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Longevity Bulletin

From the Institute and Faculty of Actuaries

Longevity: is the tide turning?

Issue 10

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Contents

1. Introduction

In high-income countries, life expectancy has increased steadily for decades, with only a few exceptions – for example, during times of war or pandemics. However, the rate at which life expectancy is improving in the United Kingdom has slowed significantly in recent years. The drivers behind this change are still being debated and possible explanations include an increase in deaths due to dementia and Alzheimer's disease. If it continues, this trend could have a significant impact on pension funds and insurers, as well as policymakers and government.

It gives me a great pleasure to introduce the tenth issue of the Longevity Bulletin, which examines this topic. This jointly published edition with Society of Actuaries (SOA) and Canadian Institute of Actuaries (CIA) outlines trends in life expectancy across the United Kingdom, United States and Canada. It also discusses the relationship between health spending and life expectancy, and provides an overview of the Continuous Mortality Investigation's updated projection model.

I wish to thank all contributors and authors for their thought-provoking and informative articles. I hope that this issue will appeal to all those with a technical, professional and personal interest in longevity, ageing and population change.

Marjorie Ngwenya
President, Institute and Faculty of Actuaries

Measuring changes in life expectancy is a core topic of interest for the actuarial profession and also one of the most challenging to estimate. The CIA is pleased to collaborate with the IFoA and other partners on this Longevity Bulletin.

In this edition, CIA member Damien Lapointe Nguyen contributes to an article examining recent changes in life expectancy in the United Kingdom, United States and Canada. Of note are the impact factors such as the increase in opioid overdoses and recent flu outbreaks, but the recent financial crisis also seems to play a role.

I encourage you to read this and the other articles in this edition. The CIA welcomes the opportunity to contribute to a greater understanding of this issue.

Sharon Giffen
President, Canadian Institute of Actuaries

The work of actuaries helps shape the perspectives and concepts on longevity and aging. As actuaries we are relied on for our knowledge of data, models and analysis. Life expectancy and mortality are one of several important areas involving our profession and also impacting society.

Members from each of the partnering organisations contributed to this publication, as we share both unique and relatable experiences involving longevity. It is good to see our actuarial organisations continued efforts to advance insights and to discuss how to inform and help the public understand longevity. Thank you to everyone involved with these efforts.

Jeremy J. Brown
President, Society of Actuaries

2. Summary

Joseph Lu, Chair of the IFoA's Mortality Research Steering Committee

2015 saw the largest yearly rise in deaths, at 5.4%, in half a century in the UK. This prompted much debate in the media about the harm of funding cuts on elderly care following the financial crisis in 2007/8. The recent levelling of death rates in pensioners (Figures 1 and 2) means that important decisions may be for longevity forecasts used in modelling pension funds and annuities

These show that the celebrated fall in death rates since World War II, as the result of improvements in medical, working and living conditions, cannot be taken for granted. In this Longevity Bulletin, we have taken an international and multidisciplinary approach to explore if the tide of falling death rates is turning.

For the older population, the fall in mortality rates has slowed down or levelled off, leading to a slowdown in the average annual rise in life expectancy at age 65 in the UK, US and Canada since 2011. For example, the UK's average annual rise in life expectancy at age 65 was 2.1 months over 2000-2011, falling to 0.4 months after 2011 as shown in Table 1. The authors explore potential reasons for the drag on life expectancy increases including public spending policies, flu epidemic, weather, data irregularities and environmental shock. On balance, the spotlight is now on the potential role of austerity following the 2007/8 economic crisis in slowing down the rise in life expectancy.

However, establishing the causes of the reduced pace in the rise of life expectancy requires more research. Analyses at population level can potentially hide important life expectancy trends of people in different socio-economic groups within each country. Further studies of sub-populations will be useful to understand the impact of austerity to inform policy and actuarial decisions.

Figure 1: Male standardised mortality rates relative to 1991 (England and Wales) (CMI 2016)

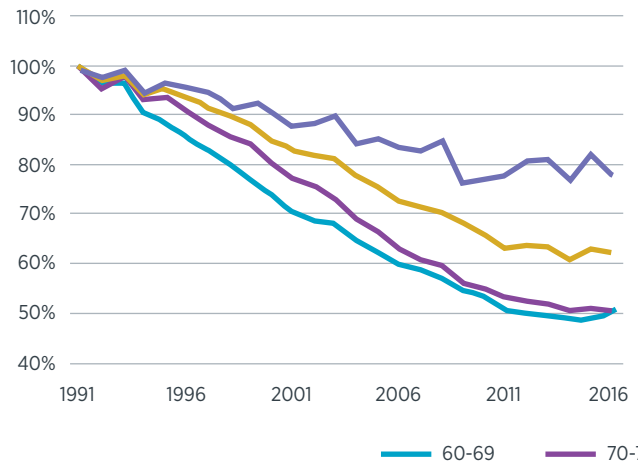

Figure 2: Female standardised mortality rates relative to 1991 (England and Wales) (CMI 2016)

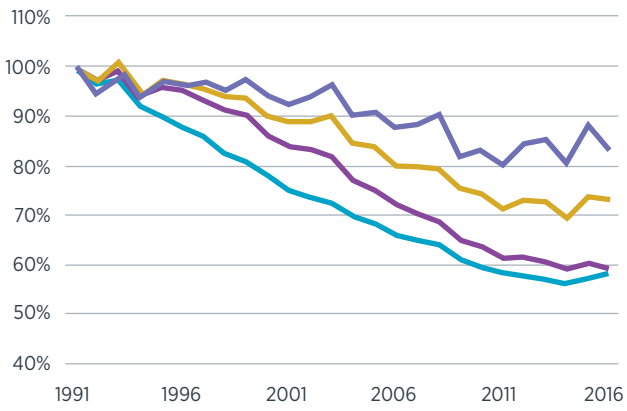

Table 1: Fall in annual rise in life expectancy age 65 (data from the National Center for Health Statistics (NCHS) and Office of National Statistics (ONS))

	Average annual rise in life expectancy age 65 2000-2011	Average annual rise in life expectancy age 65 2011-2015	% fall between pre- and post-2011
UK	2.1 months	0.4 months	88%
US	1.75 months	0.6 months	66%
Canada	2.1 months	0.4 months	80%

The tide has turned for some people. Since 2011, mortality rates have risen in the US white working age population aged 25-64, reversing decades of falling mortality. The increase in death rates among US white males has been linked to the rise in substance abuse and suicides. Policy makers in the US are looking into how to prevent drug abuse. Life and health insurers should watch this trend of rising death rates because it could mean rising claims.

International comparison of 35 OECD countries shows that life expectancy at birth increases with spending on health care per person (OECD, 2016). However, this benefit in life expectancy diminishes after the spending on health exceeds about $3,000 per head. For example, the US spent about $9,500 per person on health care but had life expectancy equivalent to countries that spent $2,000-3,000 per person in 2014.

The average annual growth, after allowing for inflation, in the spending for the UK's National Health Service (NHS) in the period between 1978/79 and 2010/11 was 3.8% p.a. This figure has fallen to 1.5% p.a. in the period between 2010/11 and 2015/16, as part of austerity measures (HM Treasury, 2016). This is lower than the estimated 3.5% p.a. growth, above inflation, required to meet the challenges of an ageing population with rising medical costs. Emerging anti-microbial resistance could be fatal and further strain the health care system, increasing mortality rates in the population. Further NHS funding and increased productivity may be required to meeting these increasing demands.

These observations of slowdown in elderly life expectancy and rising death rates of some younger populations seem gloomy. There may be further gloom in store from the continuing problems of obesity and diabetes, with substantial implications for cardiovascular and cancer mortality in the short term and, very likely, Alzheimer's in the longer term. However, improvements in health behaviour, technology and medical sciences could still reduce mortality rates further. In response to the relatively rapid change in mortality experience and potential future volatility, the Continuous Mortality Investigation (CMI) has improved its widely used Mortality Projection Model in various ways. The new model allows the users to more flexibly incorporate recent experience for the purpose of future projections.

The jury is still out on whether the tide is turning for human longevity. The rising mortality rates among US working age demonstrates that the historical fall in mortality rates cannot be taken for granted. The pace of life expectancy gains of older ages has slowed down, with some age groups showing signs of increasing death rates. These signs should be taken as warnings that worsened health care, behaviour and environment can reverse decades of success in health and longevity. Actuaries need to have a better understanding of the drivers of longevity to consider how to incorporate recent experience into forecasts of future longevity.

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3. Current changes in life expectancy

Introduction

This article discusses current changes in population life expectancy in the UK, US and Canada. It attempts to explain what has happened since 2011 in the UK, and over a similar period in the US and Canada. While it is not possible to prove causal relationships, instead this article offers plausible explanations that are supported by the available data and research.

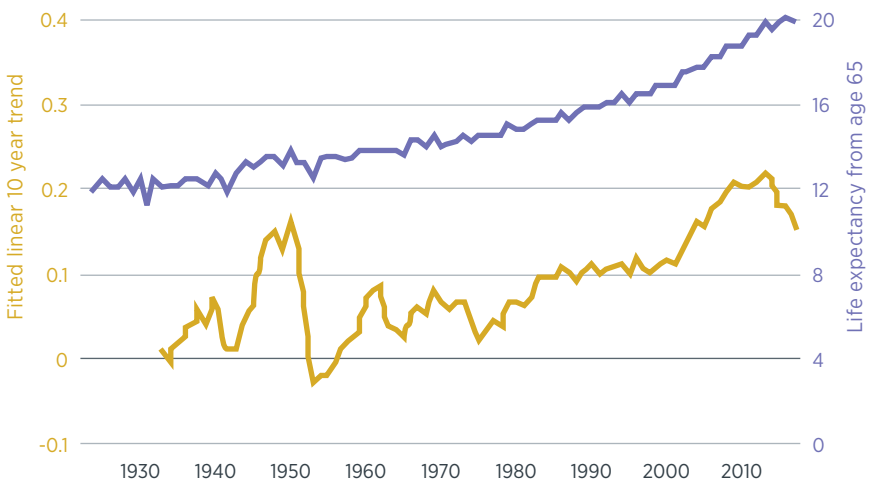
This article does not cover how insurance and pension scheme mortality may differ from overall population mortality, although this is an important consideration for (re)insurers and pension scheme trustees and sponsors. The factors that are discussed here are still relevant for the insured and for pension schemes members.

