Actuarial Research Centre
Institute and Faculty of Actuaries

University of East Anglia

ESRC Business and Local Government Data Research Centre

Big Health and Actuarial Data: overwiew

Elena Kulinskaya
Aviva Chair in Statistics,
School of Computing Sciences,
UEA

The **'Use of Big Health and Actuarial Data for understanding Longevity and Morbidity Risks'** research programme is being funded by the Actuarial Research Centre.

17 May 2018

Actuarial Research Centre
Institute and Faculty of Actuaries

Disclaimer: The views expressed in this presentation are those of invited contributors and not necessarily those of the Institute and Faculty of Actuaries. The Institute and Faculty of Actuaries do not endorse any of the views stated, nor any claims or representations made in this presentation and accept no responsibility or liability to any person for loss or damage suffered as a consequence of their placing reliance upon any view, claim or representation made in this presentation. The information and expressions of opinion contained in this presentation are not intended to be a comprehensive study, nor to provide actuarial advice or advice of any nature and should not be treated as a substitute for specific advice concerning individual situations. On no account may any part of this presentation be reproduced without the written permission of the Institute and Faculty of Actuaries.

Use Of Big Health And Actuarial Data For Understanding Longevity And Morbidity Risks, IFoA 2016-2020

Consortium

University of East Anglia: School of Computing Sciences (CMP) and Norwich Medical School (NMS).

Aviva Life Plc.

Principal Investigator

Prof Elena Kulinskaya, Aviva Chair in Statistics, CMP

UEA co-investigators

CMP: Dr Beatriz de la Iglesia, Dr Ilyas Bakbergenuly, Dr Lisanne Gitsels

NMS: Prof Ruth Hancock, Prof Nick Steel

Aviva co-investigators

Mr Nigel Wright, actuary; Ms Sarah Allen, Senior Data Analyst, the Life Risk Analytics team.

Actuarial Research Centre
Institute and Faculty of Actuaries

http://www.bighealthactuarialdata.ac.uk/

Big Health Actuarial Data

Home | Project Description | The Team | Publications | Press | Contact us

Big Actuarial Health Data > Home

This is the website of the research project on the Use Of Big Health And Actuarial Data For Understanding Longevity And Morbidity Risks. The project is funded by Institute and Faculty of Actuaries for 4 years from October 2016.

The main objectives of this project are the development of novel statistical and actuarial methods for modelling mortality, modelling trends in morbidity, assessing basis risk and evaluating longevity improvement based on Big Health and Actuarial Data.

Longevity and morbidity risks are of essential importance to the actuarial community. Longevity is increasing considerably both in developed and developing countries, including the UK. We believe that to be able to establish the drivers of this change, and to predict how they may change over time and how this would affect life expectancy, actuarial researchers need to engage in statistical modelling of mortality experience using large scale population-based individual level data collected over the long term. Big Actuarial Data such as the CMI data are then required to translate the results to the reference population of relevance to the actuarial community.

The multidisciplinary UEA/Aviva team led by Prof Elena Kulinskaya includes actuaries, statisticians, health economists, computer scientists and medical researchers. The funding supports three PhD students and a postdoctoral researcher.

Contact us

School of Computing Sciences
University of East Anglia
Norwich Research Park
Norwich
NR4 7TJ
United Kingdom
Tel: 01603 592300
Email: i.bakbergenuly@uea.ac.uk

UEA University of East Anglia

Institute and Faculty of Actuaries

Actuarial Research Centre
Institute and Faculty of Actuaries

AVIVA

Actuarial Research Centre
Institute and Faculty of Actuaries

Main objectives

Development of novel statistical and actuarial methods for:

- Modelling mortality
- Modelling trends in morbidity and uptake of health interventions
- Assessing basis risk
- Evaluating longevity improvement based on Big Health and Actuarial Data
- Tools to forecast longevity risk of a book

Science

Scientists and insurers develop 'death clock' to predict when customers will die

share

A new computer algorithm will predict how long people will live CREDIT: WALES NEWS SERVICE LTD.

