# Abstract

**Background**

All-cause age-specific mortality risks have tended to be decreasing in England & Wales for more than a century. The period 2008-2015 has seen both a global recession, and since 2010, two Conservative-led governments pursuing an ‘austerity’ agenda of reduced investment in public services.

**Aim**

To estimate trends in age-specific mortality risks from 1990 to 2010, use these trends to produce estimated age-specific risks over the period 2010 to 2015, and compare recorded numbers of deaths in each year against those predicted if trends in age-specific death rates observed during the New Labour period of 1997 to 2010 had continued.

**Methods**

Office for National Statistics (ONS) data on population counts and death counts at each age in single years from birth to age 95 years (2010 to 2014 data) or to age 89 years (2015 data) were used to construct linear regression models of mortality risk against year for each age in single years from 1990 to 2010, including dummy variables to control separately for effects of the New Labour (NL) government (1997-2010) and the 2008-2009 global financial crisis (GFC). The models were used to estimate the mortality risks that would have been expected if mortality trends during the New Labour period had continued. The number of age-specific deaths at each age in each year from 2011 to 2015 were estimated given population counts in each year, and compared with observed number of deaths in each year.

**Results**

There were slightly fewer deaths than predicted from the models in 2010 and 2011, but from 2012 to 2015 there have been an additional 42,800 deaths than predicted from up to age 90, and an additional 61,000 additional deaths up to age 95 years. Most additional deaths occurred after retirement age, and were more likely among males than females.

**Discussion**

Falling levels of investment in social and health care services in England & Wales since 2010 may be responsible for mortality rates at older ages either increasing or falling more slowly than would have been expected if previous improvements had continued. Given much of the apparent additional deaths have occurred amongst the old there is a need for accurate population and death records for people aged 90 years and older.

# Introduction

# Methods

## Data

Mid-year population count and death registrations for England & Wales for years up until 2015 were extracted from the ONS Excel spreadsheet ‘Population Estimates for England & Wales 1961 to 2014’[[1]](#footnote-1) for ages up to 95 years of age. For 2015 mid year population counts and death counts for each age in single years from birth to 89 years were extracted from the Components of Change database (table MYEB2).[[2]](#footnote-2)

## Model

For each sex, and for each age in single years each age in single years, a, from birth to 95 years old, a separate linear regression model was fit with the following specification:

|  |  |
| --- | --- |
|  | (1) |

Where is the mortality rate (death count divided by population count) in year t, at age a, and for sex s; t is year since the first year included (1990); L is a dummy variable indicating the years, 1997 to 2010, in which New Labour were in government; R is a dummy variable indicating 2008 and 2009, the years in which the UK economy entered a recession as a result of the GFC, and is an error term. The R term is included to capture any additional short-term changes in mortality rates to be captured in a separate term rather than influence the coefficients including New Labour years, and . The use of interaction terms Lt and Rt allowed for the gradients of change in log mortality rates over time to be different over the New Labour and GFC recession periods.

The above model specification was fit to ONS data for each year from 1990 to 2010 inclusive. Redefining , projected log mortality rates were calculated for years 2011 to 2015 inclusive by setting t to these year values and L to 1, i.e.

|  |  |
| --- | --- |
|  | (2) |

Predicted numbers of deaths at each age, for each sex, and in each year from 2011 to 2015 were therefore calculated by multiplying the relevant age-year-sex specific population counts by the requisite projected mortality rates, i.e.

|  |  |
| --- | --- |
| or equivalently | (3) |

Where is the projected mortality rate rather than log rate.

The age-sex specific differences in deaths are therefore , and the total difference in deaths by age A, shown in figures xxx, is .

As death and population counts from the ONS for the year 2015 was aggregated for years 90 and above rather than disaggregated by age in single years, for ages 90 to 95 years was estimated by extrapolating over ages 84 to 89 years.

All analyses were performed using the R programming environment using publically accessibly data, and the R scripts used to perform the analyses are made freely available to other researchers.

# Results

Figure X summarises the regression parameter estimates for each of the nearly two hundred separate regression models produced. The solid line indicates the point estimate of a given model parameter for a particular age and gender; the confidence band indicates plus or minus two standard errors above that particular parameter, slightly more conservative than the usual 95% coverage shown. A vertical dashed line is added at age 65, male retirement age.

As the response variable is log 10 mortality risk, the (intercept) parameter (Beta0 above) shows the variation of log10 mortality risk with age in 1990. The well-known ‘bathtub curve’ relationship is seen here, high in infancy, then rapidly declining, before rising again during adulthood and then rising log-linearly from around the age of 30 onwards. Given the mortality risk uses base 10, -1 implies a 1 in 10 risk of dying in the next year, -2 a 1 in 100 risk, -3 a one in 1000 risk, and -4 a 1 in 10000 risk.

