Trends in the cause-specific mortality experience in England and Wales
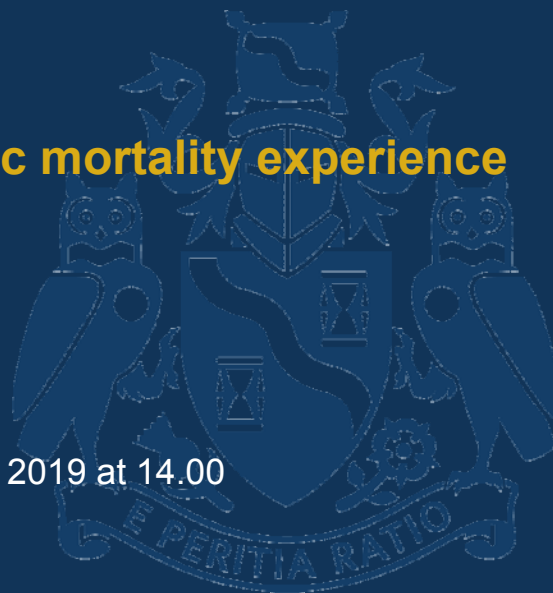
Alexander Yiu
Heriot-Watt University
Joint work with G. Streftaris and T. Kleinow

Presented by webinar: Tuesday 4 June 2019 at 14.00

02 July 2019

Introduction

- The rate of improvement in mortality rates in England and Wales has slowed down in recent years.

- The cause-specific mortality data in these countries may provide insight into the reduction in mortality rate improvements.

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Introduction

Research goals:

- Determine the location of a change in the temporal trend in mortality rates and if the change is significant.

- Determine which causes have the greatest contribution to the change in the temporal trend.

- Investigate scenarios for continuing cause-specific mortality trends.

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Outline

- Identifying changes in the temporal trend in mortality rates.

- Cause-specific contributions to the observed slowdown in all-cause mortality improvements.

- Life expectancy projections with continuing cause-specific trends.

- Application to cause-specific mortality by income deprivation decile.

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Data for England and Wales

England and Wales from 2001 to 2017:

- Death counts by International Classification of Diseases classification (ICD-10), five-year age group, gender, and year of registration.

- Mid-year population estimates by age group, gender, and year.

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Data for England and Wales

Deaths are separated into the following cause-of-death groups

- **Blood and blood-forming organ diseases –** Anaemias
- **Cancers (Neoplasms) -** Lung cancer, colon cancer
- **Certain infectious diseases –** HIV, hepatitis
- **Circulatory system diseases –** Heart attack, stroke
- **Digestive system diseases –** Hernia, liver diseases
- **Endocrine system diseases –** Diabetes, malnutrition
- **External causes** – Suicides, accidents
- **Genitourinary system diseases –** Urinary system diseases
- **Nervous system diseases –** Alzheimer's disease,
- **Mental and behavioural illnesses –** Schizophrenia, Dementia
- **Musculoskeletal system diseases –** Joint disorders, arthritis
- **Respiratory system diseases –** Pneumonia, asthma
- **Skin diseases –** Skin infections
- **All other causes**

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Identifying changes in the temporal trend in mortality rates

- $d_{x,t}$ is the number of deaths for individuals in age group x registered in calendar year t

- $E_{x,t}^C$ is the central rate of exposure for age group x in calendar year t

- E_x^S is the standardised population for age group x

- Age-specific central mortality rates for age group x and calendar year t
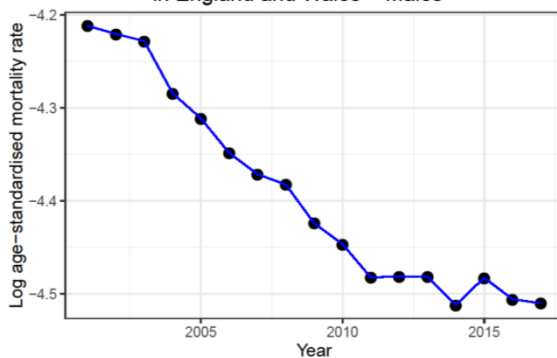
$$m_{x,t} = \frac{d_{x,t}}{E_{x,t}^C}$$

