The UK Update aims to highlight recent developments in mortality and longevity in an accessible form by providing hyperlinks through to the original webpages. We cover websites, papers, presentations and articles, and upcoming conferences. The Appendix, provided by David Raymont, IFoA librarian, gives recent academic papers. We are grateful to all contributors and to our peer reviewer, Alison O’Connell, for her constructive approach to reviewing.

Note from Brian: it has been a privilege to be involved in the IFoA Mortality Research Committee, the IAA Mortality Working Group and these Updates since they started. I’m grateful to everybody who has helped to advance these three initiatives. I’m moving on at the end of 2019 to give someone else a chance. In the words of ex-President Jose Mujica of Uruguay on longevity: "Life slips by. The way to prolong it is for others to continue your work."

Introduction
A. This is the 16th Edition of the UK Update, prepared for the IAA Mortality Working Group, members of the IFoA and other people interested in mortality research.
B. Note from Brian: I am delighted to announce two changes for the future:
   • The UK’s Mortality Research Steering Committee (MRSC) has adopted the report and will continue to provide the half-yearly UK Mortality and Longevity Updates
   • Daniel Ryan, member of the MRSC, has worked with me on this Update and will take on the role in future. His contact is: dan.ryan@coiosresearch.ch

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1. What’s new?
   • The IFoA’s Mortality Research Steering Committee is reviewing its research priorities (Sec 2.1)
   • Full agenda papers available for the IAA Mortality working Group meeting in Tokyo, 18 Nov 2019 (Sec 3)
   • Recent US and UK mortality figures have seen improvements (Secs 2.2 and 5)
   • Model available for assessing impact of antibiotic resistance (Sec 2.1)
   • IAA Reorganisation (Sec 3)
   • Concerns about health and future mortality of US millennials (Sec 5)

2. Institute and Faculty of Actuaries  Website

2.1 Mortality Research Steering Committee (MRSC)
The UK’s Mortality Research Steering Committee held a Stakeholder Discussion Forum to consider Research Priorities in the 2020s. The topics under consideration were:
   • Predicting future population mortality improvement
   • Forecasting trends in morbidity

UK Mortality and Longevity Update #16, Brian Ridsdale and Daniel Ryan Nov 2019 11/11/19
• Supporting the Profession’s efforts in resolving the challenge of providing older age care
• Managing risk in products providing longevity protection
• Tools and techniques used for analysing portfolio experience
• Communication of complex risk behaviours in ways that are easy to understand

The committee’s views that the first three should take higher priority were accepted. Inputs from the stakeholder group were wide-ranging and are now being processed by the committee.

Mortality and Longevity Seminar 11 June 2020, London
The Call for Papers has now been issued and will close on 9 December 2019. Sessions will be designed to be accessible to delegates with a broad range of prior knowledge and experience, and to have a practical or business focus. A seminar Chair is also required, apply here.

Antibiotic Resistance: Modelling the Impact on Mortality and Morbidity was issued by the IFoA Antibiotic Resistance Working Party, Chair Matthew Edwards. Summary blog article
The WP concluded that the impact of antibiotic resistance in the UK in terms of numbers of deaths would be relatively limited. For example, under many of the modelled scenarios, deaths from antibiotic resistance would be of a similar order of magnitude to the number of deaths from AIDS/HIV in the 2000-09 decade. The model developed by the Working Party (calibrated with UK data) allows actuaries to develop their own scenarios and explore the future mortality impacts of these. It is hoped that actuaries in other countries will also find the model useful. Details here.

2.2 Continuous Mortality Investigation (CMI) Website
Mortality projections
• The Q3 2019 mortality monitor (dated October 2019) is now available. The next update, for Q4 2019, is expected towards the end of January 2020.
• An updated version of the CMI_2017 software, v04, was released in October 2019 to correct an issue where using certain values of the period smoothing parameter in the Extended initial improvements input would lead to the Model not using the age and cohort smoothing parameters, described on the Working Paper 105 webpage.

Assurances (critical illness and mortality)
• Working Paper 123 was published in July 2019. This paper describes the experience of term assurances in the years 2011 to 2016. Accompanying spreadsheets show summary and detailed results. The paper and accompanying spreadsheets are available to Authorised Users only.

Self-administered pension schemes (SAPS) mortality
• Working Paper 121 was published in May 2019. The working paper presents an analysis of the mortality experience of data by industry classification over the period 2010 to 2017. You must be an Authorised User to access this paper.