Actuarial Research Centre
Institute and Faculty of Actuaries

CMI population projections

- The CMI Mortality Projections Model is a deterministic model based on the assumption that current rates of mortality improvement converge to a single long-term rate.
- The latest version of the Model, CMI_2017, published in March 2018, is calibrated to England and Wales population mortality data up to 31 December 2017.
- The CMI Model smooths historical mortality rates and then blends between current and long-term future mortality improvements.
- The CMI Model itself does not make an assumption for long-term mortality improvements. As a minimum, users need to input the long-term rate of mortality improvement.

https://www.actuaries.org.uk/learn-and-develop/continuous-mortality-investigation/cmi-working-papers/mortality-projections/cmi-working-paper-105

Quantifying longevity changes

- Medical advances and social changes are the major drivers in the longevity increase. But how to quantify this relationship?
- Our research uses The Health Improvement Network (THIN) primary care data to develop statistical models of longevity.

Data-driven models for understanding life expectancy trends.

Data: Observational Administrative data

- The Health Improvement Network (THIN) data
  - Medical records from primary care
  - Representative of the UK when adjusted for deprivation
- All patients born before 1960 and followed to 01.01.2017, this includes 3.5 million patients
- Added various social economic status variables such as Index of Multiple Deprivation and Mosaic
- Additional Actuarial Data

Actuarial Research Centre
Institute and Faculty of Actuaries

Working with Big Data: Careful Design

- For a particular condition we design a population-based retrospective cohort study using an appropriate extract of the primary care data.

- We mostly use a case-control design with cases matched with several controls from the same GP practice. This provides balanced and comparable cohorts of cases and controls and simplifies the study of comparatively rare conditions without loss of efficiency.

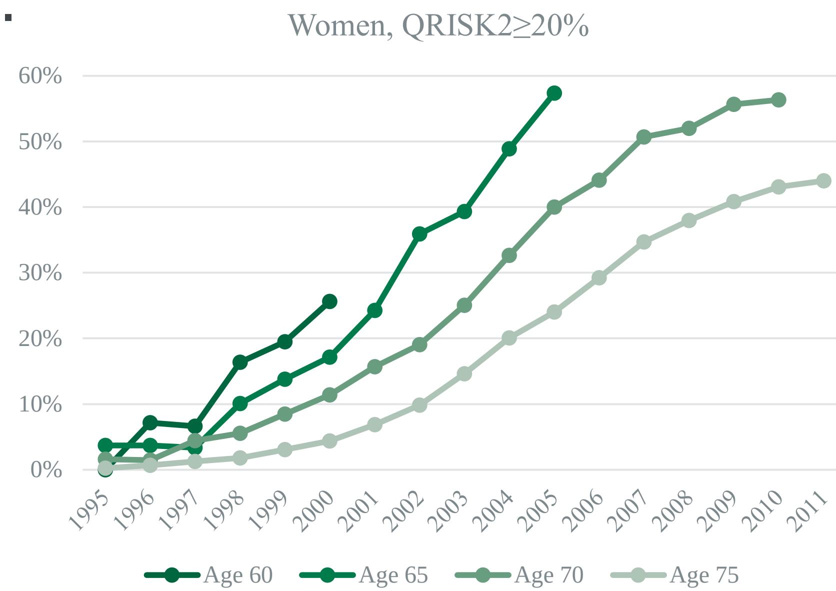
- We use multilevel modelling to account for the interdependence of patients from the same GP practice and multilevel multiple imputation to account for missing data.

Actuarial Research Centre
Institute and Faculty of Actuaries

Working with Big Data: Sophisticated Analysis

- The full list of relevant confounding variables is established from medical literature such as systematic reviews, and from expert knowledge within the team.