United Kingdom

Chris Falkous, Biometric Research Actuary, RGA UK

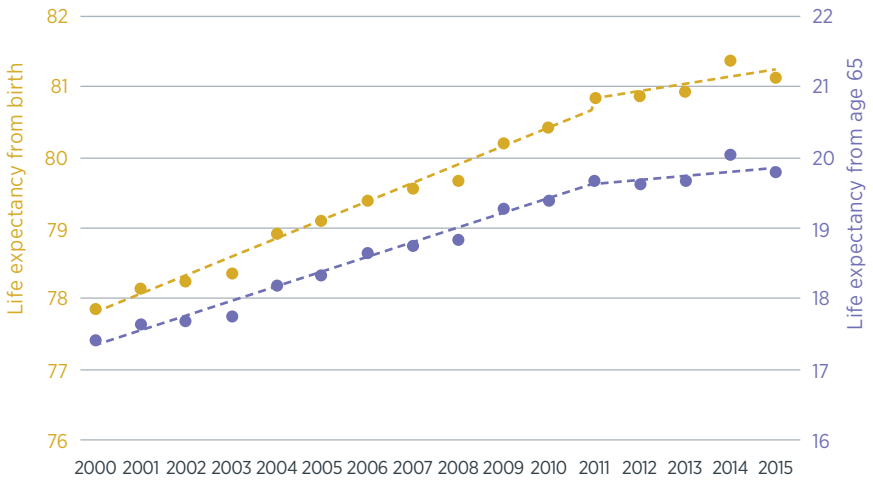
Life expectancy in the UK has increased significantly over the last century. Figure 3 shows life expectancy in England and Wales at age 65 each year since 1922, together with the estimated underlying trend in the increase in life expectancy each year, derived by fitting a linear trend to life expectancy over the preceding decade.

Figure 3: England and Wales period life expectancy at age 65, males and females combined, 1922 to 2015 (data from the Human Mortality Database (HMD) and Office of National Statistics (ONS)), and rolling fitted linear 10-year trend.



It is now widely acknowledged that population mortality improvements in the UK have slowed significantly since 2011; the causes behind this change are still being debated. Figure 4 shows the impact that this change in mortality experience has had on life expectancy in England and Wales.

Figure 4: England and Wales period life expectancy at birth and age 65, males and females combined, 2000 to 2015 (data from HMD and ONS)



The trend in the increase in life expectancy at birth fell by approximately two-thirds, from approximately 3 months per year on average over 2000-2011 to approximately 1 month per year on average over 2011-2015.

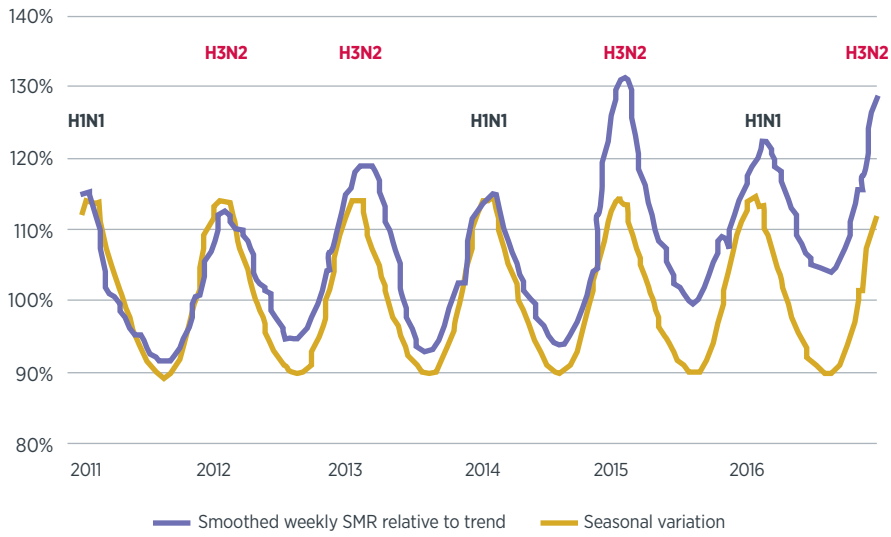


Figure 5: Smoothed, weekly standardised mortality ratio for England and Wales, relative to 2005-2011 seasonal trend (data from ONS and CMI)

It is instructive to consider the temporal pattern of excess mortality since 2011. Figure 5 shows smoothed, weekly standardised mortality ratios calculated consistently with the method described in CMI Working Paper 83 (CMI, 2015) relative to an exponential trend fitted to the period 2005-2011, and is annotated to show the dominant strain of influenza A circulating in each winter (Public Health England, 2016).

Recent winters where the dominant flu strain was H3N2 have seen higher mortality than would be expected based on recent trends. The exception is winter 2011/12, which was relatively mild; even though the dominant circulating flu strain was H3N2, there was exceptionally low flu activity. The H3N2 strain of flu tends to affect the elderly more than the young, whereas the strain H1N1 tends to affect the young more than the elderly.

Despite relatively average temperatures, winter 2014/15 was particularly bad with a mortality spike in January 2015. The mortality spike is thought to be due, in part, to the low effectiveness of the flu vaccine that season (ONS, 2015). The 2014/15 winter saw high levels of mortality at older ages across many European countries (Mølbek, et al., 2015).

The 2016/17 winter that we have just experienced has again seen the H3N2 flu strain circulating and indications are that England and many European countries have experienced high mortality, particularly in those over age 65 (Euromomo, 2017).

Figure 5 also shows that increased mortality has not just occurred during winters. Starting with 2012, higher mortality has been seen throughout each calendar year compared to what would have been expected based on recent trends. The higher mortality seen in 2012 was mainly in those over age 80, resulting in a fall in old-age life expectancy that was also seen widely across Europe (Public Health England, 2015).

As has been widely reported, 2015 saw exceptionally high rates of mortality, resulting in life expectancy at birth and at age 65 falling by approximately 3 months.

Causes of death

The next source of information that it is instructive to examine is cause of death data provided by the ONS.

As shown in Figures 6 and 7, the most obvious change in recent cause of death trends is the significant increase in dementia deaths.

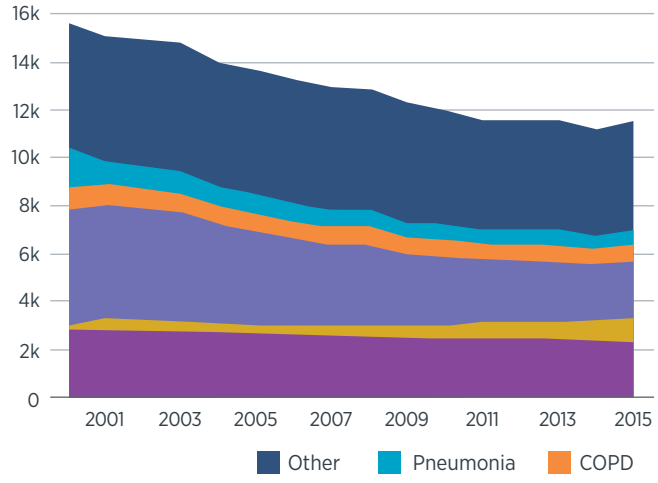


Figure 6: Age-standardised mortality rates per million, England and Wales, males (data from ONS)

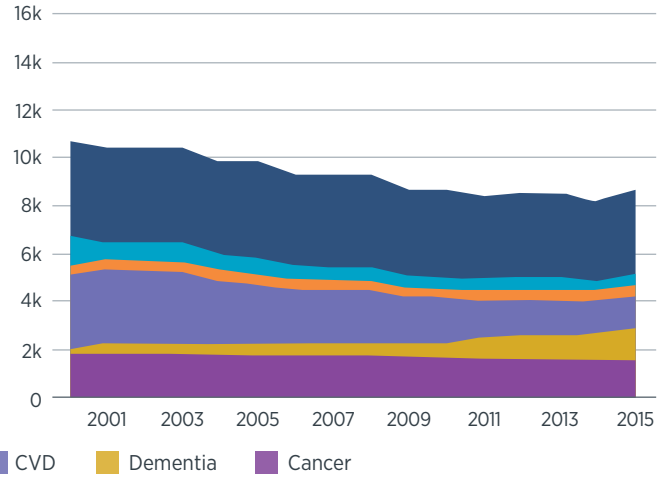


Figure 7: Age-standardised mortality rates per million, England and Wales, females (data from ONS)

Part of the increase in dementia deaths trend is because dementia was often not recorded as the cause of death historically. The increase in trend is also confounded by coding changes, and by financial incentives encouraging early diagnosis of dementia.

Most of the increase in life expectancy in the decades to 2010 can be attributed to strong improvements in mortality from cardiovascular diseases (CVD). However, over the last few years there has been a gradual slowdown in CVD improvements , which is consistent with what many life (re)insurers assumed would happen as long-term drivers fell away, such as the impact of smoking cessation and the rollout of effective medical treatments. These longer-term, slower-acting drivers, together with negative drivers like increases in obesity, are likely to be acting as a headwind slowing down improvements, but they are unlikely to be the cause of such a large fall in life expectancy trends in such a short period of time.

Overall, worsening UK mortality experience has been seen at most ages, but particularly at old ages. Those over 85 experienced a deterioration in mortality rates between 2011 and 2015. Below age 85, most ages still saw an improvement in mortality between 2011 and 2015, albeit at generally slower rates compared to previous years.

Human Mortality Database data through to 2015 are available for four European countries. This data shows Portugal has seen a broadly similar slowdown in increases in life expectancy from around 2011 compared to the UK. Germany also saw relatively little improvement in life expectancy from 2011, although its life expectancy trend has been slightly less consistent since 2000. Belgium saw a slowdown from 2011 in life expectancy from age 65 but little change in the trend in life expectancy from birth. Finland has experienced a slowdown in life expectancy from age 65 since 2008, but little change in the trend in life expectancy from birth.

HMD data through to 2014 are available for Ireland and Spain. Whereas Ireland has experienced a similar slowdown in life expectancy increases since 2010 compared to the UK, there has been little change in the trend in life expectancy improvements in Spain since 2000.

UK Discussion

When considering the significant spike in population mortality in January 2015, Hiam, et al. (2017) note four possible causes:

- Data artefact
- Environmental shock
- Major epidemic
- Widespread failure of health and social care system

They did not find data artefact to be a plausible explanation and no major environmental shocks have occurred in the UK.

In terms of infectious disease, recent winters have seen higher-than-expected deaths compared to recent trends, particularly in the elderly in seasons dominated by the H3N2 flu virus. This is in the context of a general fall in the impact of seasonal mortality over the last 60 years or so (ONS, 2016b).