High Age Mortality
• The final report of the High Age Mortality Working Party, Working Paper 122, was published in June 2019. The paper reports on how CMI investigation committees have used the HAMWP’s method for extending mortality graduations to high ages; and analysis of data collected from large self-administered pension schemes. Following the publication of this paper, the Working Party has now closed.

CMI comments on the relatively light mortality in E&W in past 12 months: England & Wales mortality monitor - October 2019 Spreadsheet
Mortality in the third quarter of 2019 was relatively light compared to the 2009-2018 average, continuing the period of relatively light mortality observed in the second half of 2018 and the first half of 2019. Comment from Conor O’Reilly of Club Vita: “Coming on the back of several years of relatively heavy mortality, this is welcome news. However, what may be less welcome is the likely impact on liabilities – schemes adopting the latest CMI model could see their liabilities increasing by upwards of 1% as a result of this experience.”

2.3 Actuarial Research Centre (ARC) Website
The ARC is the IFoA’s global network of researchers. All new IFoA research outputs can be found under the ARC programmes’ pages here. Webinars on mortality and longevity are here. All videos are free to watch.

How medical advances and health interventions will shape future longevity, Gitsels et al, BAJ
This paper shows how estimated mortality hazards can be translated to hypothetical changes in life expectancies at the individual and population levels. These calculations are illustrated by two examples: beta blockers in heart attack survivors and blood pressure treatment in hypertensive patients. The second example also illustrates the dangers of applying the results from clinical trials to much wider populations.

Modelling socio-economic differences in mortality using a new affluence index, ASTIN Bulletin. Cairns et al (2019). We introduce a new modelling framework to explain socio-economic differences in mortality in terms of an affluence index that combines information on individual wealth and income. The model is illustrated using data on older Danish males over the period 1985–2012 reported in the Statistics Denmark national register database. The model fits the historical mortality data well, captures their key features, generates smoothed death rates that allow us to work with a larger number of sub-groups than has previously been considered feasible, and has plausible projection properties.

Big Data and Socio-Economic Mortality, Andrew J.G. Cairns, ARC June 2019
Presentation to IFoA Pensions Conference June 2019. Finds spatial/regional effects are significant in explaining the variation in English male mortality, but much less important than socio-economic (non-regional) effects

Still living with mortality: the longevity risk transfer market after one decade Blake, Cairns et al BAJ Vol 24. “provides a review of the developments in longevity risk management over the last decade or so. In particular, we focus on the ways in which pension plans and life insurers have managed their exposure to longevity risk, on why capital market securities failed to take off in the way that was anticipated 10 years ago, and what solutions for managing longevity risk might become available in the future.”

3. IAA Mortality Working Group (MWG) Website
The IAA Seminar on Public Policy, Social Security and Trends in Mortality was held in May in Washington DC. (This item was included in version 2 but not version 1 of the May UK Update) Hosted by the IAA’s Population Issues and Mortality Working Groups in partnership with the Pensions & Social Security Section and Life & Annuities Section. Papers (pdf files):

• Rethinking Annuity Payouts From Defined Contribution Schemes
• Balancing Adequacy Sustainability, and Intergenerational Equity - Canada Pension Plan Auto Adjustment Mechanisms
• General trend and Issues in Finland
• Ideas to Mitigate the Global Pension Crisis
• U.S. Private and Public Sector Panel Discussion Presentation Discussion slides
• **Causes of Death in the U.S. Population**
• **Recent Developments in Longevity Trends**
• **Mortality By Career-Average Earnings Level: U.S. Social Security Administration**
• **Trends in U.S. Motor Vehicle Accident Deaths**
• **Obesity and Smoking**
• **Four Key Trends in Avoidable Mortality and How Public Health Systems Should Respond**

**Summary Report of the Seminar**, Jeff Johnson

**Updates in 13 languages** from IAA MWG meetings in Washington DC, May 2019. Gives access to **Minutes** and all papers.

**Tokyo Seminar**  
**Longevity Inside and Outside Japan** 17 November 2019  
Jointly hosted by the IAA’s Population Issues and Mortality Working Groups and the Institute of Actuaries or Japan (IAJ).

The **Mortality Working Group** meets in Tokyo on 18 November 2019. Agenda and papers are [here](#).