- Age-standardised mortality rates for calendar year

$$ASMR_t = \frac{\sum_{x=x_1}^{x_n} m_{x,t} E_x^S}{\sum_{x=x_1}^{x_n} E_x^S}$$
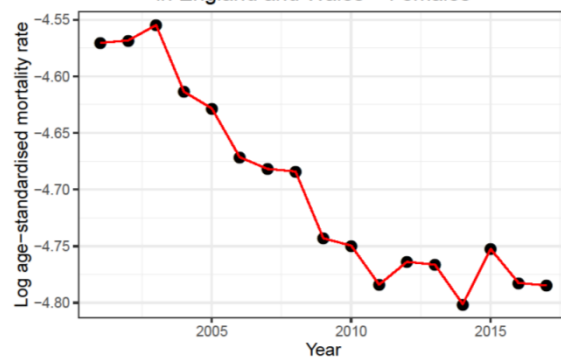
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Identifying changes in the temporal trend in mortality rates

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Identifying changes in the temporal trend in mortality rates

Model with no change in temporal trend in log ASMR

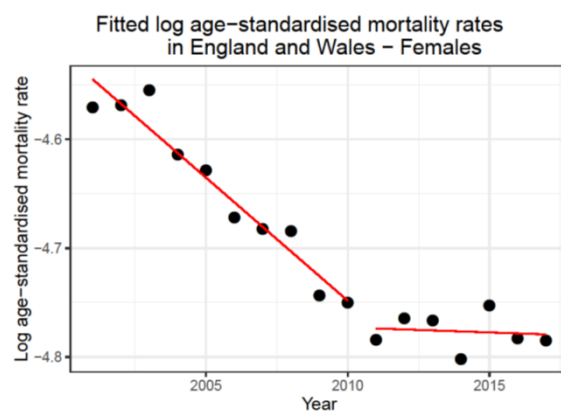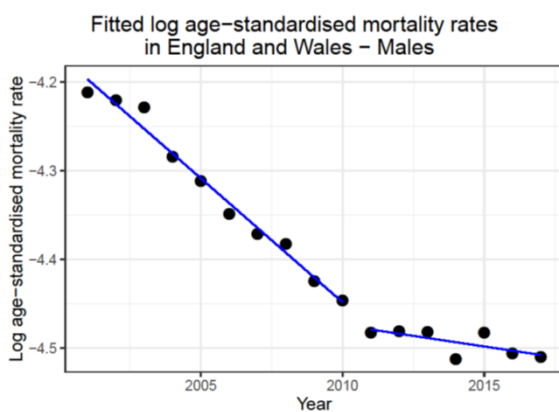$$\log\left(\widehat{ASMR}_t\right) = \widehat{\beta_0} + \widehat{\beta_1}\, t$$

Model with a single change in trend at the point $t = \varepsilon$

$$\log\left(\widehat{ASMR}_t\right) = \widehat{\beta_0} + \widehat{\beta_1}\, t + \left(\widehat{\beta_2}(t - \varepsilon) + \widehat{\beta_3}\right)I(t \geq \varepsilon)$$

- $\widehat{\beta_0}$ - intercept
- $\widehat{\beta_1}$ - pre-breakpoint temporal trend
- $\widehat{\beta_2}$ - post-breakpoint change in temporal trend
- $\widehat{\beta_3}$ - adjustment for discontinuity at breakpoint

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Identifying changes in the temporal trend in mortality rates

Fitted log age−standardised mortality rates in England and Wales − Males

Fitted log age−standardised mortality rates in England and Wales − Females

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Cause-specific contributions to the observed slowdown in mortality improvements

