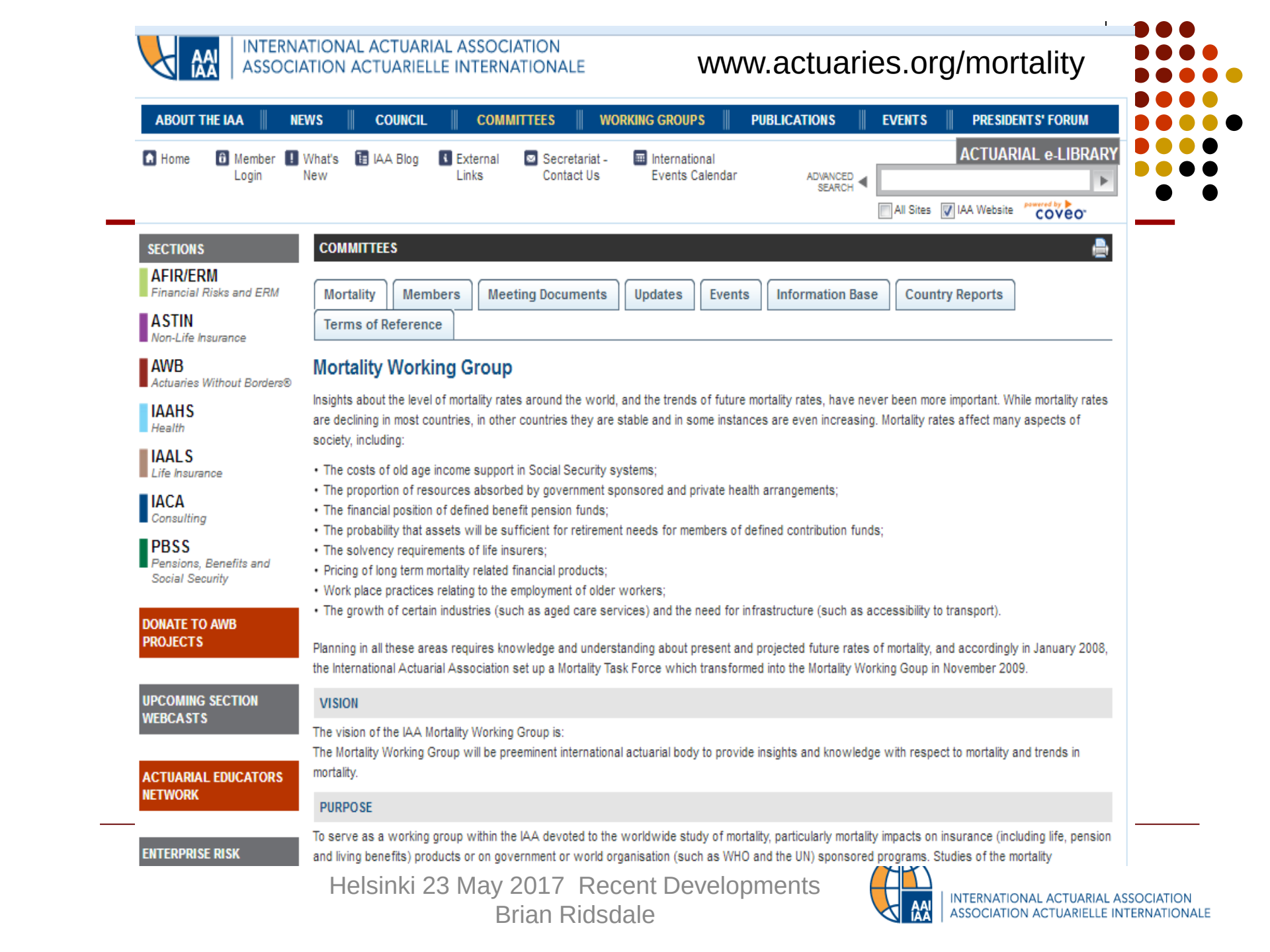
Sources hyperlinked in pages

Many areas: I'll try to pick out one point for each

IAA Mortality Working Group (MWG)

- Studies mortality, researches, communicates
- 34 Members, 27 Countries
- Meets twice a year
- Produces an Update in 11 languages after each meeting
- Organises seminars where practical in countries visited
- Maintains an Information Base

www.actuaries.org/mortalityinfo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Mortality Working Group
Insights about the level of mortality rates around the world, and the trends of future mortality rates, have never been more important. While mortality rates are declining in most countries, in other countries they are stable and in some instances are even increasing. Mortality rates affect many aspects of society, including:
• The costs of old age income support in Social Security systems;
• The proportion of resources absorbed by government sponsored and private health arrangements;
• The financial position of defined benefit pension funds;
• The probability that assets will be sufficient for retirement needs for members of defined contribution funds;
• The solvency requirements of life insurers;
• Pricing of long term mortality related financial products;
• Work place practices relating to the employment of older workers;
• The growth of certain industries (such as aged care services) and the need for infrastructure (such as accessibility to transport).
Planning in all these areas requires knowledge and understanding about present and projected future rates of mortality, and accordingly in January 2008, the International Actuarial Association set up a Mortality Task Force which transformed into the Mortality Working Goup in November 2009.
VISION
The vision of the IAA Mortality Working Group is:
The Mortality Working Group will be preeminent international actuarial body to provide insights and knowledge with respect to mortality and trends in mortality.
PURPOSE
To serve as a working group within the IAA devoted to the worldwide study of mortality, particularly mortality impacts on insurance (including life, pension and living benefits) products or on government or world organisation (such as WHO and the UN) sponsored programs. Studies of the mortality

Knowledge

Country reports
Research updates
Sharing at meetings
Conferences

MWG

Research

MWG research projects
Own research
Papers
Presentations

Dissemination

Updates – in English
+10 other languages!
Minutes and papers
Seminars in meeting countries
In-country presentations
Supranational meetings

Information Base

Aimed at providing information on aspects of mortality and longevity for actuaries and others with an interest in the subject.

Please have a look at our Information Base

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- IAALS *Life Insurance*
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Mortality Working Group

Information Base

Insights about the level of mortality rates around the world, and the trends of future rates of mortality, have never been more important. While mortality rates are declining in most countries, in other countries they are stable and in some instances are even increasing. Rates of mortality affect many aspects of society.

The following pages provide information about areas of investigation by the Working Group.

Areas of investigation

- Overview
- Cause of Death
- Mortality of Disabled People
- Financial Products
- Healthy Longevity
- International Mortality Experience Study (Society of Actuaries)
- Old Age Mortality, Heterogeneity and Frailty
- Pandemics
- Pensions and Annuity Reserving Assumptions
- Projection Techniques
- Social and Demographic Stratification
- Sources of Mortality Data Worldwide
- Trends and Uncertainty
- Underwriting
- Other Sources of Information

Current Developments in Aging and Mortality

Seminar: Tuesday, April 18, 2017
Summarised for Seminar: Tuesday 23 May, 2017

Older ages (3)

Long Term Care

High-age Mortality and Population Heterogeneity

Determination of Retirement and Eligibility Ages

Current Developments in Aging and Mortality

Seminar: Tuesday, April 18, 2017
Summarised for Seminar: Tuesday 23 May, 2017

Long-Term Care

An Actuarial Perspective on Societal and Personal Challenges

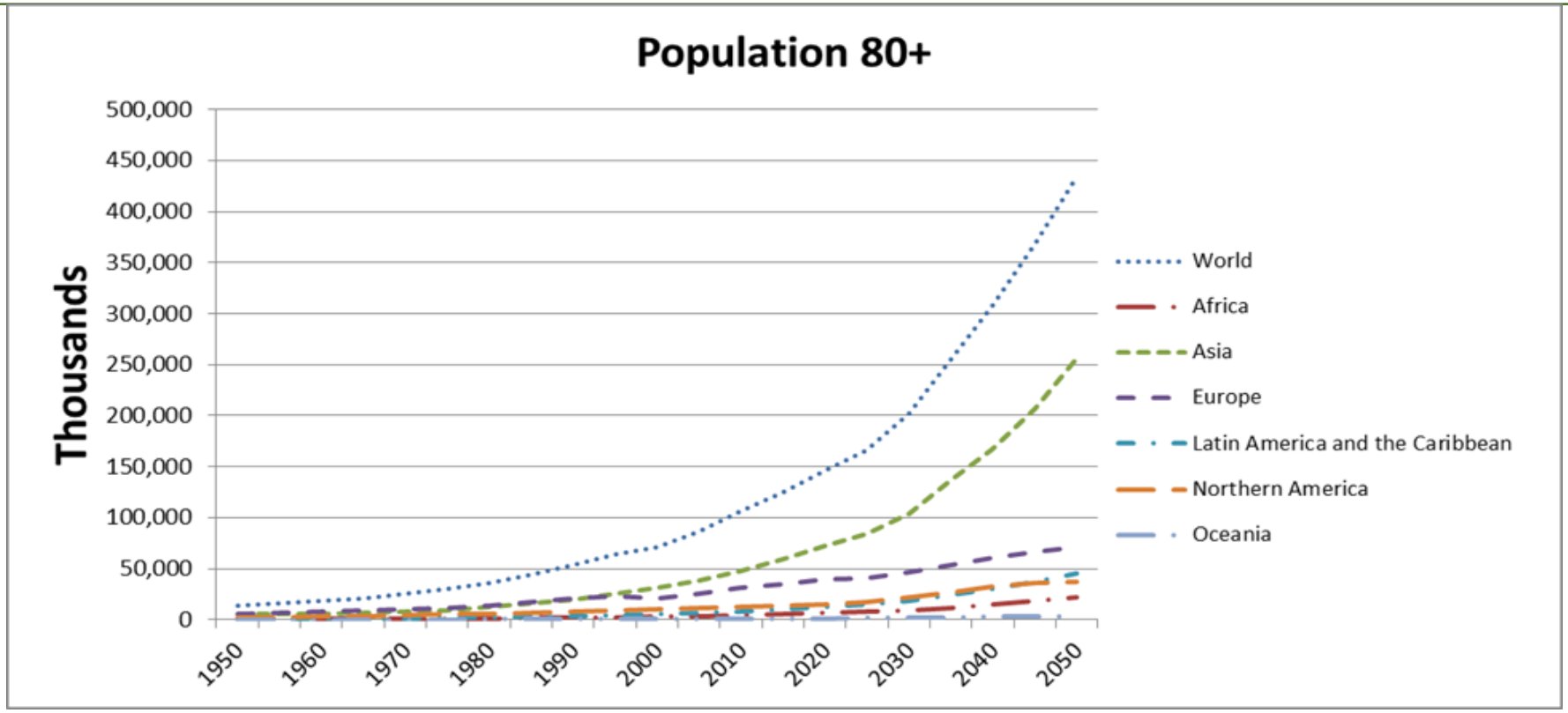
Sam Gutterman FSA, FCAS, CERA, MAAA, HonFIA

co-vice chair, IAA Population Issues Working Group

Long Term Care Report

- Prepared by the IAA's Population Issues Working Group
  - Published in April 2017
  - http://www.actuaries.org/LIBRARY/Papers/PIWG_LTC_Paper_April2017.pdf
- Scope
  - Focuses on LTC needs of the elderly, although other population segments are also in need of these services
  - Includes eight national case studies
- Objectives
  - Upgrade attention given to LTC by actuaries worldwide