One item on the agenda in Tokyo is **IAA Reorganisation**: The IAA is consulting on an extensive restructure, driven primarily by a need to be more accountable to Full Member Associations. (See Agenda and papers above.) Under the proposed new organisation the Mortality Working Group may be able to transition into a Mortality Forum whose purpose is to foster the sharing of knowledge and expertise by IAA Member Associations and the appropriate Section(s) in the field of mortality and longevity. This makes it particularly timely that the IFoA’s MRSC has taken ownership of this UK Mortality and Longevity Update.

At the end of 2019 I (Brian) shall be standing down as IFoA representative on the MWG and as Chair of the MWG.

Part of this research originated in MWG. Pitacco explains heterogeneity in observed mortality in terms of observable and unobservable risk factors. The former can be explicitly allowed for by rating factors whereas heterogeneity caused by the latter can be expressed and modelled through the concept of individual frailty. The paper provides an excellent overview of the evolution of frailty models and how these models reflect the impact of frailty on cash flows and on both pricing and reserving decisions.

### 4. Other UK

#### 4.1 Office for National Statistics

**National population projections: 2018-based** for the UK and constituent countries were published on 21 October 2019 (Statistical Bulletin). A variety of articles and datasets are published together with the Statistical Bulletin – most likely to be of interest is the **note on the mortality assumptions**

- The population of the UK is projected to increase by 3.0 million (4.5%) in the first 10 years of the projections, from an estimated 66.4 million in mid 2018 to 69.4 million in mid 2028.
- Over the next 10 years, 27% of UK population growth is projected to result from more births than deaths, with 73% resulting from net international migration.
- The proportion aged 85 years and over is projected to almost double over the next 25 years.
- Period life expectancy at birth for UK males is projected to increase from 79.6 years in 2018 to 82.6 years in 2043; for UK females, period life expectancy at birth is projected to increase from 83.2 years in 2018 to 85.5 years in 2043.
- The assumed long-term rate of mortality improvement in 2043 for the UK and each of its countries has been set at 1.2% for ages 0 to 90 years.
• Lower long-term rates of mortality improvement are proposed for ages 91 to 109 years, declining to zero mortality improvement for ages 110 years and above.
• In comparison with the 2016-based assumptions, the 2018-based principal projection of period UK life expectancy at birth in 2043 is 1.1 years lower for males and 0.9 years lower for females.

The 2018-based projected period and cohort life expectancies will be published by ONS on 2 December.

Projections for Scotland
Projections for Northern Ireland

An accompanying ONS article “Who knows the impact of Brexit? Why ONS projections are not predictions” speaks for itself.

ONS have not published the minutes of the expert panel meetings on fertility, mortality and migration but they are available on request from ONS.

National life Tables 2016-18 were published on 25 September 2019. The datasets include NLTs back to 1980-1982. Slight improvements in period life expectancy at birth were observed from 2015-17 of 3.7 weeks and 4.2 weeks for males and females respectively. This year single year life tables were also published for the UK and constituent countries for single years 1980 to 2018 (dataset).

Comment from CMI in The Actuary:
“England and Wales recorded substantially less deaths in the first three quarters of this year than they did over the same period in 2018, ... the cumulative improvement in mortality rates recorded so far in 2019 is higher than it has been for the previous 10 years.”

Suicides in UK (Statistical Bulletin) and various datasets on suicides (Statistical Bulletin)
Deaths by drug poisoning E&W (dataset)
Deaths registered in E&W (Statistical bulletin)
Deaths registered in E&W (dataset)
Child and infant mortality E&W (Statistical Bulletin)
Cancer survival smoothed life tables (dataset)

Estimates of the very old, including centenarians, UK: 2002 to 2018 (Statistical Bulletin)
Latest User guide on mortality statistics
Weekly all-cause mortality surveillance: 2019 to 2020
How the actual number and type of death registrations in England and Wales compare to predictions for each week.
Deaths registered weekly in England and Wales, provisional

4.2 Government Actuaries Department (GAD)
Mortality Insights from GAD - July 2019
The GAD Mortality Insights bulletin provides succinct and accessible information on current developments in the area of longevity research.

4.3 Public Health England
Health profile for England: 2019 Sept 2019
25 million to be offered free NHS flu jab this winter Record numbers of people in England will be offered a flu vaccine this winter. For the first time, all primary school children will be offered the nasal spray.

4.4 Cass
Fifteenth International Longevity Risk and Capital Markets Solutions Washington, Sept 2019
Parallel sessions. Some interesting papers and presentations.