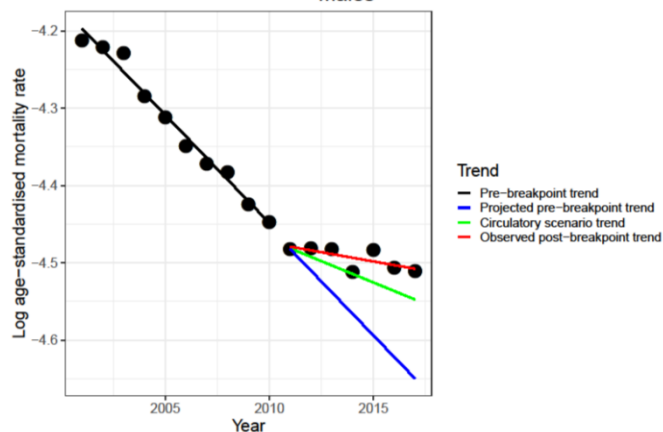Cause-specific trend scenarios

$$\log(\widehat{m}_{c,x,t}) = \hat{\beta}_{0,c,x} + \hat{\beta}_{1,c,x}t + (\hat{\beta}_{2,c,x}(t - 2011) + \hat{\beta}_{3,c,x})\mathrm{I}(t \geq 2011)$$

- $\hat{\beta}_{0,c,x}$ - cause c- and age group x- specific intercept

- $\hat{\beta}_{1,c,x}$ - pre-2011 temporal trend

- $\hat{\beta}_{2,c,x}$ - post-2011 change in temporal trend

- $\hat{\beta}_{3,c,x}$ - adjustment for discontinuity at 2011

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Cause-specific contributions to the observed slowdown in mortality improvements

Fitted log age−standardised mortality rates in England and Wales Males

The circulatory scenario trend is the projected log ASMR where the age-specific mortality rates for circulatory system diseases follow the pre-2011 trend rather than the observed trend while the observed rates for all other causes remain constant.

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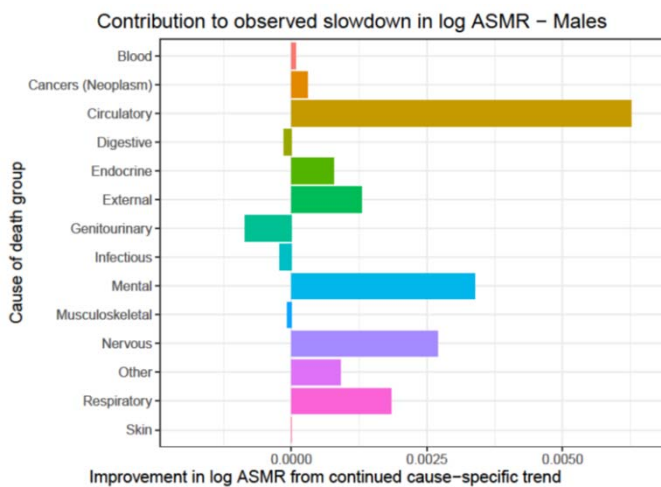of Actuaries

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Cause-specific contributions to the observed slowdown in mortality improvements

- The cause-specific contribution is the difference between the slope in the observed trend and the slope of the cause scenario trend from 2011 to 2017.