Demographic explosion



- Number of people age 80 and older is expected to increase from about 120,000 now to more than 400,000 in 2050
- Largest number will be in Asia

Source: United Nations 2015 Revision of World Population Prospects

Percent of population age 80 and older

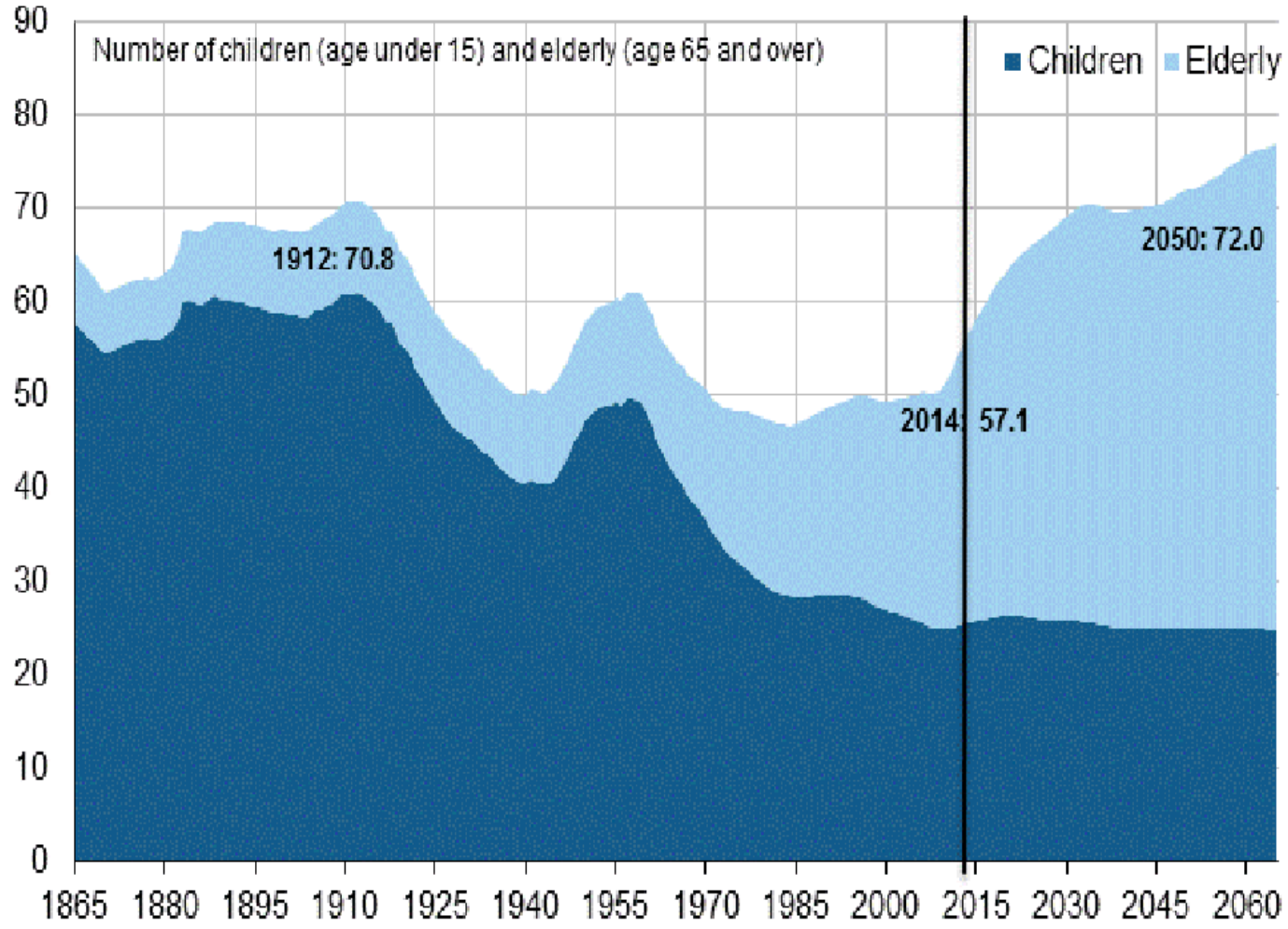
Gender	Females	Males	Females	Males	Females	Males	Females	Males
Country	Canada		China		Germany		Hungary	
1970	1.8	1.3	0.4	0.2	2.4	1.4	1.9	1.1
1990	3.0	1.6	0.8	0.4	5.2	2.2	3.4	1.7
2010	4.9	2.9	1.6	1.1	6.8	3.4	5.3	2.5
2015	5.1	3.3	1.9	1.3	7.2	4.1	5.8	2.8
2030	7.4	5.6	3.4	2.4	9.4	6.6	7.4	3.7
2050	11.8	9.5	10.2	7.8	16.1	12.7	9.4	5.3
Country	Italy		Japan		South Africa		United States	
1970	2.2	1.4	1.2	0.6	0.6	0.3	2.3	1.5
1990	4.3	2.2	3.0	1.7	0.5	0.2	3.7	1.8
2010	7.4	4.2	8.1	4.4	1.2	0.7	4.5	2.7
2015	8.5	5.1	9.8	5.6	1.3	0.6	4.6	2.9
2030	11.5	7.8	15.4	9.8	1.7	0.4	6.3	4.5
2050	18.0	13.1	18.1	12.0	2.9	1.2	9.4	7.3

- Significant increase in most countries (other than South Africa)
- Caused by increased longevity and decreased fertility

Source: World Bank

Statistics Finland http://www.stat.fi/til/vaenn/tup_en.html

Appendix figure 1. Demographic depedency ratio 1865–2065



Importance of the problem

- The aging of society
  - The downside of improvement in mortality and lower fertility
  - In countries with a post World War II baby boom
    - Explosion of LTC needs will emerge in the 2030s
- Demographic and lifestyle changes
  - Smaller and less close families
  - Increased mobility
  - In all countries
- Corresponding increase in demand for caregivers and other support

Financing the need

PUBLIC/GOVERNMENT
National or local

PRIVATE

Social Security
- General tax dollars
- Norway/Scotland
- Inheritance tax

Social Insurance
- Contributory
- Payroll (German/Japan)
- Income tax (Netherlands)
- Medicare (USA)

Private Insurance
- Standalone
- Hybrid Life/Annuity Products
- Benefits
  - Lump sum
  - Periodic
- Conversion from DI Products

Social Assistance / Means Test / Safety Net / Social Care
- Canada
- Medicaid (USA)
- Israel
- UK

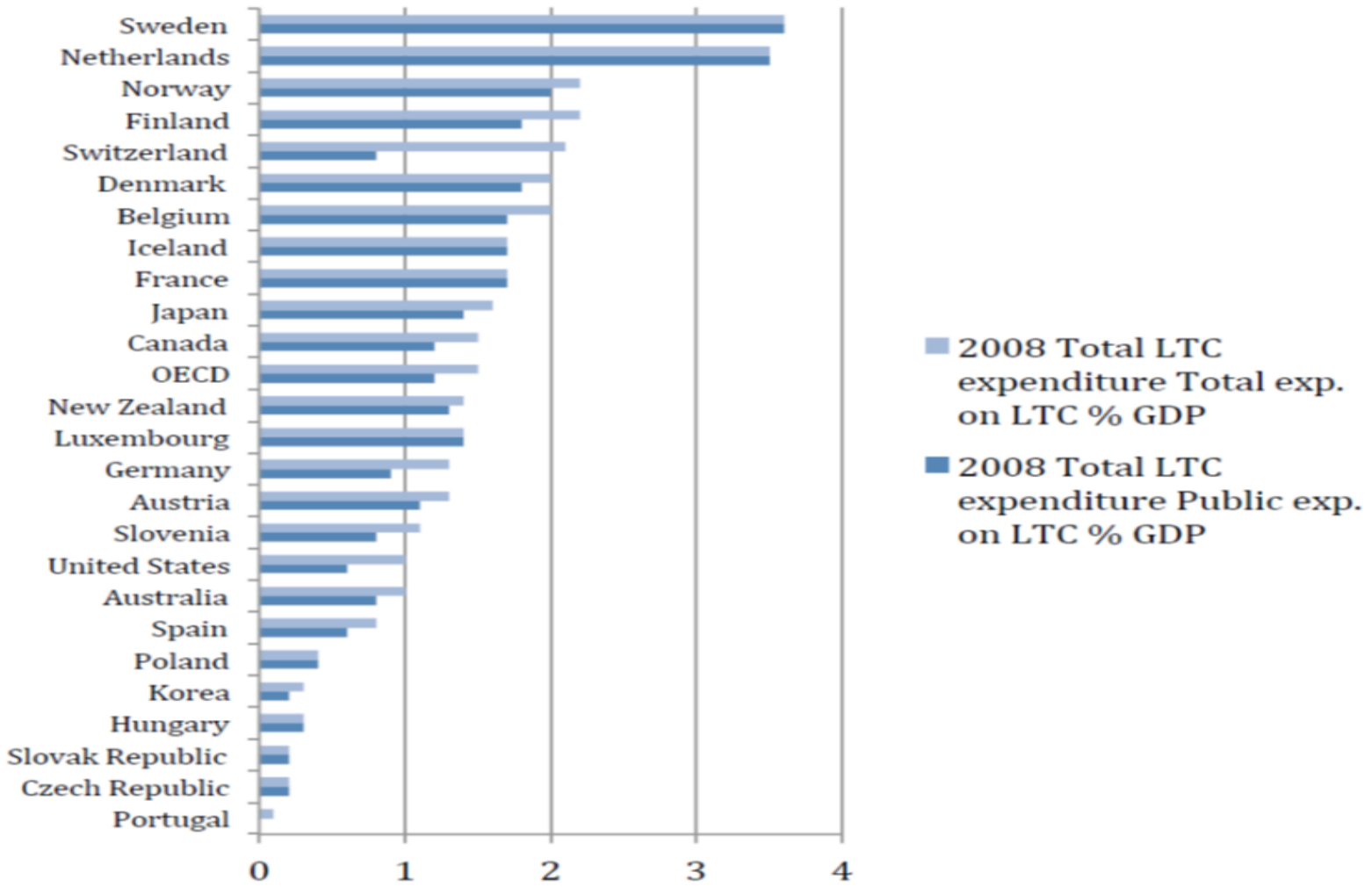
National Healthcare System
- Belgium
- Italy
- Australia

Personal Savings

Home Equity

Family, Friends and Community

Recent expenditures for LTC



Source: OECD Health Data, 2011

Criteria for a LTC program

- Coverage
- Benefit design
- Affordability
  - For individuals and society
- Appropriateness and quality of delivery
- Risk and cost management
- Sustainability of funding
- Avoiding unintended consequences

Have a look at the
Long Term Care report

Long-Term Care

An Actuarial Perspective on Societal and Personal Challenges

http://www.actuaries.org/LIBRARY/Papers/PIWG_LTC_Paper_April2017.pdf

Current Developments in Aging and Mortality

Tuesday, April 18, 2017

Budapest Marriot Hotel

High-age Mortality and Population Heterogeneity

Data, Assumptions and Modeling Issues

Ermanno Pitacco

University of Trieste - Italy

Agenda

- Introduction & motivation
- The ERM framework
- Risk identification: high-age mortality statistics
- Risk assessment: graduation via mortality laws
- Impact assessment: actuarial models and relevant results
- Risk Management actions: product design and pricing
- Conclusions & outlook

Research work, in the framework of the "Old-age mortality project", IAA Mortality Working Group

A thorough presentation that deserves reading in full.