But seasonal flu is only a contributory factor. Deaths attributed to all respiratory diseases (ICD codes J00-J99) accounted for a little under 15% of all deaths in England and Wales during 2015, although RGA research (RGA, 2017) shows a very high correlation between variations in flu and pneumonia deaths and deaths from other medical causes. In addition, as noted earlier, since 2012 deaths have been higher than expected throughout the year.

What could be causing this, and also causing a broadly similar slowdown in life expectancy trends over the same time period in some other European countries?

While cold snaps may have had an effect in some European countries (Mølbek, et al., 2015), the high number of deaths seen in the UK during the winter of 2014/15 occurred when mean monthly winter temperatures were above average (ONS, 2015).

It is possible that fuel poverty driven by high increases in energy prices is having an effect. Excess winter deaths are associated with lower indoor temperatures (Marmot Review Team, 2011) and it has been reported that cold homes caused 9,000 of the excess deaths in winter 2014/15 (BBC, 2016).

Linking to the significant increase in dementia deaths in the UK in recent years, Gray, et al., (2015) describe how Alzheimer's disease and related dementias are the second-most common cause of excess winter deaths (in terms of proportion of deaths) after respiratory diseases. There are myriad ways in which excess winter deaths can arise in this group. As the population ages and dementia becomes more prevalent, we might therefore expect an increase in the absolute number of excess winter deaths from this cause.

What is becoming increasingly apparent, however, is the potential impact of the UK's austerity response to the 2007/08 financial crisis and the subsequent economic recession.

It's worth being clear about the distinction between economic recessions and austerity. Recession refers to the contraction of the economy and associated consequences such as an increase in unemployment. Austerity refers to one possible policy response taken by governments in an attempt to recover from recession.

Most of the research into recessions and health focuses on population averages, and evaluates routine fluctuations in the economy rather than 'recession' *per se* (Suhrcke and Stuckler, 2012). Care is therefore needed in extrapolating from this to the expected impact of the Great Recession.

At the individual level, there is a wealth of epidemiological research showing the strong and positive association between low income and unemployment, and poor health. Other research at the aggregate level shows that, in high-income

countries, mortality is pro-cyclical and recessions are closely associated with reductions in a wide range of cause-specific mortality.

Overall, while many of those that do fall into unemployment are likely to suffer worse health, at the population level this effect appears to be more than compensated by improvements in the average health of the rest of the population via improved dietary habits and a reduction in lifestyle habits detrimental to health. Possible explanations for this include reductions in smoking, drinking alcohol, and work stress; increased time for healthy activities such as exercise; and driving fewer miles leading to fewer road traffic accidents. In addition, unemployment or an increase in part-time working during a recession may lead to increased levels of informal social care being provided, thereby reducing the mortality at older ages.

Austerity policies, however, may be resulting in a set of independent and much-greater adverse effects on health than economic crisis and recession (Suhrcke and Stuckler, 2012). There is historical support for this, such as the differing health outcomes seen across US states linked to their differing policy responses to the Great Depression of the 1930s, and the East Asian financial crisis of the late 1990s (Stuckler and Basu, 2013).

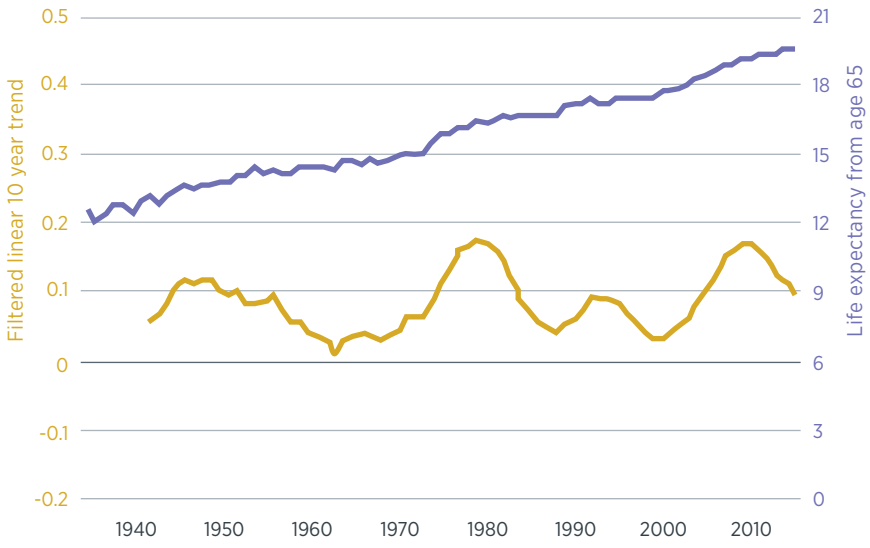
Austerity policies introduced in response to the Great Recession have been controversial (Karanikolos, et al., 2013). In the UK, there is growing consensus that the government's austerity policy response is having a negative impact on both physical and mental health, particularly on elderly mortality (Green, Dorling and Minton, 2017). There has been a decline in self-reported health in the UK every year since 2010, most rapidly in recent times (Dorling, 2016). Rising mortality rates among pensioners aged 85 and older have been linked to reductions in spending on income support for poor pensioners and social care, suggesting that austerity measures in England have particularly affected vulnerable old-age adults (Loopstra, et al., 2016). Austerity may also be exacerbating fuel poverty (Sovacool, 2015).

The British Medical Association (BMA, 2016) and the Royal College of Physicians (RCP, 2016) have both highlighted the serious public health consequences of austerity and the underfunding of the NHS. In January 2015 – when 2014/15 winter mortality peaked – all markers of NHS performance (other than cancer care) had worsened markedly (Hiam, et al., 2017).

United States
Hezhong Ma, VP & Actuary, RGA US Mortality

Figure 8 shows life expectancy in the US at age 65 each year since 1933, together with the underlying trend in the increase in life expectancy each year, derived by fitting a linear trend to life expectancy over the preceding decade.

Figure 8: US period life expectancy at age 65, males and females combined, 1933 to 2015 (data from HMD), together with rolling fitted linear 10-year trend.



The US has been experiencing slowdowns in mortality improvement and in increases to life expectancy, since around 2009/10. And while 2015 was an exceptionally bad year for UK deaths, it was also the first year in recent decades that life expectancy fell in the US.

Figure 9: US period life expectancy at birth and age 65, males and females combined, 2000 to 2015 (data from HMD)

Are the potential causes behind this slowdown the same as in the UK?

The US has experienced broadly similar flu seasons to the UK:

- 2011/12 was a mild season even though it was dominated by the H3N2 virus (Morbidity and Mortality Weekly Report, 2012)
- 2012/13, 2014/15 and 2016/17 were moderate or moderately severe seasons dominated by H3N2, with 2014/15 particularly severe due to the ineffective flu vaccine (Morbidity and Mortality Weekly Report, 2013; 2015; 2017)
- 2013/14 and 2015/16 were milder seasons dominated by the H1N1 virus (Morbidity and Mortality Weekly Report, 2014; 2016)

RGA research shows the US to be less susceptible to seasonal mortality than England and Wales (RGA, 2017). Although some deaths recorded against other causes may have been accelerated due to the impact of flu, particularly in early 2015, flu is likely to be a contributory factor only.

At the overall population level, the US cause of death profile is broadly similar to the UK profile.

US life expectancy is relatively low in comparison to other developed countries. The US ranks 26th out of 35 OECD countries in terms of life expectancy, despite having the highest health expenditure of all 35 countries (America's Health Ranking, 2016).

Part of the reason the US has relatively low life expectancy compared to life expectancies of other developed countries is the US' relatively high level of infant mortality. In 2014, US infant mortality was 5.82 deaths per 1,000 live births (NCHS, 2017). The corresponding rate in England and Wales was 3.6 deaths per 1,000 live births (ONS, 2016a).

If the US had the same level of infant mortality as England and Wales, its life expectancy at birth would be approximately 0.2 years higher.

However, infant mortality has not really contributed to the slowdown in US life expectancy at birth observed since 2009/10. Between 2000 and 2010 infant mortality fell by approximately 11%, and it fell by 5% between 2010 and 2015 (data from NCHS, 2008). Note that the corresponding falls in infant mortality in England and Wales were 23% and 16%, respectively.

In addition to a relatively high infant mortality rate in the US, it is now widely recognised that since 1999 there has been an increase in mid-life mortality of non-Hispanic whites, primarily due to drug abuse deaths and suicide (Case and Deaton, 2015).

This worsening of mortality can now be seen in the overall US working-age population, as most ages below 62 saw a deterioration in mortality between 2010 and 2015. The only age group that saw mortality improvements during this period were those in their mid- to late-forties. On an age-standardised basis, mortality for those aged 20 to 61 deteriorated by approximately 0.6% per year over this period, compared to an improvement of approximately 1.3% per year between 2005 and 2010.

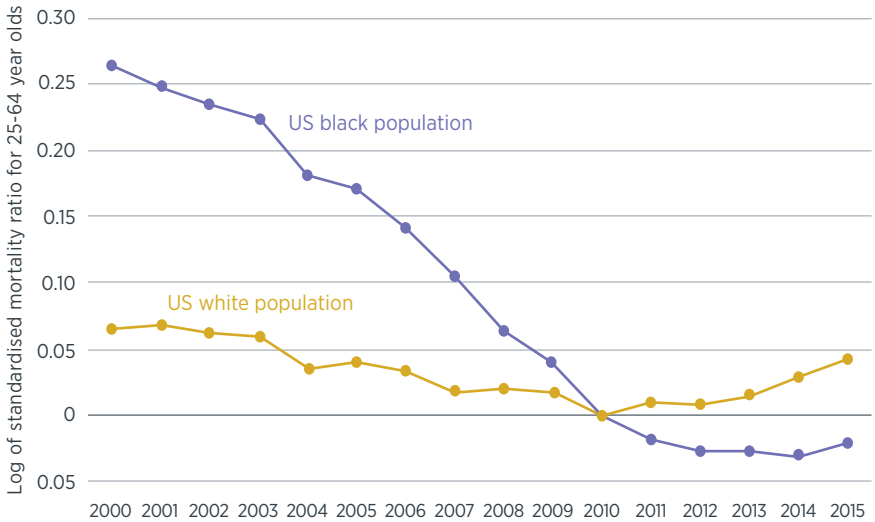


Figure 10: Log of age-standardised mortality ratios, relative to 2010, for US white and black populations aged 25-64, males and females combined (data from CDC Wonder)

In contrast, the last few years have still seen positive improvements in US mortality at older ages. For those aged between 62 and 100, age standardised mortality rates improved by approximately 0.7% per year between 2010 and 2015, compared to an improvement of approximately 2% per year between 2005 and 2010.