- The relative contributions of each cause of death may be compared for the purpose of determining the causes with the greatest contribution in the observed slowdown.
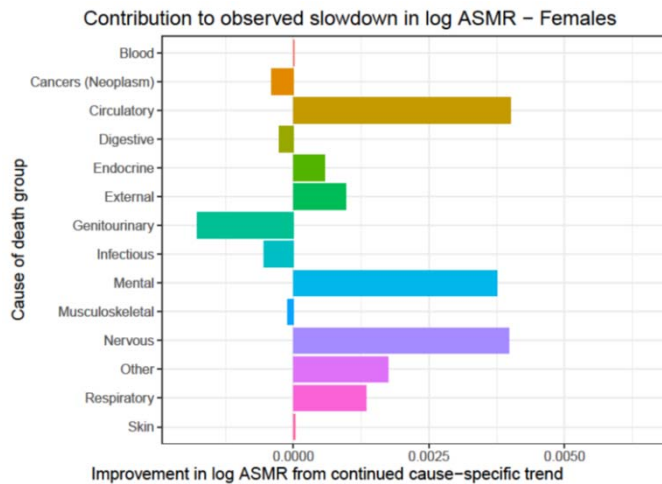
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Cause-specific contributions to the observed slowdown in mortality improvements

Contribution to observed slowdown in log ASMR – Males

The changes in the mortality trends for circulatory system diseases has the greatest contribution to the observed slowdown in log ASMR improvements.

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Cause-specific contributions to the observed slowdown in mortality improvements

Circulatory system diseases, mental and behavioural illnesses, and nervous system diseases have the greatest contributions to the observed slowdown in log ASMR improvements.
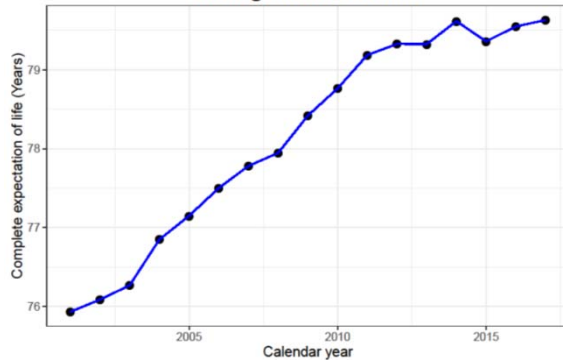
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Life expectancy projections with continuing cause-specific mortality trends
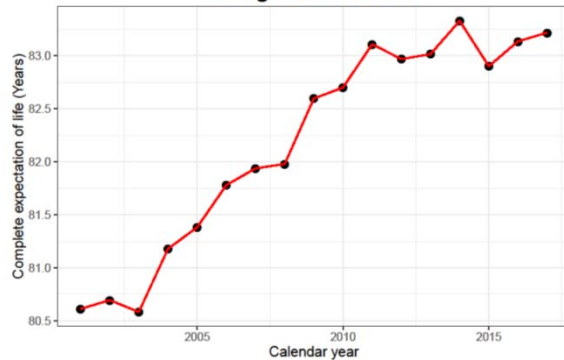
Period life expectancies

- The period life expectancies are projected using single-year period mortality rates.

- The complete expectation of life is used for the following analyses.

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Life expectancy projections with continuing cause-specific mortality trends

Complete expectation of life at birth for males in England and Wales

Complete expectation of life at birth for females in England and Wales

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Life expectancy projections with continuing cause-specific mortality trends

• Cause-specific scenarios are used to quantify changes in the projected life expectancies.

• The methodology in the age-standardised mortality rate analysis is performed for the analysis of projected life expectancies.

• The rate of improvement in a cause-specific scenario is compared against the observed improvement rate per year after 2011.

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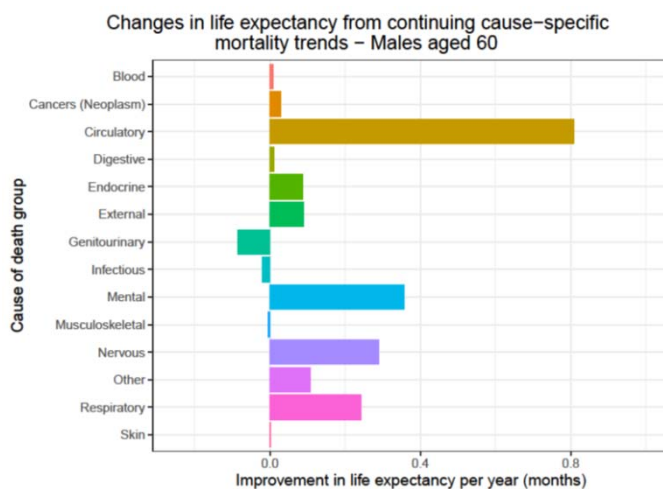# Life expectancy projections with continuing cause-specific mortality trends