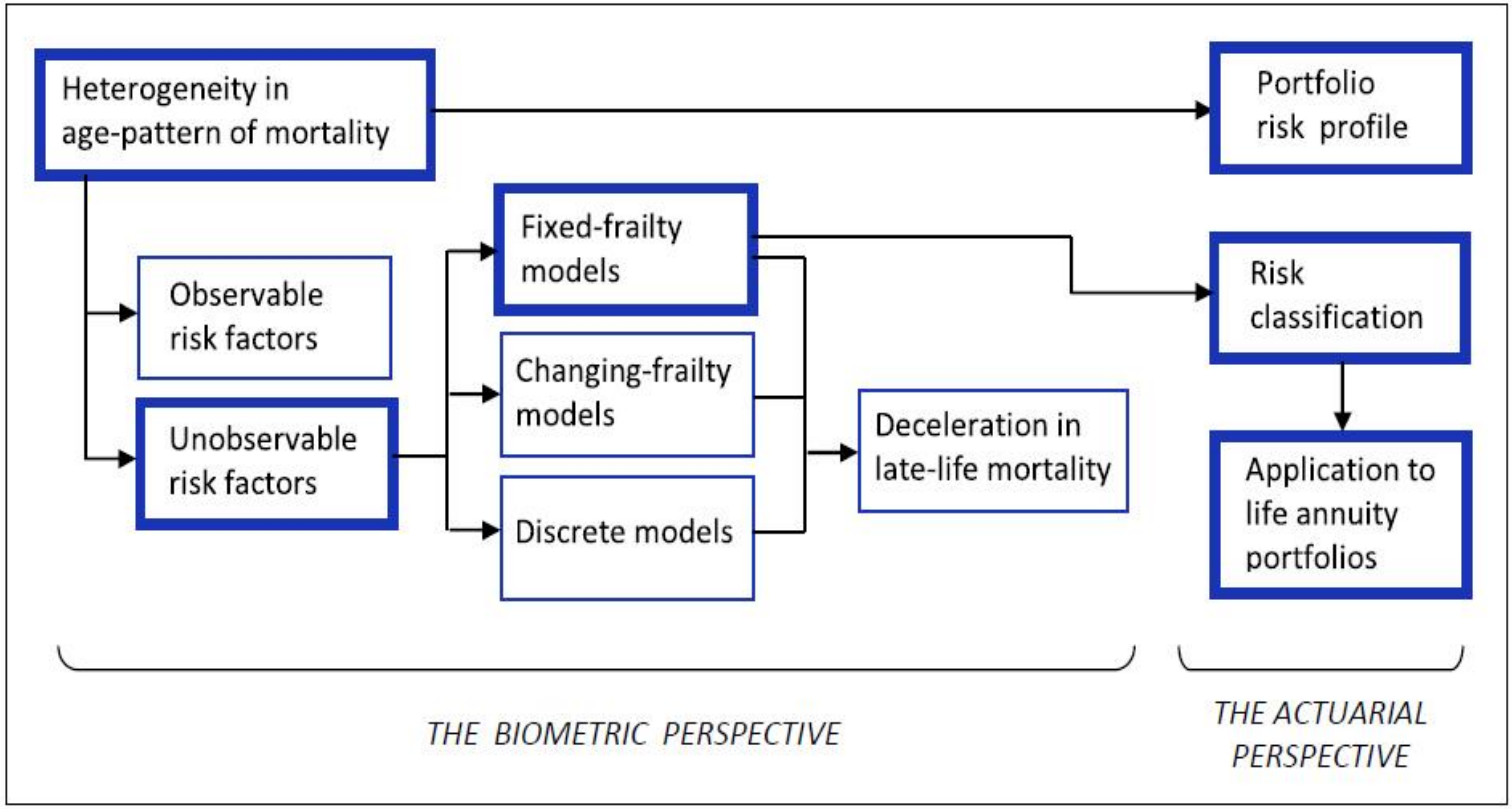
Treatment of high-age mortality is interesting as we have seen underestimation of mortality at high ages

And on the other hand, some have observed “Deceleration”, where the rate of increase in the force of mortality appears to slacken off: The so-called “DECELERATION” in late-life mortality

Ermanno looks at possible causes of this Deceleration.
Using an Enterprise-Based Risk Management approach

Conclusions & outlook *(cont'd)*

To summarize:



“Deceleration” in later-life mortality needs to be recognised and managed

Conclusions & outlook

Various problems in estimating the age pattern of mortality, especially at high ages

A possible cause of deceleration: heterogeneity, due to

(a) mixing several cohorts data (as usual in census observations)

(b) heterogeneity among individuals inside a given cohort, in particular because of individual frailty

From an actuarial perspective:

- disregarding (b) $\Rightarrow$ underestimation of
  - expected values of liabilities ($\Rightarrow$ pricing, reserving)
  - risk ($\Rightarrow$ risk margin, capital allocation)
- conversely, allowing for (b) $\Rightarrow$ suggestions on product design and pricing for life annuities $\Rightarrow$ possible advantages in portfolio risk profile

Current Developments in Aging and Mortality

Seminar: Tuesday, April 18, 2017ummarised for Seminar: Tuesday 23 May, 2017

Determination of Retirement and Eligibility Ages

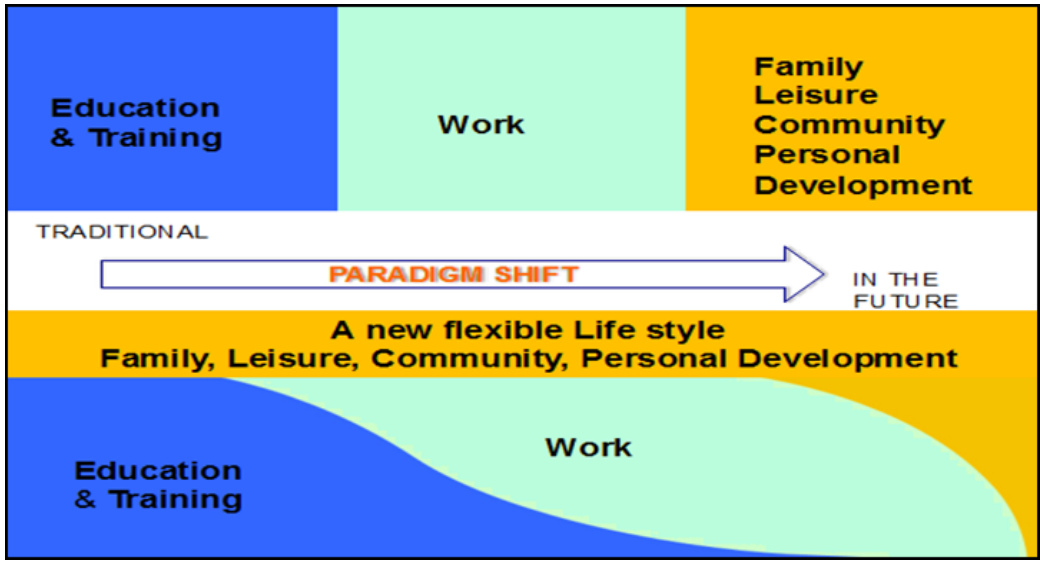
Presenter: Martin Stevenson

Vice-Chair, IAA Population Issues Working Group and former Partner Mercer Australia

Let's start with definitions

- "Eligibility age": the age when an individual is eligible to begin receiving full retirement benefits
  - Social security programs
  - Occupational pension plans
  - Or even defined by tax regulations
- "Retirement age": the actual age when retirement begins
  - Retirement: leaving labour force
- Eligibility age is one of many factors impacting individuals' decisions on when to retire

Life stages paradigm shift



The world of retirement is changing

Considers

Increasing old-age dependency ratios

Pensions systems

Trend to increasing Eligibility ages

Elimination or redesign of generous schemes

Interface with other schemes

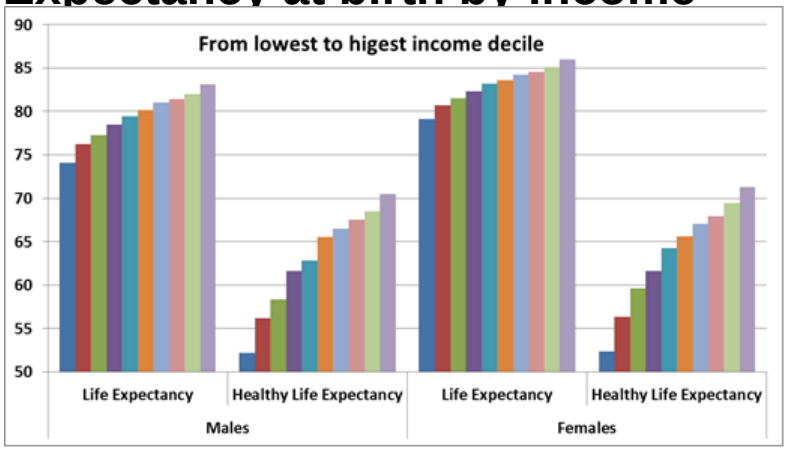
Introduces fairness between
generations
poor/wealthy
Differing jobs

Retirement policy strategies

Consideration for changing a Social Security System

- Inter-generational fairness
- Sustainability
- Actuarial fairness
- Benefit adequacy
- Inter-group fairness

Life Expectancy and Healthy Life Expectancy at birth by income



Each produces a different outcome!