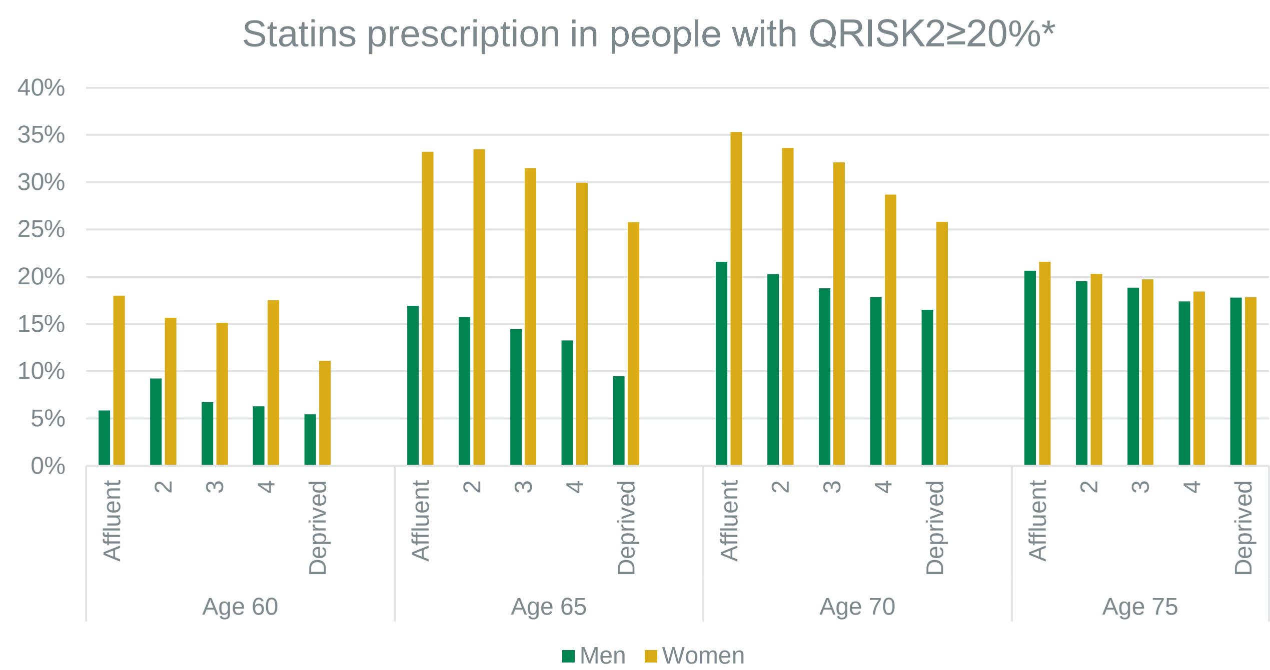
- The advantage of using individual-level medical data is that it is possible to model both the uptake of medical treatment and the effect of that treatment on longevity conditional on the individual sociodemographic and health factors.



Prevalence of statins prescription for primary prevention of cardiovascular disease over time

Actuarial Research Centre
Institute and Faculty of Actuaries

Prevalence of statins prescription for primary prevention of cardiovascular disease by deprivation quintiles (Townsend)



*summarised over 1995-2011

Recent changes in mortality improvements

“From 1968-2010, 70% of all mortality improvements can be attributed to the fall in deaths from circulatory diseases.

…

The period 2011-16 saw much lower mortality improvements in circulatory diseases.”

***Jon Palin** on behalf of the CMI Mortality Projections Committee,*

Mortality improvements in decline *The Actuary, 2017/08*

Actuarial Research Centre
Institute and Faculty of Actuaries

Drivers of these changes

- But what were the drivers of this rapid improvement and the consequent decline in longevity improvement rates?
- We show that these developments in longevity are mainly due to statins, cholesterol lowering drugs prescribed to prevent cardiovascular disease (CVD).

- Gitsels L.A., Kulinskaya E., Steel N. (2016) Survival Benefits of Statins for Primary Prevention: A Cohort Study. PLoS ONE **11**(11): e0166847. doi:10.1371/journal.pone.0166847
- Gitsels L.A., Kulinskaya E. Quantifying the impact of medical advances on longevity. *The Actuary*, to appear