Changes in life expectancy from continuing cause–specific mortality trends– Males at birth
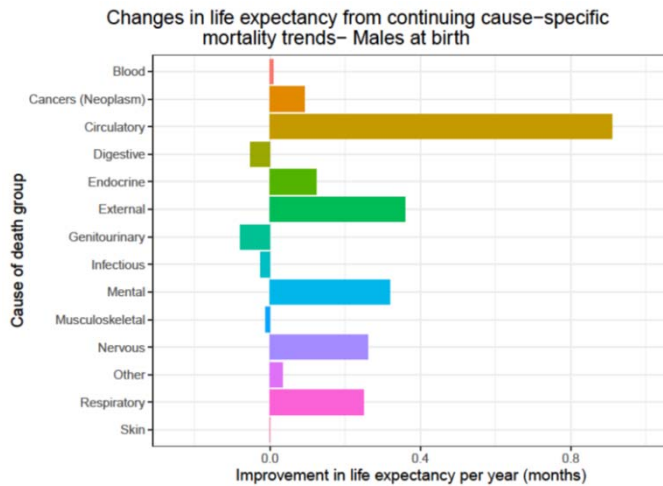
The greatest improvement in the projected life expectancy is achieved if the pre-2011 trends in age-specific mortality rates for circulatory system had continued after 2011.
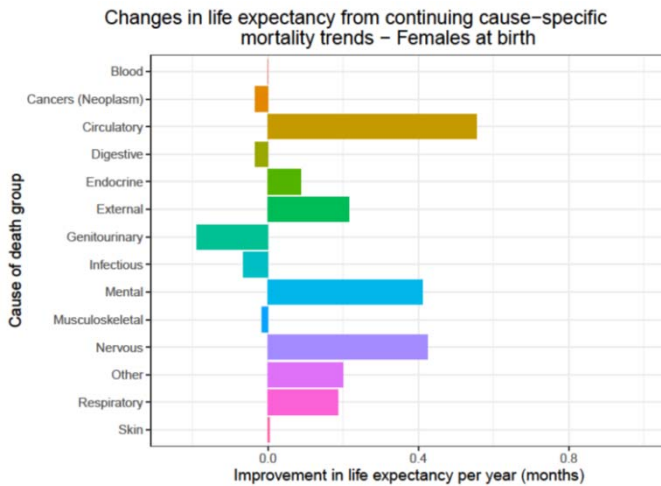
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Life expectancy projections with continuing cause-specific mortality trends

Changes in life expectancy from continuing cause–specific mortality trends – Males aged 60

The projected life expectancies for individuals aged 60 no longer capture the mortality rate improvements or reductions at younger ages.

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Life expectancy projections with continuing cause-specific mortality trends

Changes in life expectancy from continuing cause–specific mortality trends – Females at birth

Life expectancy gains from circulatory system diseases, mental and behavioural illnesses, and nervous system diseases are closer for females than for males.

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Life expectancy projections with continuing cause-specific mortality trends

Changes in life expectancy from continuing cause–specific mortality trends – Females aged 60

The projected life expectancies for individuals aged 60 no longer capture the mortality rate improvements or reductions at younger ages.