Note that this is a reversal of the position seen in the UK, where it is the population over age 85 that have seen a deterioration in mortality over the most recent period (2011 to 2015) and those under age 85 have continued to see falls in mortality rates, albeit at generally lower rates of improvement compared to prior years.

Case and Deaton have recently updated their 2015 paper and presented preliminary results at a Conference in March 2017 (Case and Deaton, 2017). Their analysis is not final, but their preliminary results show a continuation of the long-term deterioration in white non-hispanic mortality, which has also worsened for some age groups since 2010. In addition, consistent with Figure 10, at least some working ages show a slowdown in Hispanic and black non-hispanic mortality improvements since 2010. The reasons for this are not clear but it would be consistent with the pro-cyclicality of mortality described earlier, noting that since 2010 the US economy has returned to growth and the unemployment rate has fallen. Taken together, the experience of the different racial groups could have resulted in deteriorating mortality at the working-age population level. It is worth noting that Case and Deaton do not comment on the change in population life expectancy trends observed since 2011.

The US response to the global financial crisis was very different to that of the UK. The UK began the 'age of austerity' in 2010 when billions of pounds was cut from government spending (BBC, 2010). In contrast, President Obama campaigned on taxing the wealthy and investing in social services, and when he came to office in 2009 the US followed the path of stimulus with the American Recovery and Reinvestment Act (UNT Web Archive, 2017).

This difference in response is a plausible factor behind the difference in population experience in life expectancy trends at old ages between the two countries. While austerity in the UK has negatively affected national health and social care programmes, which would be expected to have a particularly detrimental effect on the old, especially the vulnerable, the same has not been seen in the US.

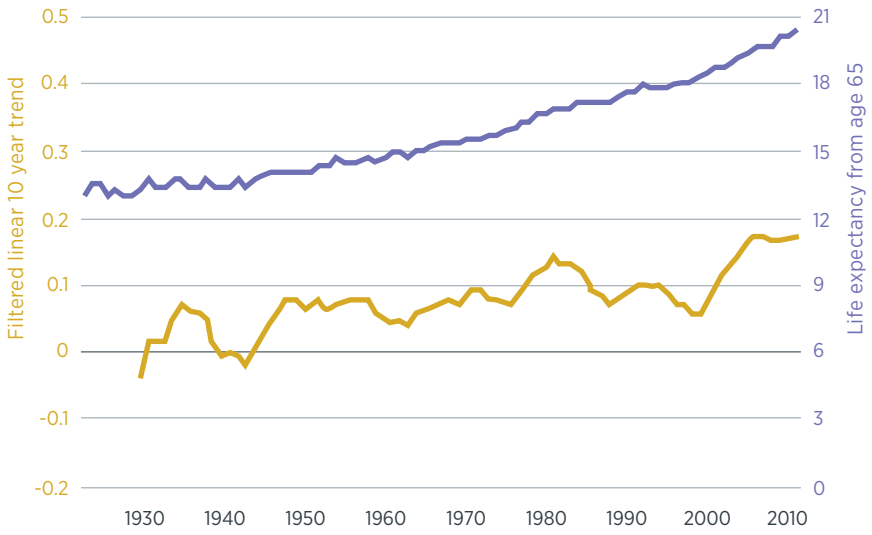
Canada

Damien Lapointe Nguyen, Director, New products, RGA Canada

There is slightly less recent data available in Canada. HMD data only goes up to 2011 and Statistics Canada data after 2011 is mostly preliminary.

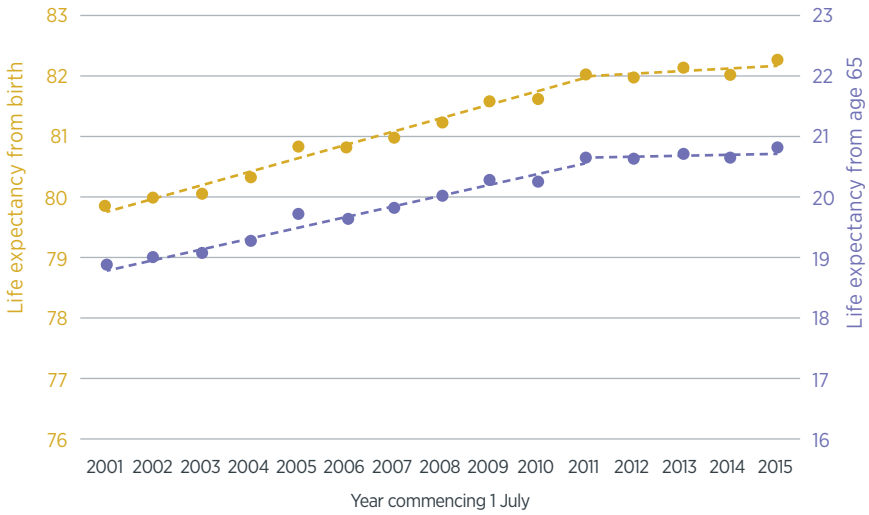
Figure 11 shows life expectancy in Canada at age 65 each year since 1921, together with the estimated underlying trend in the increase in life expectancy each year, derived by fitting a linear trend to life expectancy over the preceding decade.

Figure 11: Canada period life expectancy at age 65, males and females combined, 1921 to 2011 (data from HMD), together with rolling 10-year linear fitted trend



Using more recent preliminary data available from Statistics Canada, Figure 12 illustrates the slowdown that Canada has experienced in improvements in life expectancy since 2011.

Figure 12: Canada period life expectancy at birth and age 65, males and females combined, 2001/2 to 2015/16 (data from Statistics Canada)



This slowdown in life expectancy is supported by the most recent report into the Old Age Security Program mortality experience, which showed life expectancy increases over 2010-2013 had been lower than experienced over the previous decade (OCA, 2016).

Canada has experienced broadly similar flu seasons to the UK and US. The 2011/12, 2012/13, 2014/15 and 2016/17 seasons were dominated by H3N2 strain, with 2011/12 being fairly mild and an ineffective vaccine contributing to a severe 2014/15 flu season.

Life expectancy at birth in Canada is higher than in both the UK and the US. This is despite Canada having a relatively high infant mortality rate compared to other developed countries, although not quite high as in the US. In 2013, the infant mortality rate in Canada was 4.9 deaths per 1,000 live births (Statistics Canada, 2017). In addition to being relatively high, the infant mortality rate in Canada has been at a similar level since 2009.

Unlike both the UK and US, Canada is still seeing mortality improvements across all ages even though they have slowed significantly. On an age-standardised basis, mortality of those aged 20 to 64 improved by approximately 0.7% per year over 2011 to 2015, compared to an improvement of approximately 1.6% per year between 2005 and 2011. For those aged between 65 and 100, age-standardised mortality rates improved by approximately 0.4% per year over the period 2011 to 2015, compared to an improvement of approximately 1.8% per year between 2005 and 2011.

At the overall population level, Canada has a broadly similar cause of death profile as the profiles of the UK and the US.

Canada benefits from a 'healthy immigrant effect' (Ng, 2011). According to its 2011 census, just under 21% of the population are foreign born, compared to approximately 13% of the population in the US and UK (CPHO, 2016). Immigrants tend to have lower mortality than the general population, often attributed to medical and employment screening prior to entering the country. This difference may contribute to Canada's current higher life expectancy. However, the US and UK have each seen proportionately larger increases in their foreign-born populations, the UK particularly so, and this may have contributed to faster mortality improvements in those countries.

Canada does have a prescription opioid problem similar to the problem experienced in the US, although this has not resulted in the same effect on Canadian population mortality as has been observed in the US (Imtiaz and Rehm, 2016).

In terms of its response to the Great Recession, Canada manoeuvred the global financial crisis with relative success, but it has not remained insulated from austerity measures undermining population health. The recession itself had a negative impact on social determinants of health. Austerity measures introduced in 2012 – such as cutbacks to social assistance benefit and declines in housing funding – negatively affected the health of those who are most reliant on government support (Ruckert and Labonte, 2014). Even in the subsequent recovery, there is concern that the new jobs created are more precarious and may not provide the same level of health benefits.

The austerity response in Canada was not nearly as severe as the austerity response in the UK. Therefore, if austerity lies behind the deterioration of population life expectancy at older ages in the UK, particularly among the vulnerable, then it is plausible that the observed slowdown in Canada's life expectancy should be lower than that seen in the UK.

Conclusion

This article has focused on population life expectancy trends. Insurance and pension scheme trends are likely to differ from population trends due to, among other things, socioeconomic differences and the effects of underwriting, and these are important considerations for (re)insurers and pension scheme sponsors and trustees.

Many life (re)insurers assumed there would be a gradual slowdown in improvements in life expectancy as long-term positive drivers, such as the impact of smoking cessation, fell away and were replaced by negative drivers, such as the increase in obesity.

The fact that the slowdown in population life expectancy improvements has been seen across different geographies, over broadly the same short time period, points to other systemic causes attenuated or magnified by country-specific factors, such as the 'deaths of despair' in the US.

In addition to the pro-cyclicality of population mortality expected as countries recover from the Great Recession, it is increasingly plausible that, in countries where there was an austerity response to the financial and economic crisis of 2007/08, that response may be behind the negative impact on life expectancy trends.

However, it cannot be as simple as 'austerity will reduce life expectancy' as Spain has seen little change in life expectancy trends since 2000 despite introducing significant austerity measures in response to the Great Recession.

While some plausible explanations have been discussed in this article, further research will be needed to explain the within- and between-country differences in the change in life expectancy trends that have been observed.

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4. The relationship between health spending and life expectancy

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Introduction

Life expectancy at birth is one of the most frequently used health status indicators. Improvements in life expectancy at birth can be associated with a number of lifestyle factors: lifestyle choices, standards of living, better education, as well as greater access to good quality health services. It is difficult to disentangle the contribution of health care towards gains in life expectancy but there is evidence of improvements in life expectancy with rises in health spending (OECD, 2011).

Does spending more on health care improve life expectancy?

Looking simply at how much countries spend per head on health care and life expectancy at birth, there seems to be a positive correlation between the two. But, as Figure 13 shows, the relationship is not straightforward.