“Opportunities for actuaries in managing the stresses currently arising on retirement income systems.”

What can we do as actuaries?

- Financial analyses at all levels of programs
  - Both technical and policy
- Provide advice to pension plan sponsors
  - Prepare objective forecasts
  - Assist in risk management
  - Address issues of benefit adequacy, sustainability, equity, etc.
- Need to combine a macro-economic view with micro analyses to develop practical solutions
- Promote the use of reasonable assumptions and models to form the basis of policy decisions

Determination of Retirement and Eligibility Ages: Actuarial, Social and Economic Impacts

http://www.actuaries.org/LIBRARY/Papers/PIWG_Retirement_and_Eligibility_Ages_Paper_final_11March2016.pdf

Current Developments in Aging and Mortality

Approaches to inequality (3)

Actuarial Perspectives on Inequality (Seminar)

Tackling the socio-economic longevity gap (MWG)

Tackling the socio-economic health gap (York University)

Current Developments in Aging and Mortality

Seminar: Tuesday, April 18, 2017
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Actuarial Perspectives on Inequality

Assia Billig, FSA, FCIA, PhD

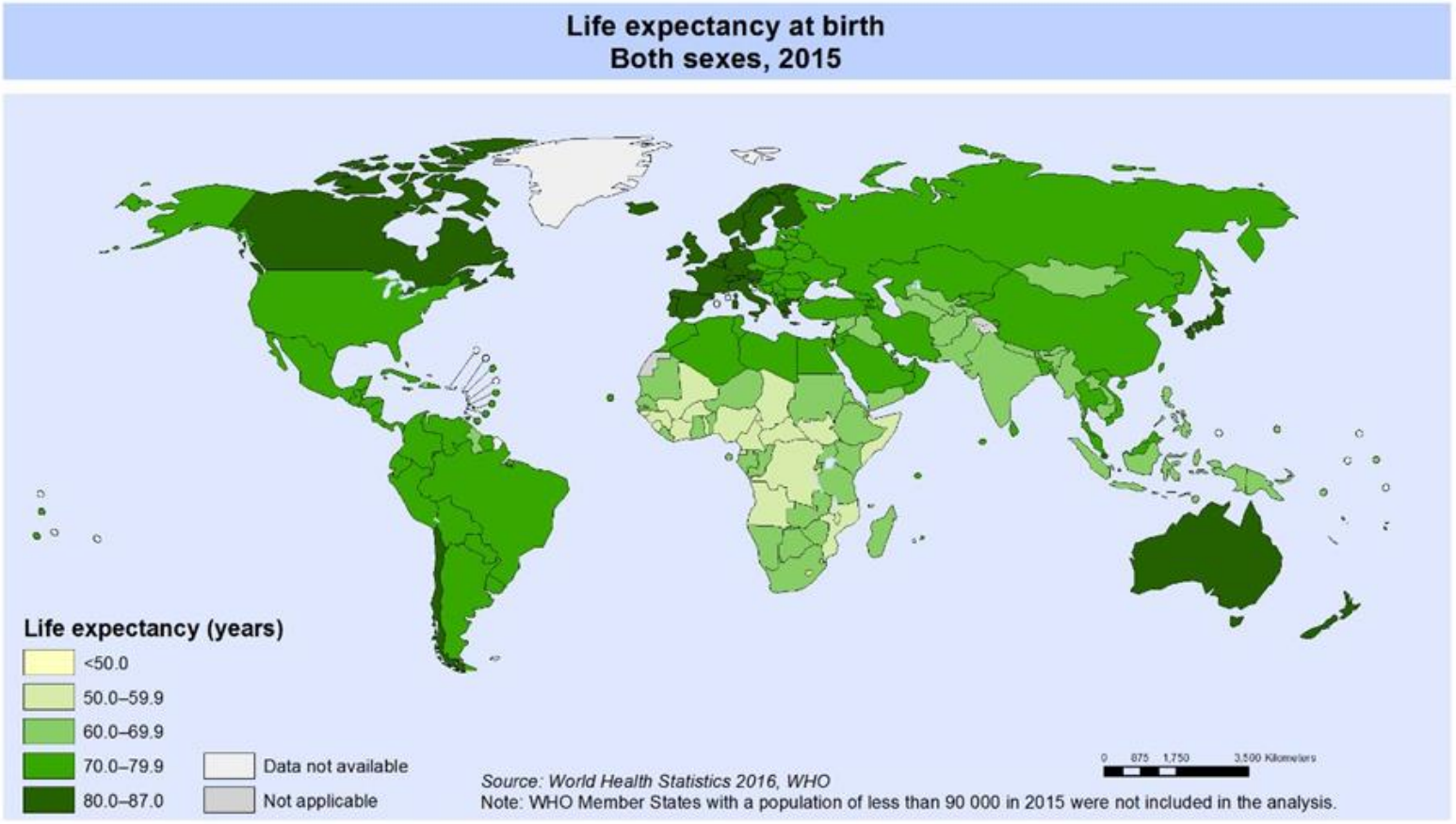
Chair of PIWG,

Senior Actuary, Office of the Chief Actuary, Office of the Superintendent of Financial Institutions Canada

Project by PIWG

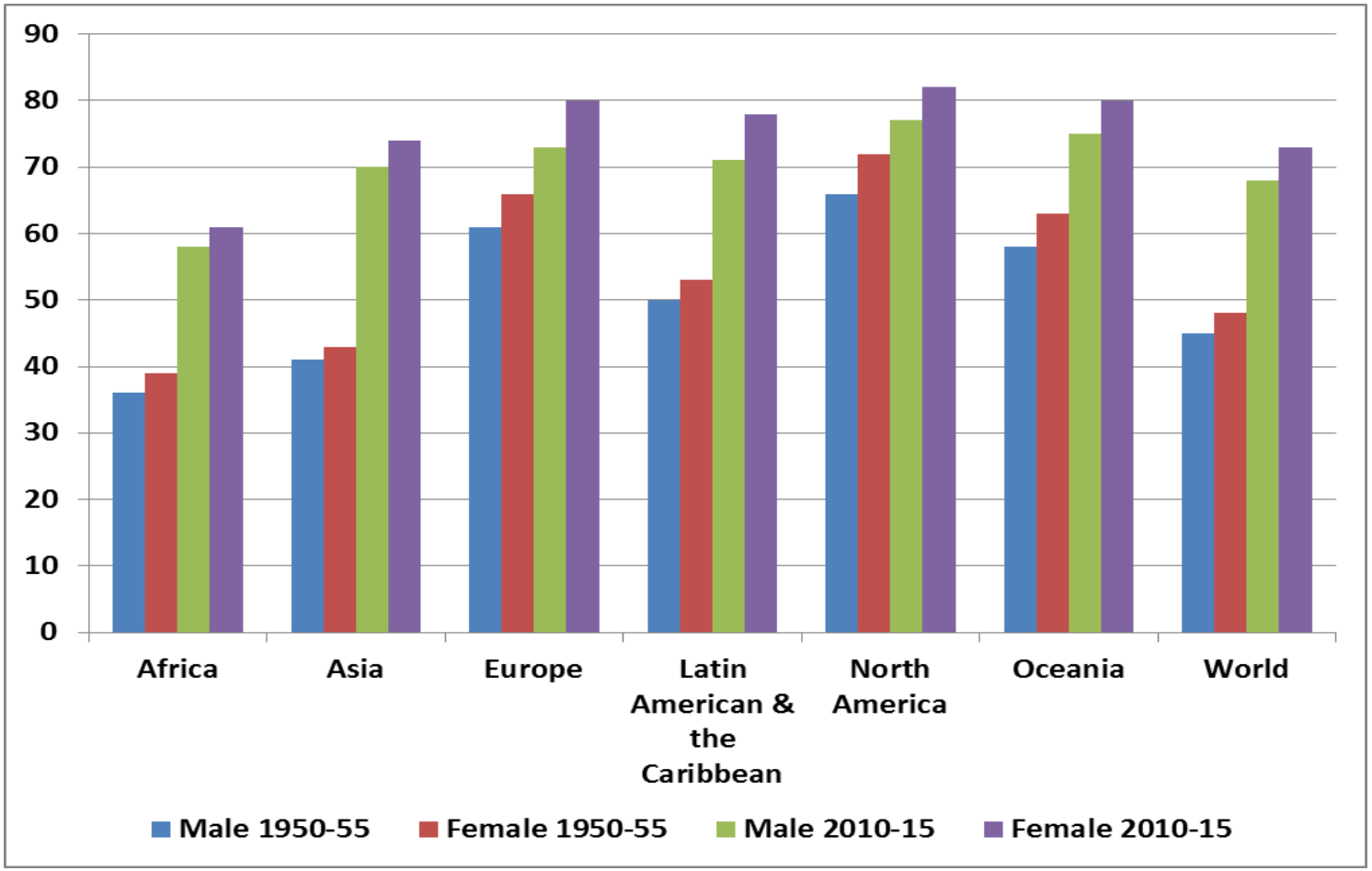
- Project of Population Issues Working Group: “Actuarial Perspective of Inequality”
- Outline
  - General overview of inequality issues
  - Trends in inequality
  - Reflecting inequality in actuarial assumptions
  - Actuarial solutions in the face of inequality
- Why we are addressing this topic?
  - Creating opportunities for individuals and subgroups enhances well-being of societies
  - Actuaries traditionally provide solutions that mitigate individual risks and enhance society well-being
  - Our mandate is the work in public interest.