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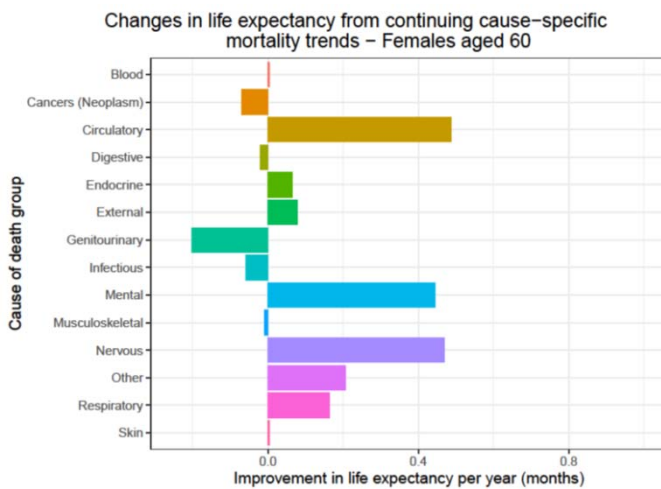
Deprivation data for England

England from 2001 to 2016:

- Death counts by International Classification of Diseases classification (ICD-10) group, age group, income deprivation decile, gender, and year of registration.

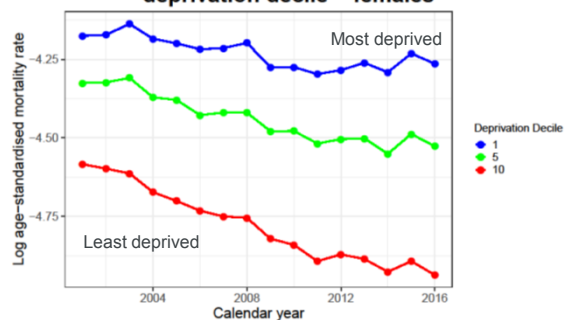- Mid-year population estimates by age group, income deprivation decile, gender, and year.

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Application to cause-specific mortality by deprivation decile

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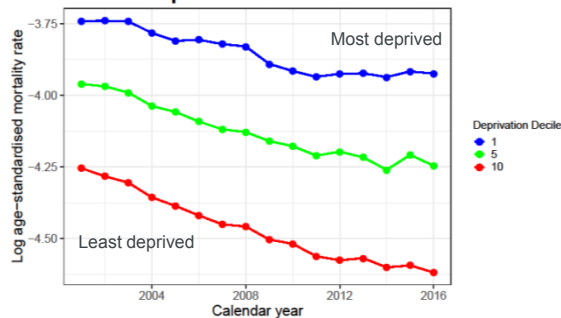
Application to cause-specific mortality by deprivation decile

Cause−specific contribution to observed slowdown in log age−standardised mortality rates by deprivation decile − Males
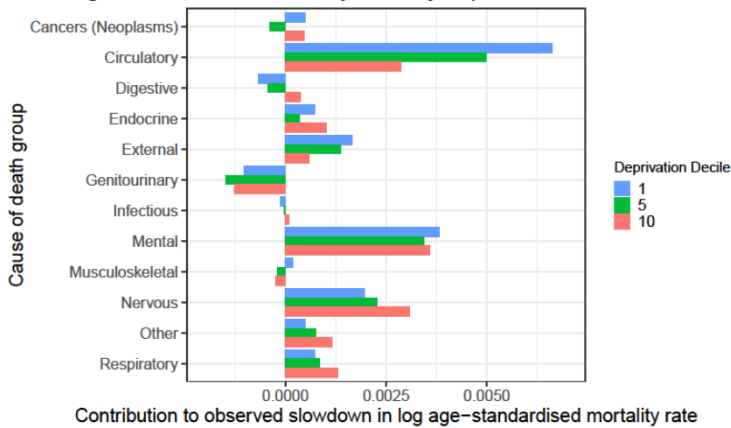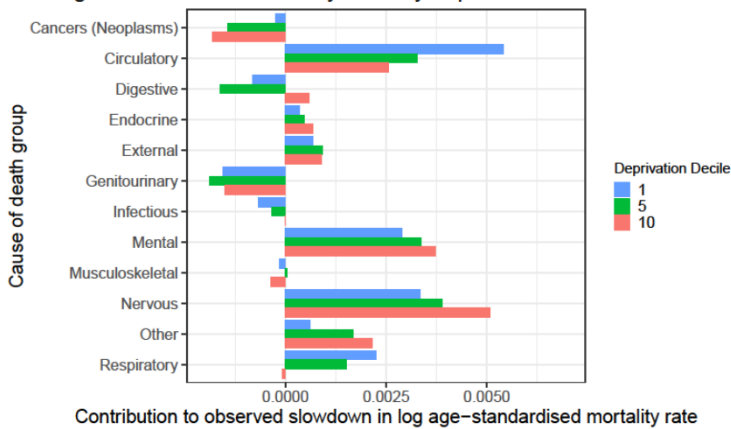