Actuarial Research Centre
Institute and Faculty of Actuaries

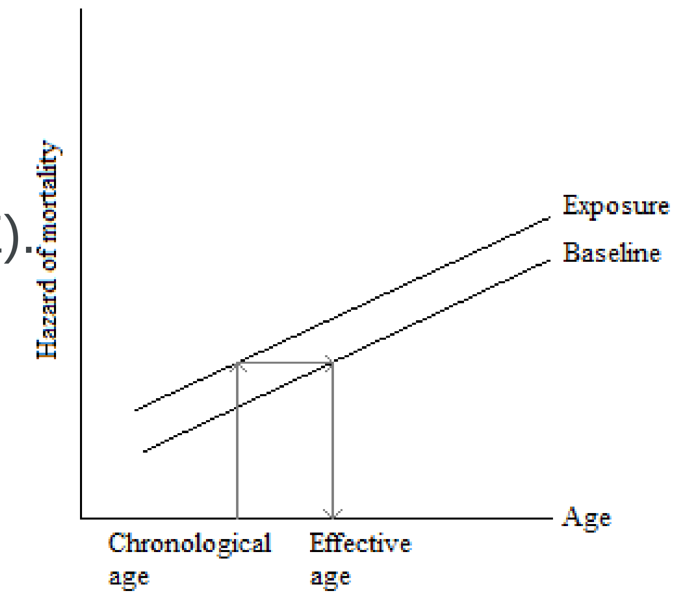
Methodology

- Build a survival model

- Translate Hazard Ratios (HRs) from the survival model into changes in effective age.

- Taking into account the uptake of intervention over time, translate to population Life Expectancy (LE).

- Assess to what extent treatments have already contributed to the past improvements in LE, and how hypothetical changes in the prevalence of medical conditions and respective treatments can be projected on future mortality rates.



Actuarial Research Centre
Institute and Faculty of Actuaries

Example: Would intensive systolic blood pressure control increase longevity?

SPRINT trial reported considerable survival benefits of intensive systolic blood pressure (SBP) lowering below 120 mmHg.

The intensive treatment has a hazard ratio (HR) of 0.73 (0.60, 0.90) compared to standard treatment:

a decrease in effective age of 3.4 to 3.6 years.

The American Heart Association changed its hypertension guideline on the basis of SPRINT results (Whelton et al. 2017).

AHA Guidelines: boost to the LE in the US?

New NICE guidelines on BP are under development.

Actuarial Research Centre
Institute and Faculty of Actuaries

Goal of this workshop

Wide scale medical advances may (or may not) change longevity.

Use observational data to evaluate possible effects in general population

Pathways to Impact:

- Guidelines, Implementation, Education…
- Possible changes in mortality assumptions, hence in population projections.
- Resulting changes in a variety of policies and business models, from public health to pensions and insurance products.

Mapping possible collaborations?

References

- Brenner H, Gefeller O, Greenland S. (1993) Risk and rate advancement periods as measures of exposure impact on the occurrence of chronic diseases. *Epidemiol Camb Mass*. 4(3):229–36.
- Gitsels LA, Kulinskaya E, Steel N (2016) Survival Benefits of Statins for Primary Prevention: A Cohort Study. PLoS ONE **11**(11): e0166847. doi:10.1371/journal.pone.0166847.
- Spiegelhalter (2016) How old are you, really? Communicating chronic risk through 'effective age' of your body and organs. *BMC Medical Informatics and Decision Making,* 16:104
- The SPRINT Research Group**.** A Randomized Trial of Intensive versus Standard Blood-Pressure Control. *New England Journal of Medicine*, 2015 373:2103-2116, DOI: 10.1056/NEJMoa1511939

Actuarial Research Centre
Institute and Faculty of Actuaries

Actuarial
Research Centre

Institute and Faculty
of Actuaries

The Actuarial Research Centre (ARC)

A gateway to global actuarial research

The Actuarial Research Centre (ARC) is the Institute and Faculty of Actuaries' (IFoA) network of actuarial researchers around the world.

The ARC seeks to deliver cutting-edge research programmes that address some of the significant, global challenges in actuarial science, through a partnership of the actuarial profession, the academic community and practitioners.

The '**Use of Big Health and Actuarial Data for understanding Longevity and Morbidity Risks**' research programme is being funded by the ARC.

Questions

Comments

University of East Anglia

ESRC Business and Local Government Data Research Centre

Actuarial Research Centre
Institute and Faculty of Actuaries

The views expressed in this presentation are those of the presenter.