Inequality in mortality between countries



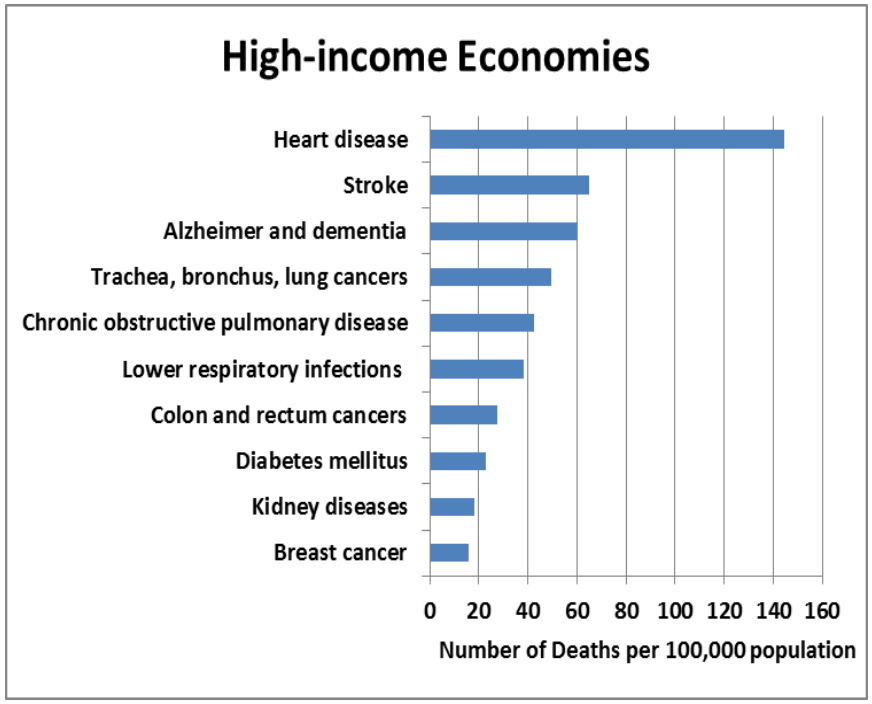
Positive developments mainly due to reduction in maternal and infant mortality

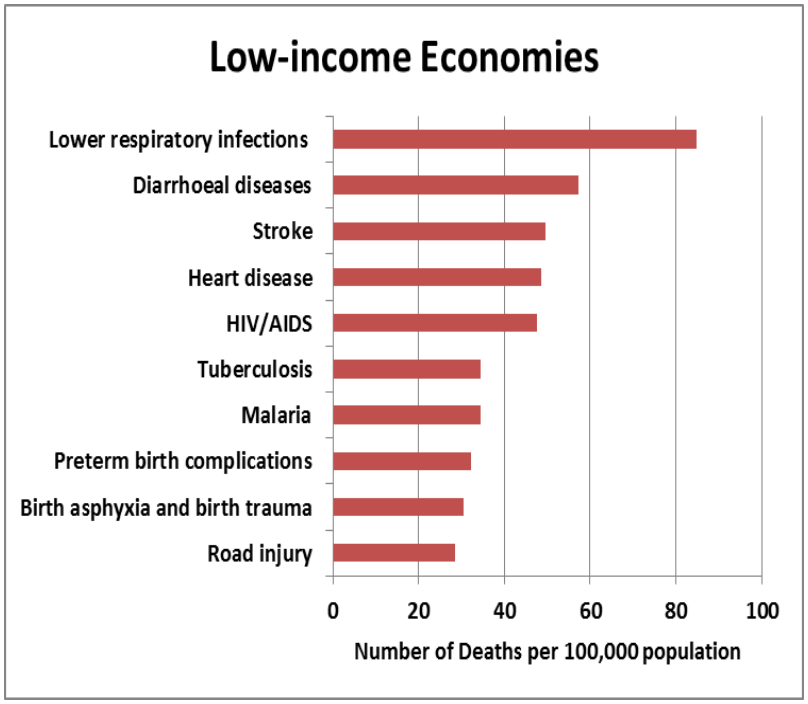
DEVELOPMENT OF LIFE EXPECTANCY FROM BIRTH BY REGION AND SEX OVER THE LAST 60 YEARS



Source: ISSA Demographic Megatrends

Will this trend continue? Causes of death differences between high- and low-income countries





Source: WHO data

- Societal causes of death – crime, pollution, etc.
- How much of medical advances from high-income countries will spread to lower-income countries?
- Humanitarian efforts

Why mortality is different in the same country?

- Mortality outcomes depend on socio-economic status
  - UK (2013): The gap in life expectancy in England between the 10% most affluent areas and the 10% least affluent areas is 8 years.

- Determinants are often
  - Quality of life style
  - Access to medical care
  - Access and quality of education

Why mortality is different in the same country?

- Mortality outcomes depend on socio-economic status
  - UK (2013): The gap in life expectancy in England between the 10% most affluent areas and the 10% least affluent areas is 8 years.
  - *… and the gap in healthy life expectancy is 12 years!*
- Determinants are often
  - Quality of life style
  - Access to medical care
  - Access and quality of education

Paper covers:

Poverty

Cost of Nutrition
Cost of health specialists
Transport to health service

Education

Jobs

Design of social security programmes

Maternity leave
State healthcare systems
Vaccinations, maternal health, schools, child benefit, contingent income, social assistance, universal income

The role of actuaries

Actuaries are well-equipped to work on social care systems

Actuarial involvement needs to increase

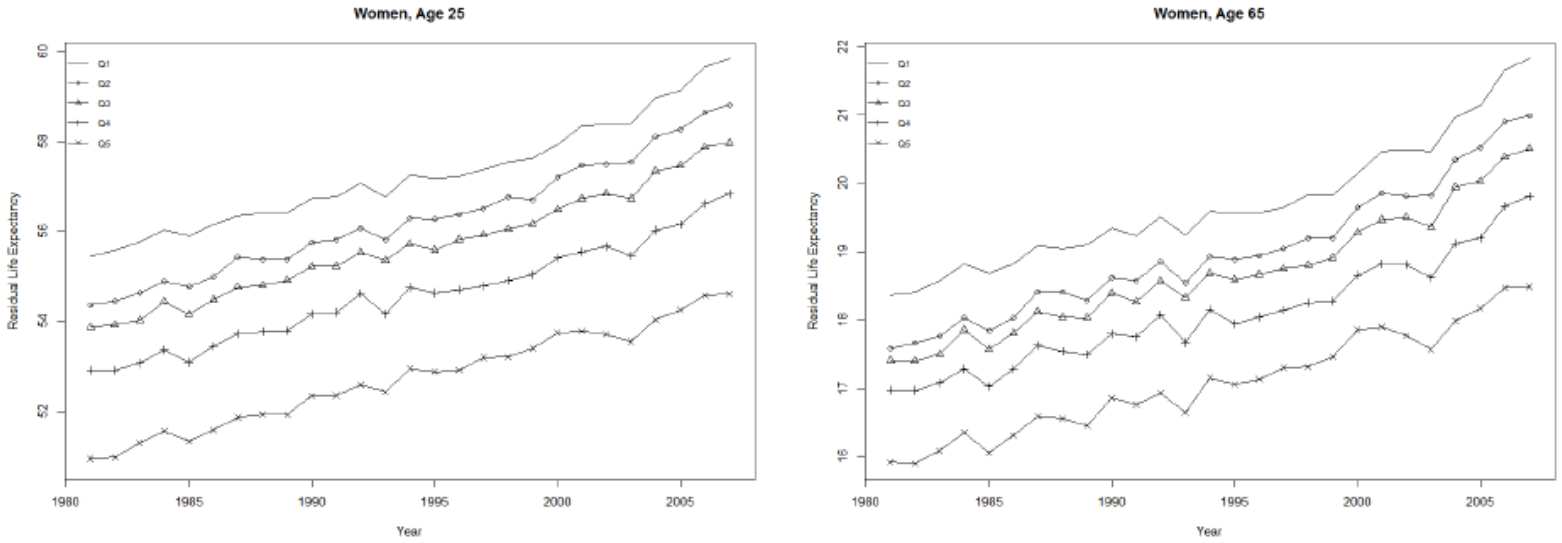
- Actuaries combine “costs” and “benefits” in one analysis
  - These skills could contribute to efforts to reduce inequality
- There are certain areas of social security where actuaries are not widely involved
  - Actuaries should aim at changing this situation
- There is a need for more in-depth inter-branch analysis and design
  - Actuarial expertise for holistic approach is invaluable.

Mind the Gap: A Study of Causal Mortality by Socio-Economic Circumstances

Séverine Arnold
(joint work with Daniel Alai, Madhavi Bajekal and Andrés Villegas)

MWG meeting - Budapest
April 21, 2017

Recent observations



(a) Age 25 (b) Age 65

Figure: Life expectancy, England, females

Summary

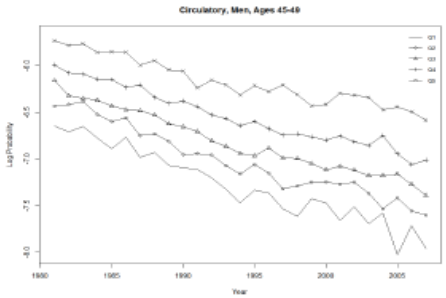
Differences in life expectancy between the lowest and the highest socioeconomic categories have widened over past decades in several countries

Some causes of death have reduced substantially, some have risen

The researchers looked at how reducing/removing a particular cause of death might
a) affect average life expectancy
b) affect the socioeconomic gap

They found that the intervention that most improved average life expectancy actually worsened the socioeconomic gap

Recent observations

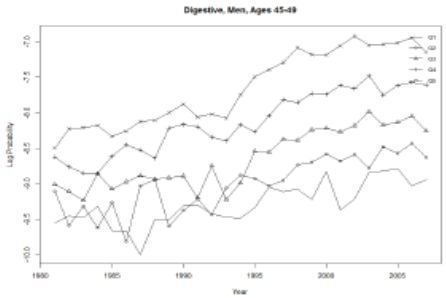


(a) Circulatory system

(b) Neoplasms

(c) External

(d) Respiratory



(e) Digestive

(f) Other

Figure: Log-mortality over time, England, males

Conclusion

The researchers provide a basis to assist government bodies in implementing well-informed strategies aimed at reducing social inequalities.

Decline in **heart disease** mortality:

- Major contributor to increases in life expectancy
- BUT also increases inequalities.

The optimal cause-of-death to target in order to reduce life expectancy gaps changes over time.

- It's crucial to take into account the latest time trends.

To reduce inequalities, **respiratory diseases** need to be targeted as a priority.

WHO target increases inequalities for men

- A more optimal solution would be to target **digestive diseases** instead of **neoplasms**.

Need to choose focus:

- improving population life expectancy
- or closing the gap

You can't have both!

Summary

Interventions aimed at improving average life expectancy by reducing/removing a particular cause of death can further widen the socioeconomic gap

The researchers look at what causes of death would have to be eliminated to produce specific outcomes

The Aim: *(next steps)*

- **What**? Develop a tool that would help policy decisions aiming at reducing differences in life expectancy between socioeconomic categories
- **How**? By developing a model which takes into account the main causes of death for each socioeconomic category.