Circulatory system diseases have the greatest contribution towards the slowdown for the most deprived decile while mental and behavioural illnesses is the leading cause group for the least deprived decile.

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Application to cause-specific mortality by deprivation decile

Cause−specific contribution to observed slowdown in log age−standardised mortality rates by deprivation decile − Females


Circulatory system diseases are the greatest contributor towards the slowdown for the most deprived decile while nervous system diseases is the leading cause group for the least deprived decile.
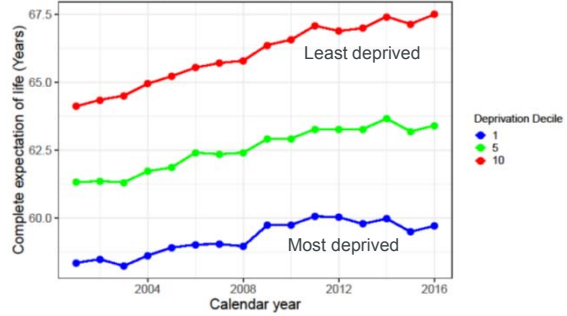
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Application to cause-specific mortality by deprivation decile

Complete expectation of life at age 20 by deprivation decile – males
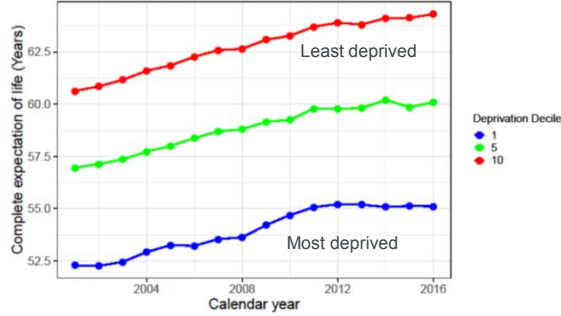
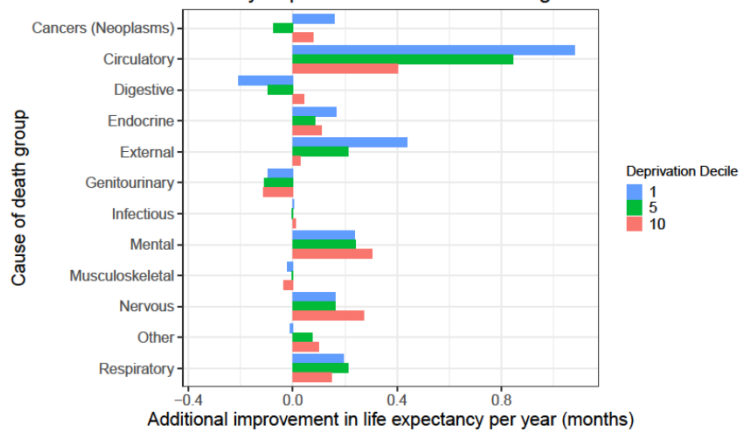Complete expectation of life at age 20 by deprivation decile – females

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Application to cause-specific mortality by deprivation decile