First of all, the US stands out as being somewhat different from the rest. After excluding the US from the sample, there seems to be a correlation between health spending per head and life expectancy. However, the correlation prevails mainly because of some lower income economies such as Turkey, Latvia and Mexico who spend little on health and have lower life expectancy.

Perhaps more importantly, the relationship seems to give diminishing returns after an initial level of spend, with little evidence of any relationship at all after spending of around $3,000 per head. This does not necessarily mean, however, that there ceases to be a causal link from health spending to life expectancy once a certain level of spending is reached. It might instead be that the link is confounded by other factors. There are limits to medicine once past a certain level of spend, and wealthier countries also spend more on things that benefit health, like housing, better food and so on.

It is important to understand what health spending should be spent on. John Bunker et al (1994) provided detailed estimates of the gain in life expectancy, such as in vaccination programmes, where big returns have measurable impact. However, further spending on hospitals and specific surgery such as hip operations have not added any extra years of life, but do provide better quality of life.

What are the prospects for UK (NHS) health spending?

Government spending on health in the UK in 2015/16 was £138.1 billion: 2.7% higher than the amount spent in 2014/15. However,

Figure 13: Relationship between health spending per capita and life expectancy at birth, for 35 OECD countries, 2014 (OECD, 2016)

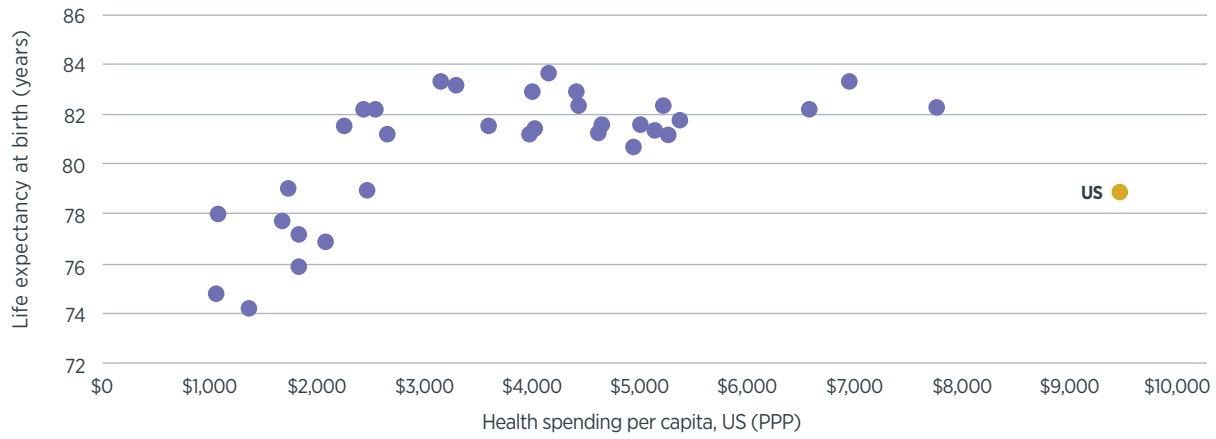


Table 2: Government identifiable expenditure on health in the UK: 2009/10 to 2015/16 (£ billion) (HM Treasury, 2016)

	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Cash terms	£116.1	£118.9	£120.6	£123.6	£128.9	£133.6	£138.1
Share of GDP	7.6%	7.5%	7.4%	7.3%	7.3%	7.3%	7.3%
Real terms (in 2015/16)	£127.1	£127.9	£127.9	£128.4	£131.5	£134.5	£138.1
Real terms change		0.6%	0.0%	0.4%	2.5%	2.2%	2.7%

funding increases since 2010/11 have been much lower than the average of 3.8% since 1978/79 (OBR, 2016).

Government expenditure on health was worth 7.3% of UK GDP in 2015/16, having fallen steadily since a peak at 7.6% in 2009/10 (Public Expenditure Statistical Analyses, 2013).

Since public spending is a significant portion of health financing in the UK, any changes in overall health spending are dominated by the trends in public spending. Figure 14 illustrates trends in public spending on health in England and as the share of national income in the UK. Between 1998/99 and 2009/10, NHS spending had risen by 108% in real terms, taking its share of Gross Domestic Product (GDP) from 3.8% to 6.4%, with an annual average real increase in spending of 6.9%.

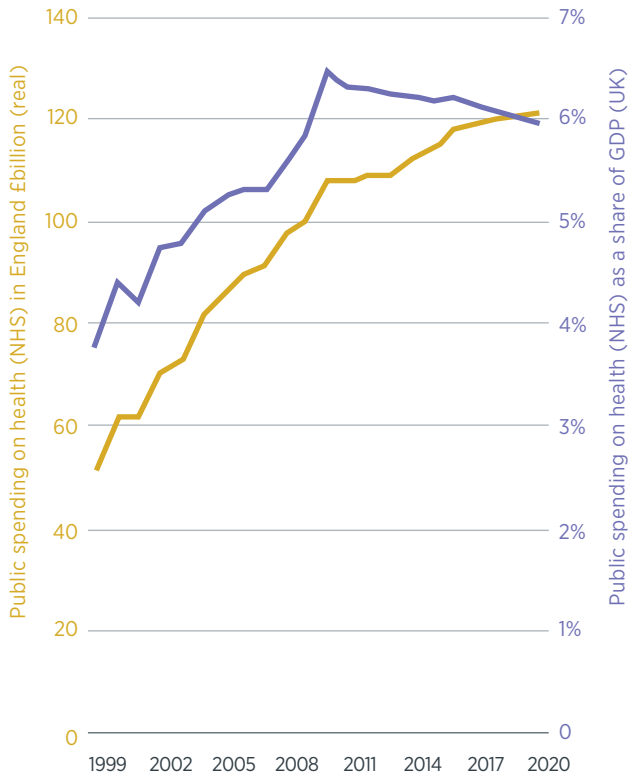


Figure 14: Public service spending on health in England and as a share of the UK national income in real terms. (Nominal health spending data from HM Treasure Public Expenditure Statistical Analyses. Real spending refers to 2015-16 prices, and uses the ONS National accounts deflator.)

As part of their austerity programme, the government in England made large-scale cuts to the spending of many departments, notably social services, welfare and education. However, spending on the NHS in England was 'protected' in real terms.

Protection for the NHS has meant small real increases in funding compared to the period before 2010. Between 2010/11 and 2015/16, for example, NHS spending in England rose by 9% in real terms, with an annual average growth of 1.5% - a slower growth than the economy and hence reducing its share of GDP from 6.3% to 6.2%. Growth per capita for over-65s will have been materially less, given the UK's population growth and ageing.

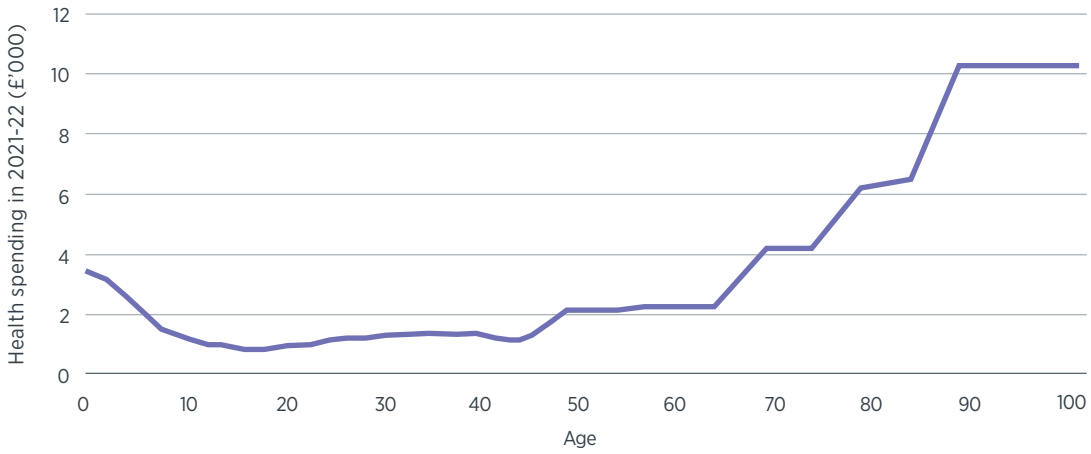
This represents the tight funding environment, where NHS funding lagged behind the demographic and non-demographic–driven cost pressures against the backdrop of cuts to social services.

What are the cost pressures facing the NHS?

The NHS faces a number of pressures that tend to increase the real cost of providing a given level of health care over time. The spending varies between different sections of the population – for example, by age, deprivation or gender.

Figure 15 (overleaf) illustrates the profile of health spending by age. The chart demonstrates that health care spending rises significantly with age. For an average person, the amount of health care resources they consume begins rising significantly around the age of 50, and rises particularly sharply after they are 70. This shows the high cost associated with end-of-life care and how health spending appears to be concentrated among a relatively small section of the population. Proximity to death is also an influence on health spending, as hospital costs increase significantly in the final months of life, regardless of a person's age. Part of the reason that health spending is higher at older ages is that mortality rates are higher at those ages, so a higher proportion of those cohorts will be subject to the much higher costs associated with the final months of life. It is estimated that the mean hospital expenditure for an average 90-year-old is three times greater than for an average 70-year-old and nine times that of an average 50-year-old (Kelly et al, 2015).

Figure 15: Profile for health spending, by age (Office of budget responsibility, 2017)



The NHS faces a considerable challenge in providing high-quality health care in the face of rapid demographic changes, while at the same time containing overall spending. Moreover, the population aged 75 and over is expected to grow to 35% by 2024 (ONS, 2015). Even before the pressures of an ageing population, according to the Office of Budget Responsibility there are extra non-demographic pressures (OBR, 2016). Health care is a relatively labour intensive sector where nearly two-thirds of hospitals' operating expenses account for staff costs (Lafond et al, 2014). Also, advancement in medical technology adds to the cost.

Impact on sustainability of the NHS

The unprecedented slowdown in the growth of NHS funding since 2010 has led to a gap between what the NHS receives and what it will require based on patient needs. To satisfy rising demand without reducing quality would require increases in real funding or increases in productivity, or both. Judging historically, and bearing in mind the inevitable uncertainty of any projections, it has been estimated that an average annual real increase of around 3.5% is required to keep the NHS finances in line with historical figures (Appleby, 2016).