Mind the Gap

Interventions to improve life expectancy

Need to choose focus:

- improving population life expectancy
- or closing the gap

You can't have both

Mind the Gap
Interventions to improve life expectancy

Need to choose focus:
- improving population life expectancy
- or closing the gap

Unequal Lives:
Breaking the Wealth-Health Link
Interventions to improve healthy life expectancy

Need to choose focus:
- improving population healthy life expectancy
- or closing the gap

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Unequal Lives:
Breaking the Wealth-Health Link

Professor Richard Cookson

Centre for Health Economics
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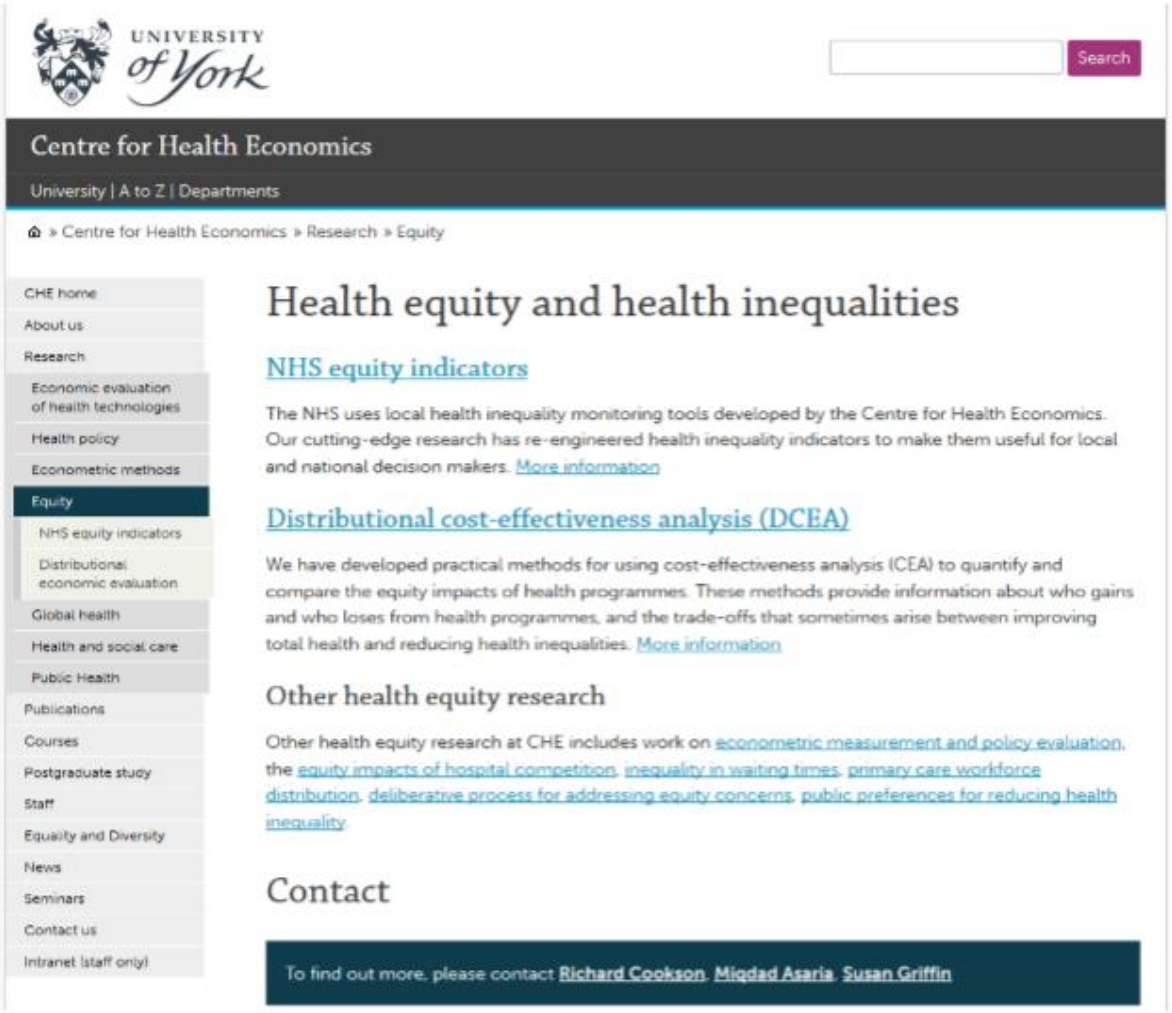
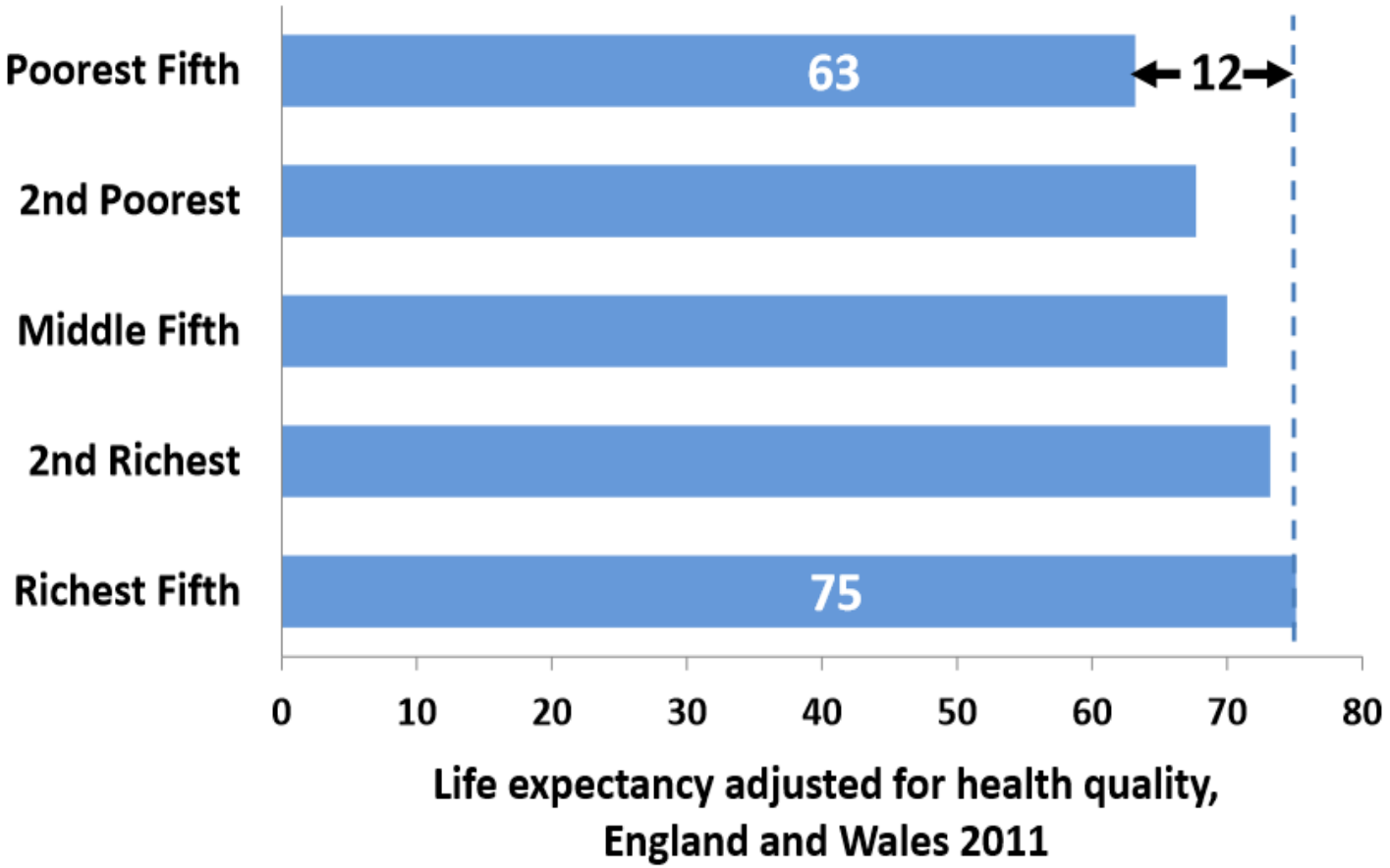


Source: Richard Cookson, Centre for Health Economics University of York

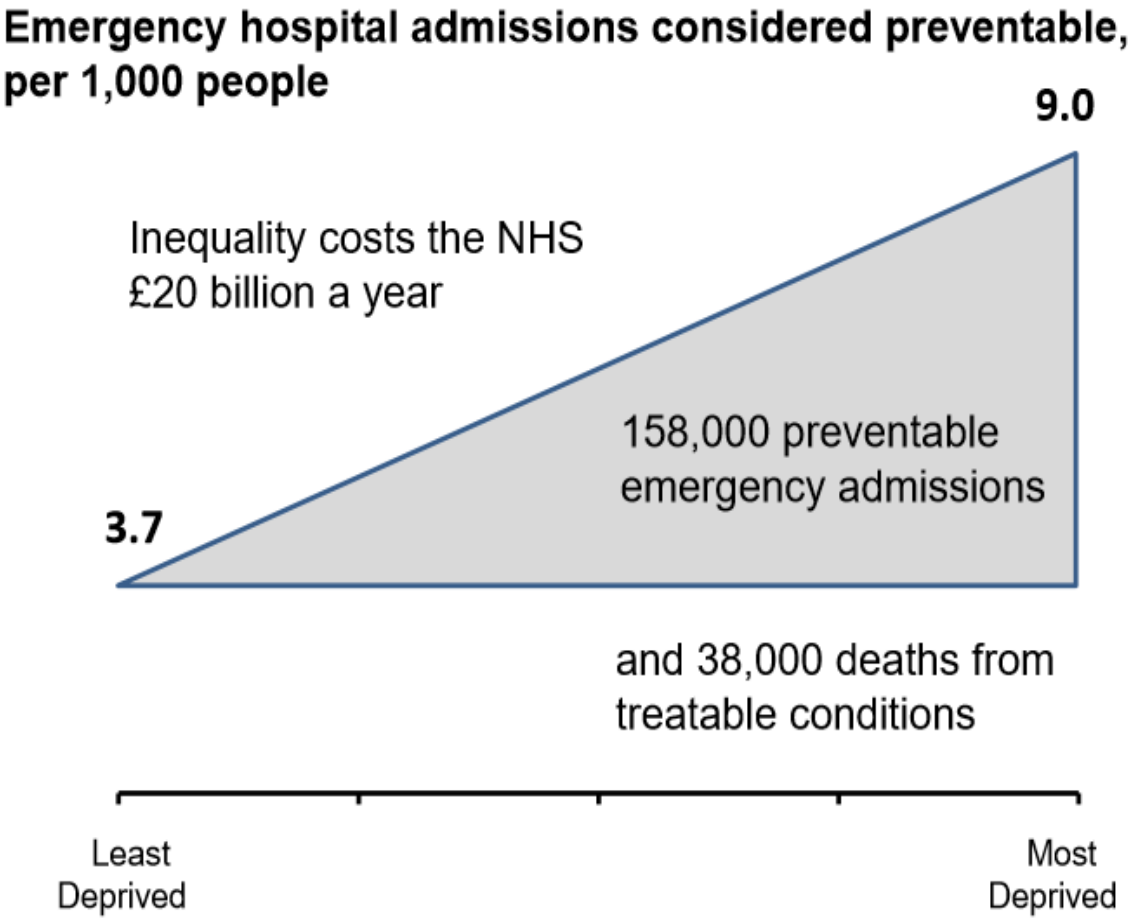
Healthy Years of Life



Source: Love-Koh, J., Asaria, M., Cookson, R., & Griffin, S. (2015). The Social Distribution of Health: Estimating Quality-Adjusted Life Expectancy in England. *Value in Health*, 18(5), 655-662.