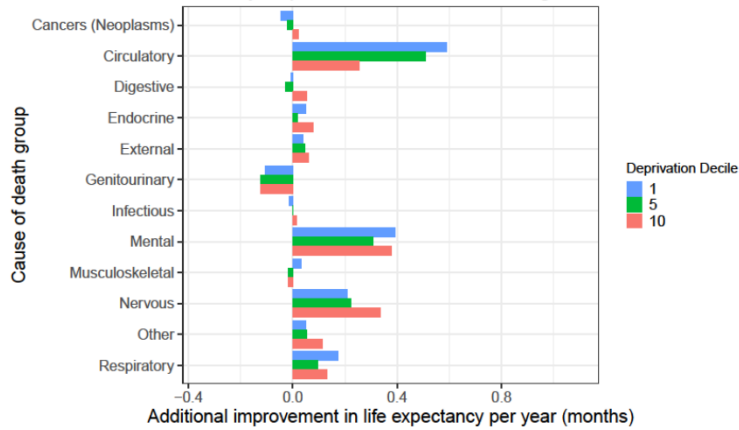Changes in life expectancy from continuing cause-specific mortality trends by deprivation decile – Males aged 20

Continuing trends in circulatory system diseases result in the greatest improvements in life expectancy for the most deprived decile.

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Application to cause-specific mortality by deprivation decile

Changes in life expectancy from continuing cause−specific mortality trends by deprivation decile − Males aged 60
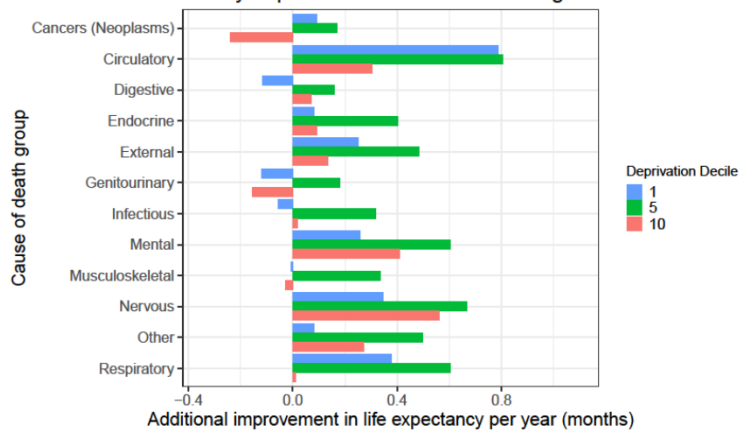
The greatest gains for the least deprived decile result from causes of death where the changes in mortality rate trends were greatest at older ages.

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Application to cause-specific mortality by deprivation decile

Changes in life expectancy from continuing cause−specific mortality trends by deprivation decile − Females aged 20

Life expectancy gains are not as great for the least deprived decile as these individuals do not experience as great of a reduction in mortality rate improvements compared to other deciles.

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Application to cause-specific mortality by deprivation decile

Changes in life expectancy from continuing cause−specific mortality trends
by deprivation decile − Females aged 60

Continuing trends in circulatory system diseases result in the greatest improvements in life expectancy for the most deprived decile.

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Concluding remarks

- Circulatory disease mortality trends have the greatest impact on the observed slowdown of mortality rate improvements in the overall population.

- Individuals in the most deprived decile experienced the greatest reduction in improvement rates past 2011.

- Projected life expectancies capture more information about age-specific mortality trends in cause-specific mortality.

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Questions

Comments

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References

- Office for National Statistics (2018). Changing trends in mortality: a cross-UK comparison, 1981 to 2016. https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/lifeexpectancies/articles/changingtrendsinmortality/acrossukcomparison1981to2016

- Office for National Statistics (2018). National life tables, UK: 2015 to 2017. https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/lifeexpectancies/bulletins/nationallifetablesunitedkingdom/2015to2017

- The cause-specific mortality data for England and Wales and cause-specific mortality by income deprivation decile data for England was supplied by the Office for National Statistics.

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