Life expectancy reflects not just health spending but also choices of lifestyle, such as the consumption of alcohol and tobacco, education, socio-economic factors and so on. These factors have to be taken into account of when assessing the efficiency of health care spending. However, continuing to improve health outcomes would require an increase in health care spending, though it could be by a smaller amount than over the previous decade.

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5. Antibiotic resistance and life expectancy

Nicola Oliver, Director, Medical Intelligence

Antibacterial resistance is a natural evolutionary phenomenon that was first identified in 1940. Resistance can arise as a random mutation which is then replicated through reproduction as well as gene exchange. The economic costs of antibacterial resistance are immense; recently calculated at around €1.5 billion in health care expenses and lost productivity each year in the EU alone.

It has been estimated that about 25,000 patients die in the EU from an infection with multidrug-resistant bacteria annually. The final O'Neill (2016) analysis estimates that based on scenarios of rising drug resistance for six pathogens to 2050, unless action is taken, the burden of deaths from antibacterial resistance could balloon to 10 million lives each year by 2050, at a cumulative cost to global economic output of 100 trillion USD.

Routine procedures are subject to antibiotic prophylaxis and may be affected by increasing antibiotic resistance. This includes chemotherapy, colorectal surgery, spinal surgery, appendectomy and hysterectomy/ caesarean section as well as the insertion of any device such as a pacemaker or artificial joint.

Quantifying a material impact on life expectancy is challenging; we have certainly witnessed a dramatic rise in life expectancy throughout the 20th century as seen in Figure 16, with deaths from infectious diseases rapidly declining as shown in Figure 17.

Antibiotic use, however, is not the key driver involved; public health measures exerted an impact long before Fleming's serendipitous discovery.

Figure 16: Life expectancy, England and Wales, by years spanned in census, 1841-2014 (ONS, 2015)

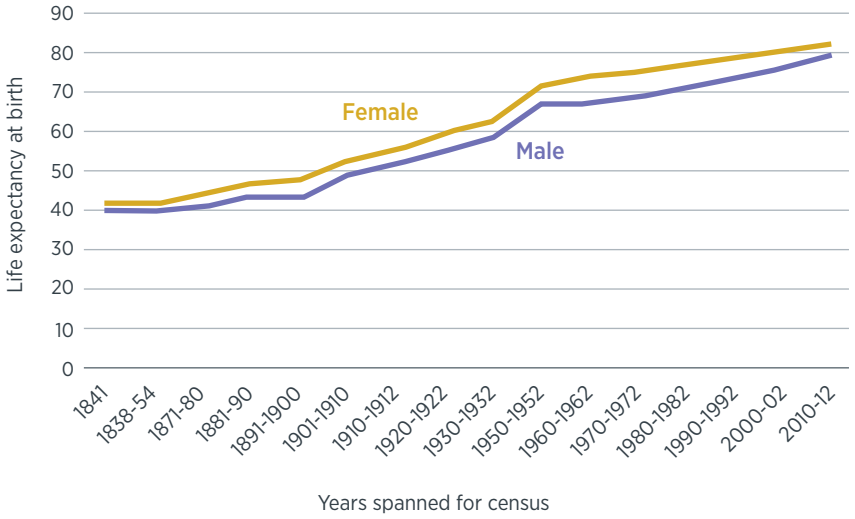


Figure 17: Crude death rate for infectious diseases, per 100,000 population, United States, 1900-1996 (CDC, 1999)

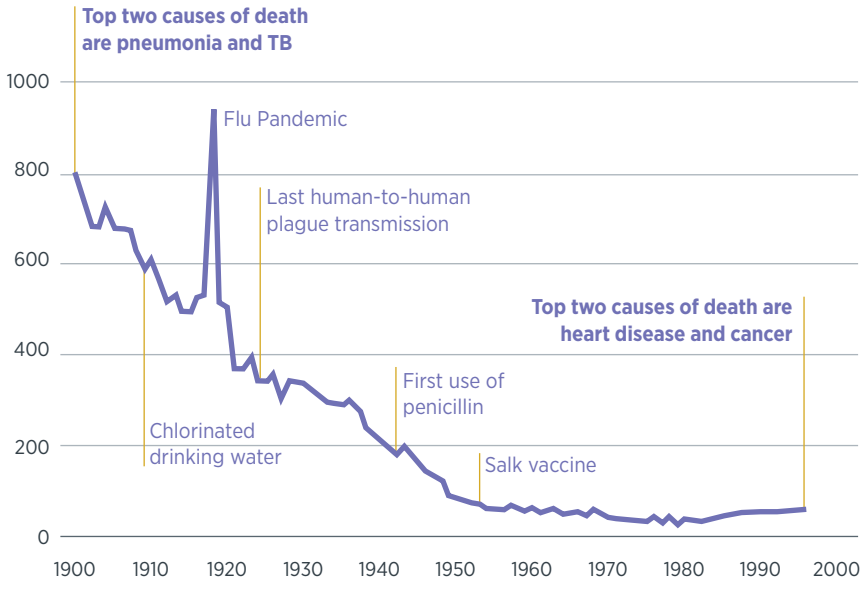


Figure 18 shows the mortality rate for infectious and parasitic diseases in England and Wales, 1995-2014. A definite peak occurred in deaths in around 2007 with rates falling to pre-2002 rates from around 2010. This may be related in part to a reduction in MRSA deaths.

We can compare this directly to circulatory disease and cancer mortality rates over the same period to give a workable comparison, displayed in Figure 19. Mortality rates from infectious disease remain low when compared to the major causes of death in the UK.

It is certainly fair to say that the discovery of antibiotics has had a positive influence on life expectancy during the mid-20th century, with some anecdotal estimates suggesting an average life expectancy increase of 2-20 years as a result of antibiotic use.

However, that is not to say that the absence of effective antibiotics would have a material impact of that magnitude, particularly in high-income populations with efficient public health mechanisms. In order for that to happen, we would, for instance, have to undergo a reversal in the gains made in life expectancy in the latter part of the 20th century and the early 21st century as a result of improvements in treatment and management of heart disease.

In addition, technologies such as genomic editing, and vaccine development, as an alternative to antibiotic use, will have a role to play in reducing the impact of infectious diseases. Let's also not forget the effectiveness of the human immune system, which is quite capable of dealing with the majority of pathogens. There are also one or two novel classes of antibiotics showing promise in the pharmaceutical pipeline.

At this stage, there is limited evidence to suggest a material impact on life expectancy as a result of antibiotic resistance. There would have to be a perfect storm comprising a complete breakdown in effectiveness of ALL antibiotics, a simultaneous population-wide human immune system catastrophe and total lack of medical innovation for this to happen. The impact on morbidity and disability at this time is the more immediate threat.

Figure 18: Infectious and parasitic disease mortality rate/100,000 population (Compendium of Population Health Indicators, 2015)

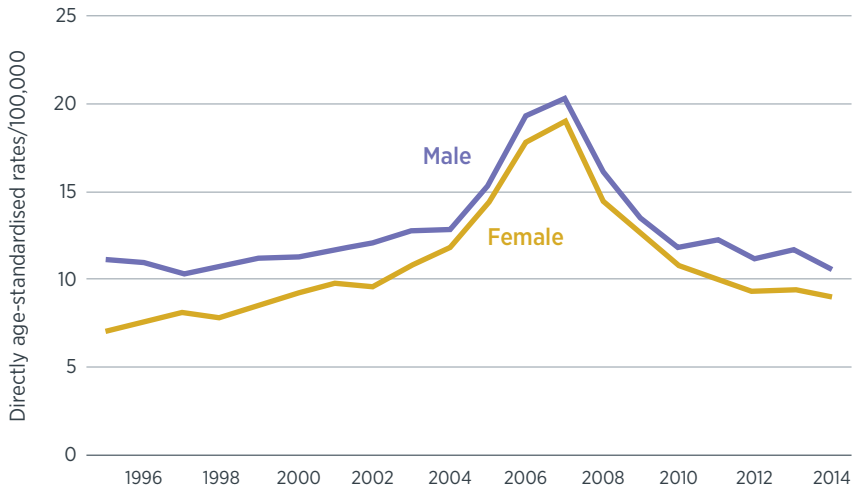
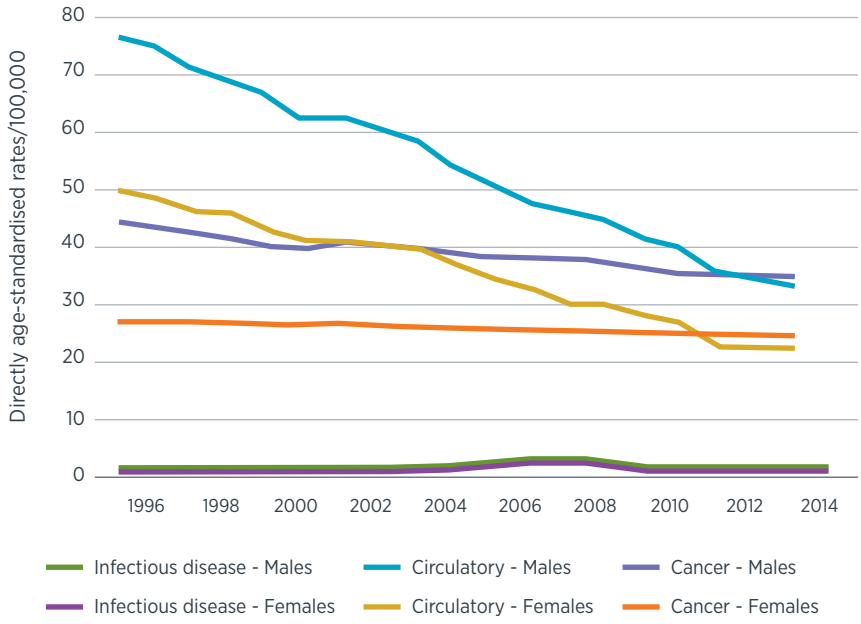


Figure 19: Mortality rates/100,000 population for infectious diseases, circulatory diseases and all cancers, England & Wales (Compendium of Public Health Indicators, 2015)



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6. Continuous Mortality Investigation: Mortality Projections Model

The Continuous Mortality Investigation

The Continuous Mortality Investigation (CMI) published CMI_2016, an update to its Mortality Projections Model ("the Model"), in March 2017. This makes a number of changes to the previous method, partly reflecting the unusual mortality experience of recent years. The new version is expected to be widely adopted and will generally lead to lower projected life expectancies.

The original Model

The CMI published the first version of the Model, CMI_2009, in November 2009. This was driven by concerns over existing projection methods, and the growing importance of longevity assumptions due to increasing rates of mortality improvement and the low interest rate environment in the UK.