Source: Richard Cookson, Centre for Health Economics University of York

Unfair Health Emergencies



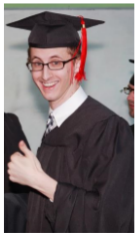
Notes:

1. Admissions for long-term conditions like heart and lung disease, diabetes and dementia
2. *Source:* Hospital episode statistics; England 2011/12; indirectly age-sex adjusted

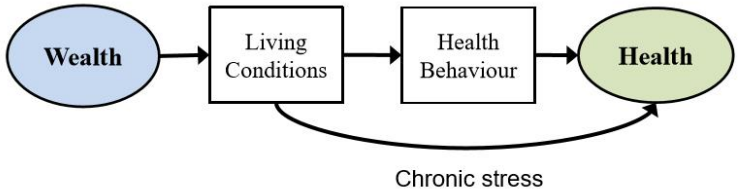
Source: Richard Cookson, Centre for Health Economics University of York

A lifetime perspective on the wealth-health link

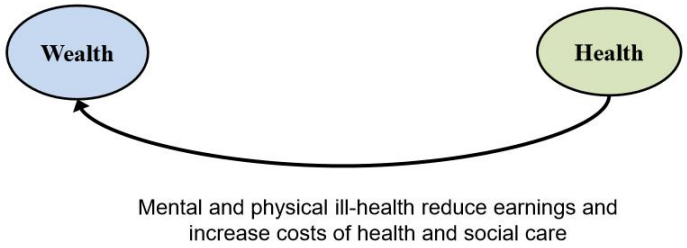
1: Family inheritance and childhood development



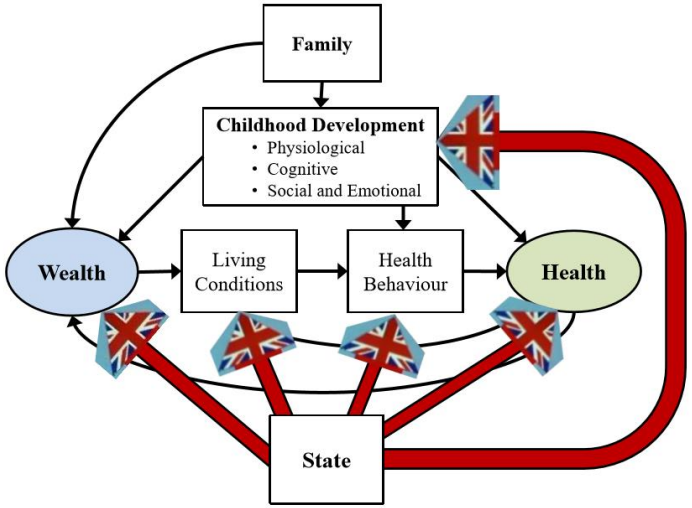
2: Living conditions



3: Ill-health impacts on wealth



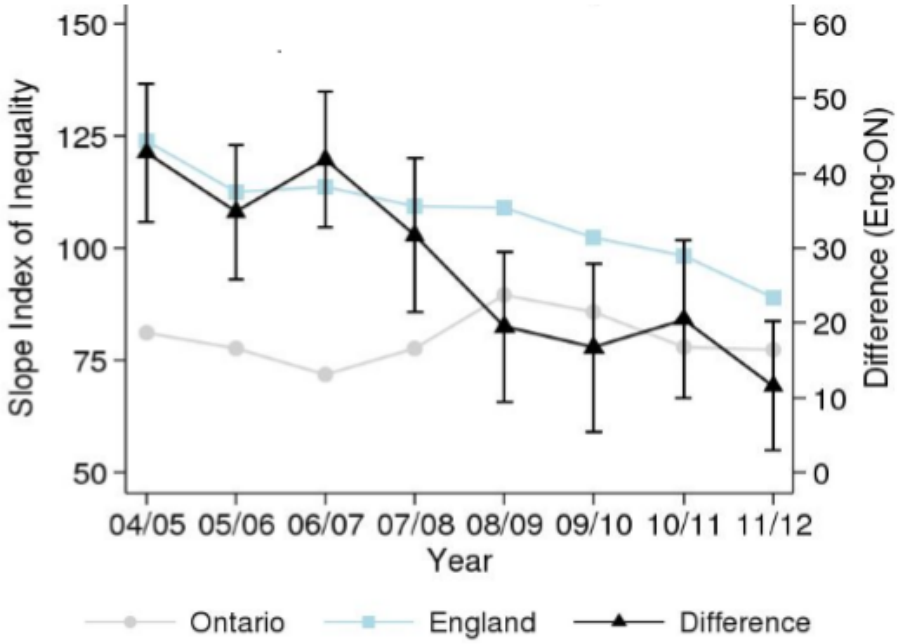
Breaking the wealth-health link



Source: Richard Cookson, Centre for Health Economics University of York

Can the NHS reduce health inequality? Yes it can!

Inequality in mortality amenable to health care
England vs. Ontario, 2004-11



Source: Richard Cookson, Centre for Health Economics University of York

The next steps

Finding Solutions
Equity-informative health economic evaluation

Confronting Trade-Offs
How much do you care about reducing health inequality versus improving total health?

Monitoring Progress
Equity-informative quality assurance

Richard Cookson is at the forefront of efforts to develop new analytical tools to enable 'equity-informative' economic evaluation and quality assurance of health services, and the NHS recently adopted his methods for detailed monitoring of local progress in tackling health inequality.
Public services can use such tools to curb the rising costs of preventable illness associated with inequality and bridge the health divide.

It does work

Source: Richard Cookson, Centre for Health Economics University of York

NHS

NHS success in tackling health inequality varies hugely across England

Researchers find some clinical commissioning groups are much better at tackling health inequalities than others

Sarah Boseley Health editor

Saturday 20 August 2016 07.00 BST

Other developments (3)

Human Mortality Database

Actuarial Research Centre programmes

Drivers of Mortality

Longevity Bulletins:

- Antimicrobial resistance
- Big data in health

HMD Main Menu

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What's New
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Data Availability
Zipped Data Files
Citation Guidelines
Links
Max Planck Institute
UC Berkeley
UC Berkeley Demography
INED
Human Life Table Database
Canadian HMD
General
Contact us

The Human Mortality Database

Vladimir Shkolnikov, ***Director***	Max Planck Institute for Demographic Research
Magali Barbieri, ***Associate Director***	University of California, Berkeley and INED, Paris
John Wilmoth, ***Founding Director***	United Nations and formerly University of California, Berkeley

The Human Mortality Database (HMD) was created to provide detailed mortality and population data to researchers, students, journalists, policy analysts, and others interested in the history of human longevity. The project began as an outgrowth of earlier projects in the Department of Demography at the University of California, Berkeley, USA, and at the Max Planck Institute for Demographic Research in Rostock, Germany (see history). It is the work of two teams of researchers in the USA and Germany (see research teams), with the help of financial backers and scientific collaborators from around the world (see acknowledgements). The Center on the Economics and Development of Aging (CEDA) French Institute for Demographic Studies (INED) has also supported the further development of the database in recent years.

We seek to provide open, international access to these data. At present the database contains detailed population and mortality data for the following 38 countries or areas:

Australia	Finland	Latvia	Slovenia
Austria	France	Lithuania	Spain
Belarus	Germany	Luxembourg	Sweden
Belgium	Greece	Netherlands	Switzerland
Bulgaria	Hungary	New Zealand	Taiwan
Canada	Iceland	Norway	U.K.
Chile	Ireland	Poland	U.S.A.
Czech Republic	Israel	Portugal	Ukraine
Denmark	Italy	Russia	
Estonia	Japan	Slovakia	

For more information, please begin by reading an overview of the database. If you have comments or questions, or trouble gaining access to the data, please write to us (hmd@mortality.org).

Human Mortality Database (HMD) - at risk

- Detailed mortality and population data for 37 countries or areas.
- Open, free, international access
- Two teams of researchers in the USA and Germany.
- Only source of consistent multi-country data.
- 40,000 + users
- HMD working on:
  - Cause of Death analyses
  - US State-level mortality

- Some funding being withdrawn
- New commitments needed to fund new and existing projects

If your company uses it,
it needs your support!

ARC: Actuarial Research Centre

- 2016: Institute and Faculty of Actuaries scaled up significantly its programme of funded and commissioned research
- Funding focus: substantial, long-term research problems
- Shorter term research problems: volunteer working parties
- ARC:
  - vehicle for oversight and delivery of commissioned research
  - development of an international, virtual network for actuarial researchers with specific interests in applied actuarial research
  - Objective: *research with impact*

Source: Andrew J.G. Cairns Director, Actuarial Research Centre, IFoA
Heriot-Watt University, Edinburgh

ARC: Actuarial Research Centre (cont.)