4.5 Other
“Although many countries have seen slower increases in life expectancy since 2011, trends in England and Wales are among the worst. The poor performance of female life expectancy over the long-term is in part driven by the relative timing of the smoking epidemic across countries. The previously overlooked higher mortality among young working-age adults in England and Wales relative to other countries deserves urgent attention.”

“Our new model allows highly parsimonious modelling of risk factors with automatic convergence by age, but without rates crossing over at advanced ages. The model also permits selection effects and age-varying time trend to be estimated from portfolio experience data. Combined with our existing mis-estimation assessment, the model is ideal for (re)insurers underwriting bulk buy-outs, longevity swaps or other large-scale liability transfers.” Longevity has also released its latest version of its survival modelling for analysing risk factors such as mortality, longevity, critical illness or persistency Longevity article on Mortality Convergence at older ages here.

The LUCID (Life Underwriting, Claims and Insurance Doctors) conference was held Oct 2019. Agenda and Speaker presentations (some illuminating and some gory!) are accessible online.

News and insights from Club Vita contains several topical articles including the contribution of different flu strains to excess winter deaths and one on the contribution of advances in technology to healthcare, particularly cancers... “The Cancer Research UK charity notes that the UK’s 10 year survival rates (an average across all cancers) improved from 25% in 1970 to 50% by 2010. It has set itself the target of reaching 75% by the early 2030’s, effectively doubling the pace of improvement.”

5. International
Old and New Perspectives on Mortality Forecasting, Editors: Tommy Bengtsson, Nico Keilman
This open access book has a variety of fascinating articles. “The key question in the book is whether it is possible to project future mortality accurately, and if so, what is the best approach.” It’s part of the Demographic Research Monographs series.

US: The economic consequences of Millennial health, Moody’s Analytics, Nov 2019
“Millennials ...... the generation born from 1981 to 1996 ... are the largest, most educated, and most connected generation the world has ever seen. However, recent data also show the beginnings of troubling generational health patterns that could hamper the future prosperity of millennials, and in turn the prosperity of the U.S.....

UK Mortality and Longevity Update #16, Brian Ridsdale and Daniel Ryan Nov 2019 11/11/19
1. Millennials are seeing their health decline faster than the previous generation as they age..... without intervention, millennials could feasibly see mortality rates climb up by more than 40% compared to Gen-Xers at the same age.

2. These accelerated declines will result in greater demand for treatment and higher healthcare costs in the years ahead. Under the most adverse scenario, millennial treatment costs are projected to be as much as 33% higher than Gen-Xers experienced at a comparable age.

3. Poorer health among millennials will keep them from contributing as much to the economy as they otherwise would.... “


Countries were allocated into three different modelling strategy groups based on the availability of data, enabling the paper to provide a comprehensive assessment of HIV/AIDS incidence, prevalence, mortality and antiviral recombinant therapy (ART) coverage over the period 1980-2017 and forecasts up to 2030. The number of deaths peaked at 1.95m globally in 2006, reducing to 0.95m in 2017. New cases peaked in 1999 at 3.15m, but have reduced more slowly to 1.95 million also in 2017. As a result, global prevalence is 36.8million, and only a minority of countries will hit the UNAIDS targets for ART coverage of 81% in 2020 (54 expected) and 90% in 2030 (12). HIV/AIDS continues to be a major threat to public health, requiring increasing investments in HIV prevention initiatives.


One of the key objectives of the Global Burden of Disease is to promote understanding of mortality, morbidity and disability at the regional level. Zhou et al analysed health patterns in 34 province-level administrative units in China. The report illustrates significant differences between provinces despite government initiatives such as Healthy China 2030 and highlights the need for targeted strategies on key risk factors and diseases in each province. Non-communicable diseases represent 8 of the top leading causes of disability in 2017 (up from 4 in 1990), and stroke is the leading cause of Years of Life Lost (“YLL”) despite reductions in mortality of a third since 1990. The paper focuses in particular on key risk factors such as smoking, high systolic blood pressure, high body-mass index and particular matter pollution, as well as the distribution and extent of the hepatitis B virus vaccination program that was prompted by high rates of mortality from liver cancer.

Recent mortality in the US: Good news maybe? Quarterly Provisional Estimates for Selected Indicators of Mortality, 2017 to Quarter 1, 2019

Courtesy Sam Gutterman: “The U.S. had a really good first quarter, with significantly improved mortality across the board, certainly affected by a good flu season, but also for such causes as cardiovascular diseases. The rolling-12 month mortality trend ending in March saw the largest decrease in the history of this data source (since 2014). So, maybe the mortality doldrums during the period of the early and mid 2010s is behind us (but you can never tell with mortality!).”