The Model projects mortality improvements rather than mortality rates. Users of the Model can apply its mortality improvements to their own choice of base mortality table to obtain projected mortality rates.

The Model projects by interpolating between current and long-term improvement rates. Current improvements are calculated by analysis of recent mortality data, but the long-term rate is an assumption. The motivation for this approach is that while recent experience is thought to be a good guide to future mortality in the short term, the long-term drivers of mortality improvements could be very different. For example, a large proportion of mortality improvements in recent decades has come from reductions in deaths from circulatory disease. But as circulatory disease is now responsible for a much smaller proportion of all deaths, it has less influence on future mortality improvements.

The CMI provides a default assumption for all of the Model's parameters except for the long-term mortality improvement rate. Consequently the CMI does not itself make a projection of mortality improvements, rather it provides a model to enable its users to make their own projections, and to compare their views to those of others.

The Model is widely used for analysis, disclosure, and benchmarking of mortality improvements, both in the UK and overseas. Over 90% of UK pension schemes use it, and over two-thirds of these use a long-term rate of 1.5% p.a.

Updates to the Model

Since 2009, the CMI has produced updates to the Model roughly annually. The main change each year has been to the data used to calibrate the Model, incorporating an additional year's data as it becomes available. There were more significant changes to the underlying dataset in CMI_2012, reflecting revisions made by the Office for National Statistics (ONS) following the 2011 Census. Until CMI_2016 the method was unchanged apart from some relatively minor technical changes in CMI_2014.

The more material changes made in CMI_2016 follow a thorough review of the Model and consultation with its users. The review took place during a period of unusual mortality experience in the UK, and this has influenced the Model.

Recent mortality

Figure 20 shows standardised mortality rates (SMRs) in England & Wales since 2000. SMRs show how average mortality rates would have changed if the structure of the population, by age and gender, had remained constant. The SMRs remove the confounding impact of a population that has grown and aged over this period. All charts in this article are for ages 20-100 with males and females combined.

SMRs fell steadily between 2000 and 2011. However, more recent SMRs have not followed the 2000-2011 trend, and SMRs in 2015 and 2016 are more than 10% higher than that trend.

Figure 21 shows standardised mortality improvements, derived from SMRs, averaged over five-year periods. The average improvement of 0.3% p.a. for the period 2011-2016 is lower than any five-year period since the 1970s.

Figure 20: Standardised mortality ratio and 2000-2011 trend (CMI calculations based on ONS data)

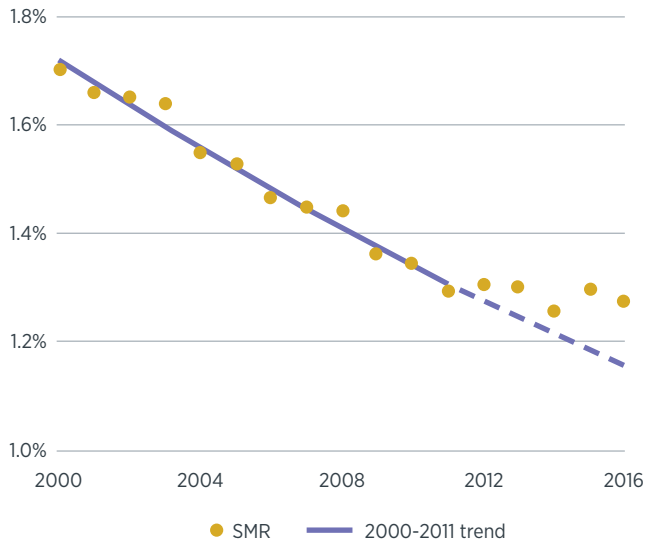
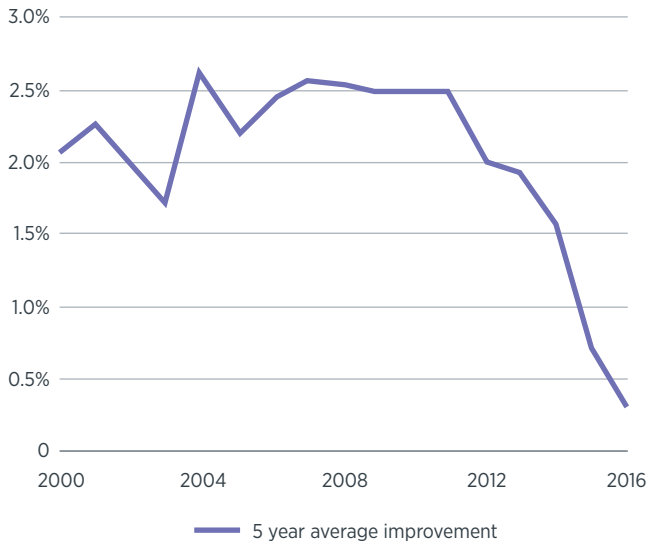


Figure 21: Five-year average standardised mortality improvement (CMI calculations based on ONS data)



This marked change in mortality improvements surprised many commentators and there has been considerable debate over the reasons for the change – whether it is caused by one-off events, such as the high number of deaths in early-2015 due to influenza, or is the start of a longer-term trend. As outlined in article 3 in this Bulletin, the unexpectedly high mortality in recent years has been linked by some commentators to the impact of economic austerity on government spending on health and social care.

CMI_2016

When the Model was first released in 2009, this was in an environment of steady mortality improvements, and there was relatively little debate on the level of current improvements, or the method used by the CMI to determine these within the Model. However, given recent experience, the CMI has introduced a new "period smoothing parameter", denoted S_κ, into the Model. This allows users to express their own view of current levels of mortality improvement, and how strongly the Model should respond to new data.

Figure 22 shows the Standardised Mortality Ratios from 2000 to 2016 and the impact of smoothing them using different values of the period smoothing parameter. Figure 23 shows mortality improvements derived from these. The CMI's default assumption is 7.5.

Using a lower period smoothing parameter, means that the smoothed rates follow the actual SMRs more closely, and leads

Figure 22: Smoothed and unsmoothed standardised mortality ratios (CMI calculations based on ONS data and the CMI_2016 Model)

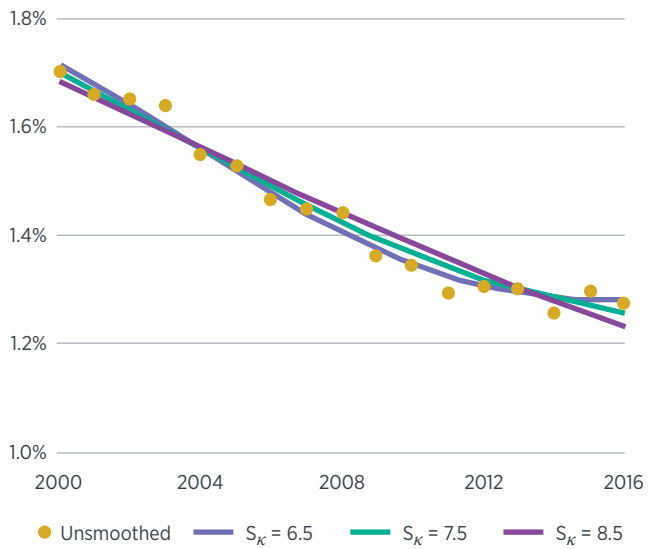


Figure 23: Smoothed and unsmoothed standardised mortality improvements (CMI calculations based on ONS data and the CMI_2016 Model)

to lower mortality improvements in recent years. Using a period smoothing parameter of 6.5 rather than the default of 7.5 would reduce male life expectancy at age 65 by nearly 3%. Conversely, a higher value leads to more stable improvements that do not follow actual experience so closely.

The CMI has also made a change to the definition of the long-term rate. Although it is common to refer to the long-term rate as a single figure (e.g. 1.5% p.a.), the default assumption in the Model is that it reduces to zero at the oldest ages. In the CMI_2009 to CMI_2015 Models, this reduction was made between ages 90 and 120 (e.g. a 1.5% long-term rate meant 1.5% at 90, 1.0% at 100, 0.5% at 110 and nil at 120), but in CMI_2016 the reduction happens earlier, between ages 85 to 110. This change better reflects actual experience and typical modifications to the default assumption made by many insurance companies.

The impact of this change is to reduce life expectancies and also to reduce the sensitivity of the Model to the long-term rate assumption. Together with the introduction of the period smoothing parameter, this places relatively more emphasis on current mortality improvements and less on the long-term rate.

There are a number of other changes to the method, which are described in Working Paper 97 (CMI 2016). An important effect of the changes is that the whole process of calibration and projection is done in one piece of software. This makes it much easier for users of the Model to understand the entire process, and to make their own modifications if they wish.

The combination of new data and changes in method leads to materially lower life expectancies in CMI_2016 than in previous versions of the Model. Compared to CMI_2015, life expectancies at age 65 are 1.3% lower for males and 2.0% lower for females in CMI_2016, and falls in life expectancy are greater at the oldest ages.

Basis risk

The Model is calibrated to data for the general population in England & Wales. However it is typically applied to a specific subgroup of that population, such as a pension scheme or insurance portfolio. This creates basis risk – the risk that the Model is used for a population which behaves differently to the one it is calibrated to.

Analysis by the CMI and others has shown that mortality improvements can differ significantly between subgroups and the population as a whole. Over the period 2011-2015, mortality improvements in the CMI's pensioner dataset have been higher than in the general population. Users of the Model should consider whether to adjust the default parameterisation of the Model to allow for this.

Summary

Given the popularity of the CMI Model, the modifications to CMI_2016 are evolutionary in nature. The CMI has taken the opportunity to simplify some features of the process, and the key changes to the method noted above respond to the unusual mortality experience of recent years. The introduction of the period smoothing parameter allows users to reflect their views of recent mortality in the Model, and to communicate this to others in a standard way.