Major funded research programmes (2016-2020/21):

- Use of Big Health and Actuarial Data for Understanding Longevity and Morbidity
  - The development of new statistical and actuarial methods in the use of Big Data, in the context of health and wider applications
- Modelling, Measurement and Management of Longevity and Morbidity Risk
  - A new generation of mortality and morbidity models, with a specific focus on the drivers for mortality
- Minimizing longevity and investment risk while optimising future pension plans
  - Future pension products that meet customer needs, balancing stability, performance and cost

Drivers of Mortality – in progress

Authors (10)	Countries (7)
Assia Billig	Canada
Simon Brimblecombe	UK
Mathew Edwards	UK
Michael Eves	Switzerland
Sam Gutterman	US
Al Klein, Chair	US
Mika Mäkinen	Finland
Darko Medved	Slovenia
Lars Pralle	Germany
Marianne Purushotham	US

Drivers of Mortality

11 Key Broad Drivers	
Aging	**Lifestyle**
Catastrophes	**Medical advances**
Diseases	**Political**
Environmental	**Technological advances**
Healthcare/medical care	**What we don't know today**
Inequality	

What Paper will Cover

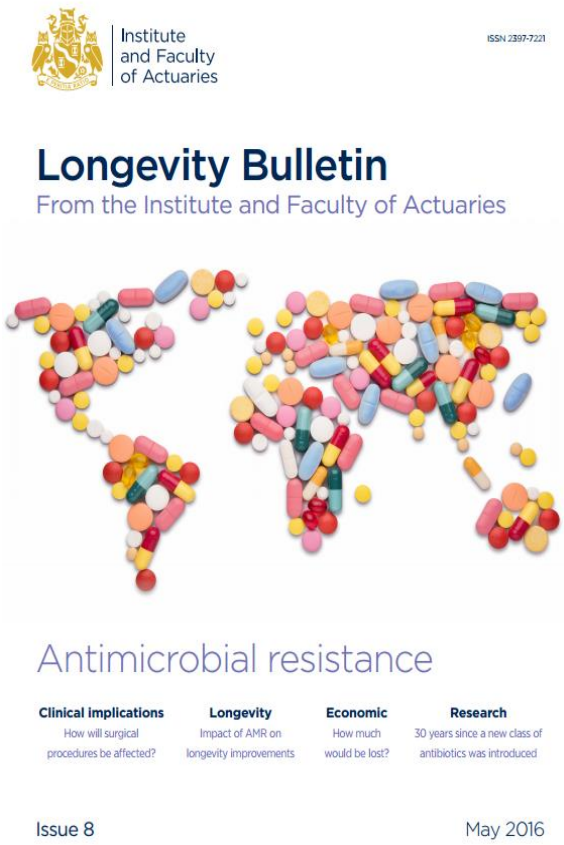
- An overview
- A discussion of each driver
  - History of the driver and the current situation
  - Discussion on how future drivers will impact both:
    - Developed countries
    - Developing countries
- Considerations on how to quantify drivers
  - May be most difficult task

Longevity Bulletin
Antimicrobial resistance

INTERNATIONAL ACTUARIAL ASSOCIATION
ASSOCIATION ACTUARIELLE INTERNATIONALE

Antimicrobial Resistance

Longevity bulletin Antimicrobial Resistance edition, May 2016



Contents, inter alia –

- How resistance emerges
- Clinical implications
- Basic facts
- Economic implications
- Current developments
- Research into new antibiotics
- Case study

Antimicrobial resistance 2050

estimates. Ivo Holanec IFoA

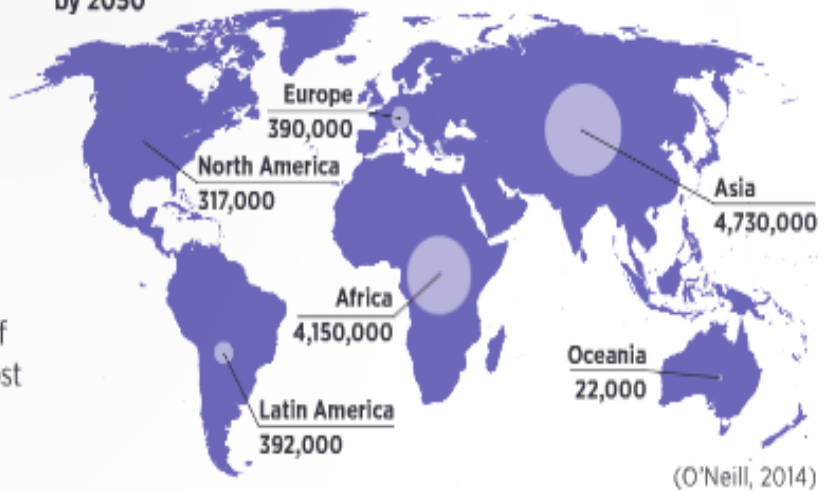
Economic and human consequences

The human consequences of increased antibiotic resistance are mainly higher mortality in patients with resistant infections, increased length of hospital stays, and higher treatment costs for resistant infections.

In 2050 the deaths attributable to antibiotic resistance would be approximately 10 million per year as seen in Figure 6. Comparison to other major causes of death can be seen in Figure 7.

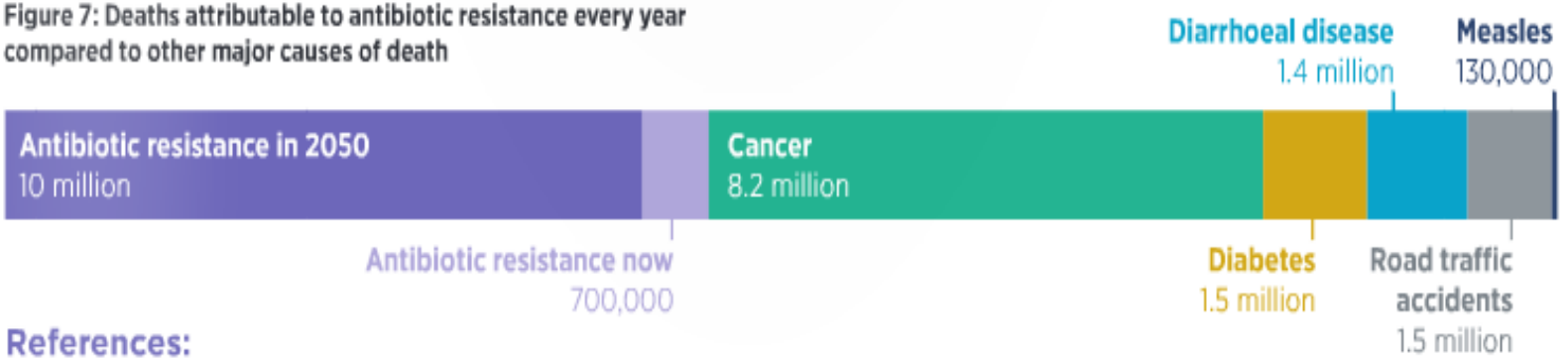
Deaths from antibiotic resistance would result in a reduction of 2% - 3.5% in GDP, costing the world up to £66 trillion due to lost productivity (O'Neill, 2014).

Figure 6: Deaths attributable to antibiotic resistance every year by 2050



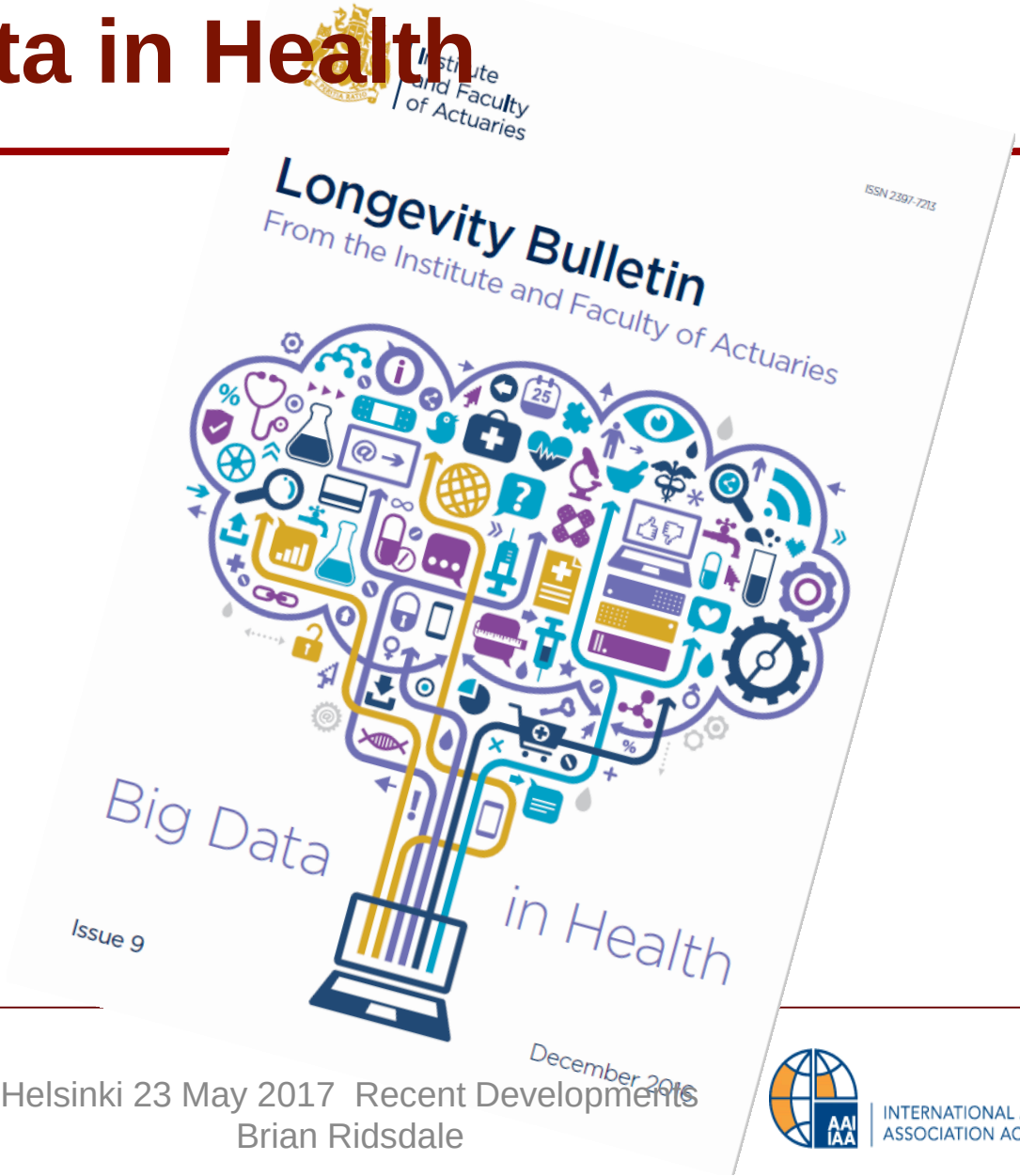
(O'Neill, 2014)

Figure 7: Deaths attributable to antibiotic resistance every year compared to other major causes of death



References:

Longevity Bulletin
Big Data in Health



INTERNATIONAL ACTUARIAL ASSOCIATION
ASSOCIATION ACTUARIELLE INTERNATIONALE

Subjects covered

- About the IAA Mortality Working Group (MWG)
- Recent developments in mortality and longevity
  - Seminar, Current Developments in Aging and Mortality – Budapest (MWG and Population Issues WG)
  - Older ages (80 plus): 3
  - Approaches to inequality: 3
  - Other: 3
- Discussion

Sources hyperlinked in pages

Thank you!

Recent developments in mortality research

Brian Ridsdale

Chair, IAA Mortality Working Group (MWG)

Tues 23 May 2017, Helsinki

br@ridsdales.com