The Cancer Survival in High-Income Countries (SURVMARK-2) project aims to provide a comprehensive overview of cancer survival across Australia, Canada, Denmark, Ireland, New Zealand, Norway and the UK. The study captured data on 1-year and 5-year survival rates for over 3m cancer diagnoses. Whilst improvements were seen in all countries, survival rates were relatively worse in New Zealand, Denmark, Ireland and the UK. The strongest improvements were in patients under age 75 and for cancers with poor prognosis such as stomach, pancreas and lung.

UK Mortality and Longevity Update #16, Brian Ridsdale and Daniel Ryan Nov 2019 11/11/19
The study used data from the 1985-2011 National Health Interview Survey Linked Mortality File to investigate how the relationship between education attainment and mortality varied between different US states. Whilst higher-educated adult mortality declined similarly across most US states, lower-educated adult mortality either decreased, increased or stayed constant depending on the US state. Increasing disparities were most common in the South and Midwest of the USA, affecting 11 of the 36 US states examined. The study highlights the need for further investigation but highlights differences in minimum wages, tobacco taxes and earned income tax credits.

Introduces the need to consider population dynamics theory when considering the evolution of aggregate mortality patterns and longevity indicators in the presence of heterogeneity (such as increasing mortality differentials between different socioeconomic groups). The authors show how a cause-of-death reduction could be compensated for in the presence of heterogeneity, which could lead to misinterpretations when assessing public policies impacts and/or for the forecasting of future trends.

This paper describes a dynamic corrective methodology to improve the ability of existing stochastic mortality models to replicate historical data and predict future mortality through modelling fitting errors as a Cox-Ingersoll-Ross process. The methodology is demonstrated on the MS Cairns-Blake-Dowd model using mortality data on Italian and French females.

US Mortality: Underlying Trends By Socioeconomic Group and Cause of Death, Andrew Cairns and Cristian Redondo Loures Presentation to Actuarial Research Conference, Indianapolis, August 2019

US SOA, new pension tables for corporately sponsored pensions Exposure Draft: Pri-2012 Private Retirement Plans Mortality Tables

SOA’s 2010 Living to 100 International research symposium 13-15 Jan 2020

Canada Trends in Canadian Mortality By Pension Level: Evidence From the CPP and QPP Wen, J., Kleinow, T., Cairns, A.J.G: 19 September 2019 Headline conclusions were consistent with observations in other countries: significant variation in the level of mortality by pension level between all pension levels, especially at younger ages, and the inequality gap narrows with age. But some surprises too, including a prominent healthy-immigrant effect in the CPP.

An introduction to gevistic regression mortality models. Scandinavian Actuarial Journal. Medford et al (2019). Medford and Vaupel introduce the Generalised Extreme Value (GEV) distribution as an extension of existing stochastic mortality models that can be presented in a GLM structure. The GEV distribution is typically used in statistics for modelling rare and/or extreme events. The authors demonstrate the value of this distribution for modelling adult mortality in developed, low mortality countries, particularly at the highest ages where population sizes are small. extreme old ages where deaths and survivors are rare. This paper only considers analysing historical data, but future work is expected to explore the value of such models to forecasting future mortality.
New Zealand **A tale of two mortality decades**: Alison O’Connell – June 2019. “The long-run trend is still that the life expectancy of the New Zealand population continues to increase. Average lifespans are getting longer, just not as fast as they once were.

**OECD/Eurostat lists of preventable and treatable causes of death** (2019 version)

**International Alliance for Cancer Early Detection** is a new £55 million partnership between Cancer Research UK, the Canary Center at Stanford University, the University of Cambridge, the Knight Cancer Institute at OHSU, University College London and the University of Manchester.