References

Continuous Mortality Investigation (UK) (CMI) (2016). *Working Paper 97* Continuous Mortality Investigation. **https://www.actuaries.org.uk/learn-and-develop/continuous-mortality-investigation/cmi-working-papers/mortality-projections/cmi-working-papers-97-98-and-99** [Accessed 21 April 2017]

7. Recent developments and events

News from the IFoA's Actuarial Research Centre

Actuarial Research Centre®
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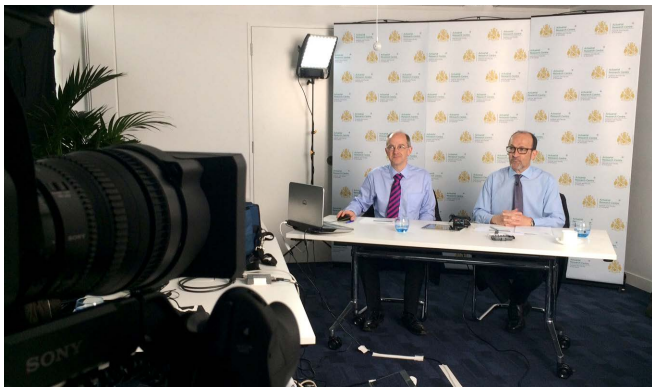
The Actuarial Research Centre (ARC) is a network of actuarial researchers around the world, collaborating with industry to provide cutting-edge actuarial research programmes which are relevant, innovative and practical.



The ARC has been running a set of webinars to showcase three of its largest research programmes.

We were delighted that over 1,000 viewers from more than 30 countries tuned in to watch these webinars on the day. Post-event recordings are now available to view on-demand and free of charge through the links below.

- **Modelling, Measurement and Management of Longevity and Morbidity Risk** – Developing a new generation of mortality and morbidity models, with a specific focus on the drivers for mortality. **http://bit.ly/arc2165**
- **Use of Big Health and Actuarial Data for understanding Longevity and Mortality** – New statistical and actuarial methods in the use of Big Data, in the context of health and wider applications. **http://bit.ly/arc2173**
- **Minimising Longevity and Investment Risk while optimising Future Pension Plans** – Development of pension product designs that keep the customers' needs at the forefront, with a real income in retirement that minimises costs for the customer. **http://bit.ly/arc2142**

All ARC videos can also be viewed by all through the IFoA's YouTube channel and dedicated playlists here: **http://bit.ly/ifoa1589** The IFoA sessional meetings can also be viewed through this channel and covers a wide range of topics from the IFoA's wider research agenda.

In addition to the three world-class programmes referenced above, the ARC is also developing further research initiatives:

- Economic Modelling – Current approaches in economic modelling and the identification of gaps requiring future research
- Behavioural Finance – Behavioural Aspects of Institutional Investment Decision-Making

To find out more information about the ARC and the research programmes visit **www.actuaries.org.uk/arc**

Want to engage with the ARC?

Part of ensuring the relevance of the ARC's research is through partnering with others, in both commissioning and sponsoring programmes. If your organisation would be interested in supporting any of the existing programmes or have identified your own research gaps that could be addressed through ARC, please contact the team at the IFoA on **arc@actuaries.org.uk**

Networking Event: Big Health and Actuarial Data

This event will highlight the work of a commissioned research programme by the IFoA's Actuarial Research Centre on the "Use of Big Health and Actuarial Data for Understanding Longevity and Morbidity Risks". This programme aims to develop new methods for assessing basis risk and evaluating longevity improvement based on Big Health and Actuarial Data.

The format of the event will be a presentation after which we will open up the floor for questions & debate with a panel session, including non actuarial panellists, this will be followed by an opportunity to network over a drink.

This event will take place in London on 27 September 2017, 17.00 – 20.00. For more information and bookings, please visit: **http://bit.ly/ifoa1289**

Want to stay up to date with the latest in ARC and IFoA research?

Sign up for the IFoA's Research and Knowledge eNewsletter by e-mailing the IFoA's Research and Knowledge team at **research@actuaries.org.uk**

News from the IFoA

Institute and Faculty of Actuaries

Recent papers in the British Actuarial Journal (BAJ) and the Annals of Actuarial Science (AAS)

The BAJ publishes papers presented at the sessional research meetings of the Institute and Faculty of Actuaries as well as papers of interest to practitioners.

Papers published recently cover topics such as social care funding, operational risk models, international approaches to post-retirement solutions and the risk reporting provisions of the UK corporate governance code.

The BAJ is now an open access publication and all content from the current volume onwards is accessible at **http://bit.ly/ifoa9125**

The AAS covers all areas of actuarial work, publishing an equal mix of theoretical and applied research.

Highlights from the 2017 volume include Fei Huang and Bridget Browne applying a modified CMI model to forecast mortality in China and a series of papers from David Wilkie and Şule Şahin on stochastic economic modelling.

Find out more at **http://bit.ly/ifoa2531**

Antibiotic Resistance (ABR) Working Party

The IFoA's ABR working party has been active since the beginning of 2017, with the aim of creating an ABR modelling framework with UK parameterisation by the end of the year. It has now decided on the modelling approach, has built a prototype, and is now working to develop and parameterise the model. The working party aims to present its preliminary findings at the IFoA's Life conference in November, with a fuller paper to developed for later dissemination.

To find out more information, please visit **http://bit.ly/ifoa2856**

Impact of Wearables and the Internet of Things Working Party

The rapid evolution of wearable technology and the internet of things has significant implications for health and care providers, and much more broadly for the actuarial profession. The key objectives of the working party are to:

1) Understand how stakeholders are responding to this emerging technology, and how this might evolve in the future.

2) Understanding how the current and known future technologies can be used to measure health and wellbeing, what data is captured and how, how accurate and reliable the data is, and how end users would typically engage with this technology.
3) Derive the practical uses of this technology within the life and health insurance market.

Further details about this working party can be found on: **http://bit.ly/ifoa2389**

Health and Care Networking Event: Wearables and Internet of Things

This event will provide an overview of the current and future use of wearables and the Internet of Things (IoT). The format of the evening will be a presentation followed by questions and debate. Attendees will have an opportunity to network over a drink after the main programme.

This event will take place in London on 17 October 2017, 17.00 – 20.00. For more information and bookings, please visit: **http://bit.ly/ifoa2567**

International Mortality and Longevity Symposium Publication

The International Mortality and Longevity Symposium took place in London in September 2016. The event brought together thought leaders to discuss the latest thinking on the future of mortality trends in populations, with the aim of better understanding and managing this complex subject. The IFoA has produced a publication which includes articles by each plenary speaker, workshop abstracts and delegate views.

Download the publication from our website on **http://bit.ly/ifoa6785**

Life Conference 2017

The Life Conference is the premier event for professionals interested in life insurance. Offering a wide range of workshops and plenary sessions it's the perfect opportunity to discover what's hot and current in life insurance.

The Life Conference 2017 is taking place in Birmingham from 22 - 24 November 2017. For more information and bookings, please visit: **http://bit.ly/ifoa1298**

News from the CMI

Continuous Mortality Investigation
Institute and Faculty of Actuaries

The Continuous Mortality Investigation (CMI) carries out research into mortality and morbidity experience, providing outputs that are widely used by UK life insurance companies and pension funds. The following is a summary of the CMI's latest outputs.

The CMI Mortality Projections Model

The latest version of the CMI Model, CMI_2016, was published in March 2017. The Model uses ONS England & Wales population mortality experience covering the period 1 January 1976 to 31 December 2016 and models a smooth fit of past experience, which converges over time to a long-term rate of mortality improvement chosen by the user.

This version of the Model incorporates changes in method from previous versions; further details can be found in article 6 in this Bulletin.

The Model and Working Papers are available to subscribers to the CMI here: **http://bit.ly/cmi2377**

The CMI's Mortality Projections Committee hosted a discussion on mortality improvements at the Staple Inn Actuarial Society (SIAS) in April 2017. Slides and an audio recording of the event can be found on the SIAS website: **http://bit.ly/cmi2387**

Final "08" Series assurances tables

The final "08" Series accelerated critical illness and term mortality tables were released in January 2017. These are based on insurance companies' data covering the period 2007-2010 and update the "00" Series mortality tables, which were based on data covering the period 1999-2002 and the "AC04" Series accelerated critical illness tables, which were based on data covering the period 2003-2006.

CMI Working Paper 94: **http://bit.ly/cmi2497**

Mortality experience of pensioners for the period 2008 to 2015

The CMI SAPS Committee carries out analyses of pensioner mortality experience every year. The latest report was published in February 2017 and contains an analysis of the mortality experience for the period 2008 to 2015, based on data collected by 30 June 2016.

The mortality experience for this dataset is compared against the unadjusted "S2" series tables and the "S2" series tables projected with the CMI_2015 Model. Results are provided for the various pensioner categories, by calendar year and split into pension amount bands.

CMI Working Paper 95: **http://bit.ly/cmi9611**

Income Protection sickness experience for the period 2007-2010

Working Paper 96 describes the experience of individual Income Protection policies over the period 2007 to 2010. It contains a comparison of the 2007-2010 claim inceptions and terminations experience with those of previous quadrennia, and updates previous analyses by cause of sickness.

CMI Working Paper 96: **http://bit.ly/cmi1635**

News from around the community

Canadian Mortality: Overview (2012 and 2013)

On 12 July 2017, Statistics Canada released an overview of mortality for 2012 and 2013. Some notable statistics include the following:

- The life expectancy of men is slowly catching up to that of women. From 2010/2012 to 2011/2013, life expectancy at birth increased by 2.4 months for men to 79.6 years, and 1.6 months for women to 83.8 years;
- Canada ranks 13th among women and 11th among men for life expectancy at birth for OECD countries;
- Life expectancy gains occur mostly after age 65. Today, gains in life expectancy at birth occur mostly after age 65, whereas in the early 20th century these gains were mainly due to decreases in infant (under 1 year) and juvenile (between 1 and 4 years) mortality;
- British Columbia had the highest life expectancy at birth in the country in 2011/2013, for men (80.4 years) and for women (84.4 years); and
- The winter/summer death ratio for Canada was 1.16 in 2013, which means the number of deaths in winter was 16% higher than the number of deaths in summer.

Further details can be found from Statistics Canada here: **http://bit.ly/statcan45**

Living to 100 Insight on the Challenges and Opportunities of Longevity

Living to 100 is a research initiative featuring triennial international symposia as a means to share knowledge and cultivate innovation. The Society of Actuaries' Committee on Life Insurance Research, the Committee on Knowledge Extension Research, and the Product Development Section announce the release of a new report that provides an overview and analysis of the mortality models, theories and trends contained in the papers presented at the past five international Living to 100 symposia.

To download the report, please visit **http://bit.ly/soa2598**

Global Mortality Improvement Experience and Projection Techniques

This report examines historical rates of improvement for both the general population and the insured population from a global perspective. Included in the report is also a detailed discussion of current techniques for projecting future mortality and mortality improvement experience.

More information about the report can be found on **http://bit.ly/soa6823**

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