6. **Forthcoming Seminars and Conferences (summary)**
   - The Seminar **Longevity Inside and Outside Japan** Tokyo, Sunday, 17 November
   - **ARC Workshop: Modelling Socio-Economic Differences in English Mortality** London 2 Dec 2019
   - SOA’s **2010 Living to 100** International research symposium 13-15 Jan 2010
   - IFoA’s **Mortality and Longevity Seminar** 11 June 2020, London

7. **Reference Sites**
   - IFoA [Actuarial Research Centre (ARC)]
   - IFoA [Continuous Mortality Investigation (CMI)]
   - IFoA [Mortality Research Steering Committee (MRSC)]
   - IFoA [Event paper archive]
   - SoA [Mortality & Longevity Strategic Research (overview)]
   - SoA [Research Papers]

..........................................................**About this note**..........................................................
This is a note for the UK Actuarial profession and others, and for the International Actuarial Association (IAA). The previous UK update, May 2019 is [here](opens pdf). This one can be accessed [here](opens pdf)

The web page for the IAA Mortality Working Group is [here](opens pdf). From there you can navigate to Meeting Documents, Updates, the Information Base and other pages.
The web page for the Institute and Faculty of Actuaries Mortality Research Hub is [here](opens pdf), for the CMI is [here](opens pdf) and for the ARC is [here](opens pdf).

You can give us your feedback [here](opens pdf) if you like

Brian Ridsdale and Daniel Ryan November 2019

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INSTITUTE AND FACULTY OF ACTUARIES LIBRARY SERVICES

A note from David Raymont, IFoA librarian:
“The IFoA Library offers online access to articles in journals for IFoA members via its ‘Actuarial Knowledge Hub’: http://discovery.actuaries.org.uk. There is a prepared search for articles on ‘Mortality, Longevity and Ageing Population’ via the IFoA Library’s ‘New acquisitions and subject search’ page, or click here.

IFoA members can use the login link or http://bit.ly/ifoaathenslogin using their member login for the IFoA website to access full text of most articles.”

Members can also request books via the new catalogue at http://library.actuaries.org.uk

The IFoA Library has acquired two books that may be of interest to members:

Abstract: Managing longevity risk (LR) requires an understanding of a wide range of issues, from the measurement of LR for pricing, reserving and setting aside capital, to the management of risk through de-risking, reinsurance and capital markets solutions. These diverse topics are assiduously explored in this text by longevity thought-leaders and practitioners, whose extensive experience cuts across disciplines, from (re)insurance to capital markets, from law to medicine and academia, as well as across the major longevity markets globally. As LR evolves, so does the sophistication of the tools with which we measure and manage the risk. It is the aim of this book to inform the reader and arm them with the knowledge to develop robust and innovative solutions, enabling the effective management of longevity risk, for the long-term benefit of future generations.


THE ACTUARY


ASTIN BULLETIN: THE JOURNAL OF THE INTERNATIONAL ACTUARIAL ASSOCIATION


DEMOGRAPHY

Montez, Jennifer Karas; Zajacova, Anna; Hayward, Mark D; Woolf, Steven H; Chapman, Derek and Beckfield, Jason (2019). Educational disparities in adult mortality across U.S. States: how do they differ, and have they changed since the mid-1980s? Demography 56(2): UK Mortality and Longevity Update #16, Brian Ridsdale and Daniel Ryan Nov 2019 11/11/19
621-644.
https://doi.org/10.1007/s13524-018-0750-z

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Medford, Anthony; Christensen, Kaare; Skythte, Axel and Vaupel, James W (2019). A cohort comparison of lifespan after age 100 in Denmark and Sweden: Are only the oldest getting older? Demography 56(2): 665-677. 
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https://doi.org/10.1007/s13524-019-00785-3

https://doi.org/10.1007/s13524-019-00789-z

EUROPEAN ACTUARIAL JOURNAL

https://doi.org/10.1007/s13385-019-00194-3

https://doi.org/10.1007/s13385-019-00207-z

INSURANCE: MATHEMATICS AND ECONOMICS

https://doi.org/10.1016/j.insmatheco.2019.07.001

https://doi.org/10.1016/j.insmatheco.2019.07.004

https://doi.org/10.1016/j.insmatheco.2019.06.005

https://doi.org/10.1016/j.insmatheco.2019.07.005

JOURNAL OF RISK AND INSURANCE

https://doi.org/10.1111/jori.12203

https://doi.org/10.1111/jori.12229

THE LANCET

https://doi.org/10.1016/S2352-3318(19)30196-1

https://doi.org/10.1016/S0140-6736(19)30427-1

https://doi.org/10.1016/S1470-2045(19)30455-6

NORTH AMERICAN ACTUARIAL JOURNAL

https://doi.org/10.1080/10920777.2018.1513369

https://doi.org/10.1080/10920777.2018.1556701

UK Mortality and Longevity Update #16, Brian Ridsdale and Daniel Ryan Nov 2019

11/11/19


POPULATION STUDIES


SCANDINAVIAN ACTUARIAL JOURNAL