The variable ‘year’ shows the rate of change in mortality rates over the 20 years included in the models. These are negative for all ages and statistically significant, indicating clear reductions in mortality risk. On the log scale, these are greatest in early childhood and approaching retirement age, but given the baseline risk is much higher at older than younger ages small annual falls in mortality risk can confer very large substantive reductions in death rates.

The coefficients ‘newlabTRUE’ and ‘year:newlabTRUE’ jointly allow for different intercepts and gradients over time during the New Labour years than during other years. The confidence bands indicate that at most ages in single years the coefficients are not statistically significant, except at a number of ages after male retirement age. Neither of the series of coefficients associated with the GFC appear statistically significant.

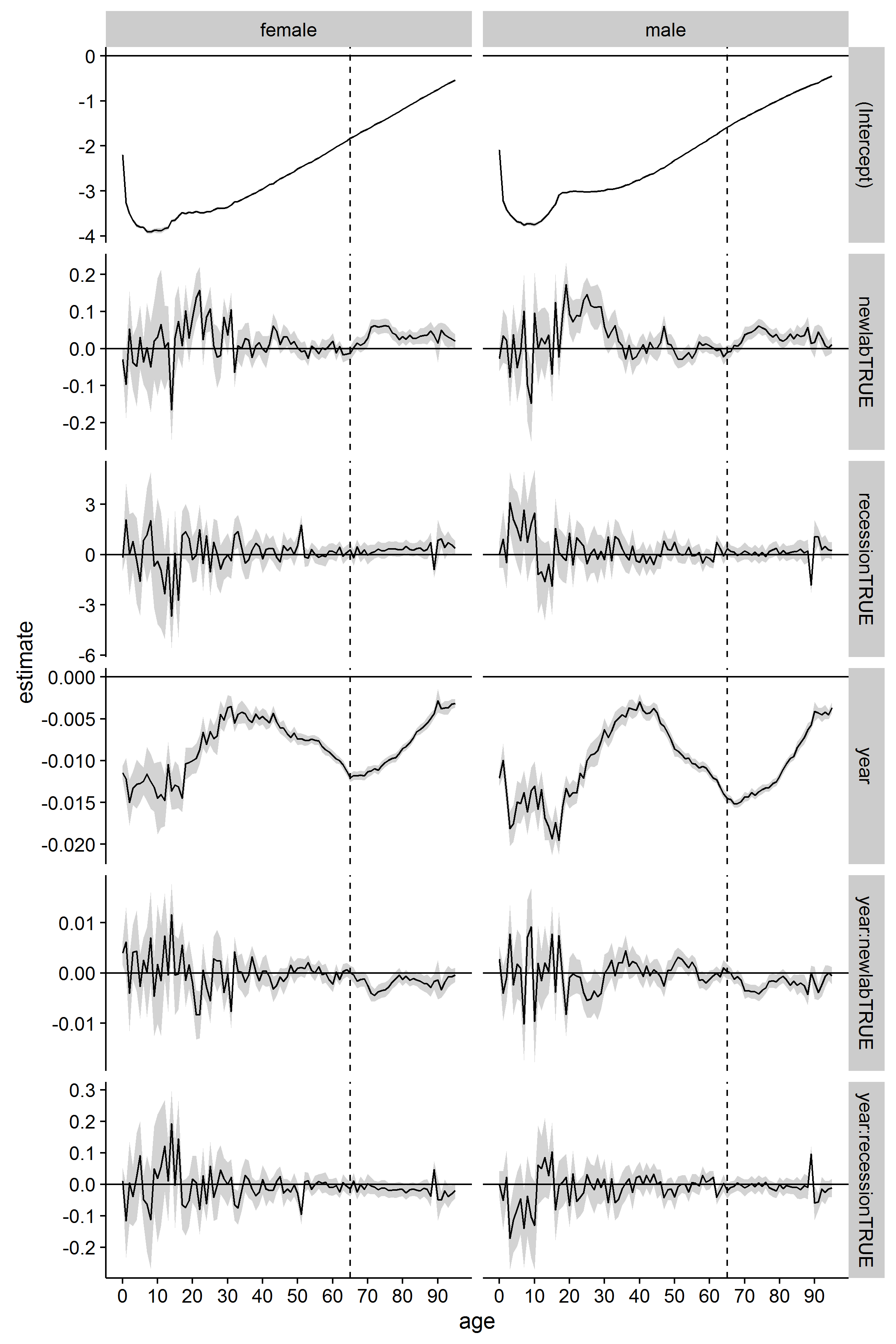


Figure Model coefficients

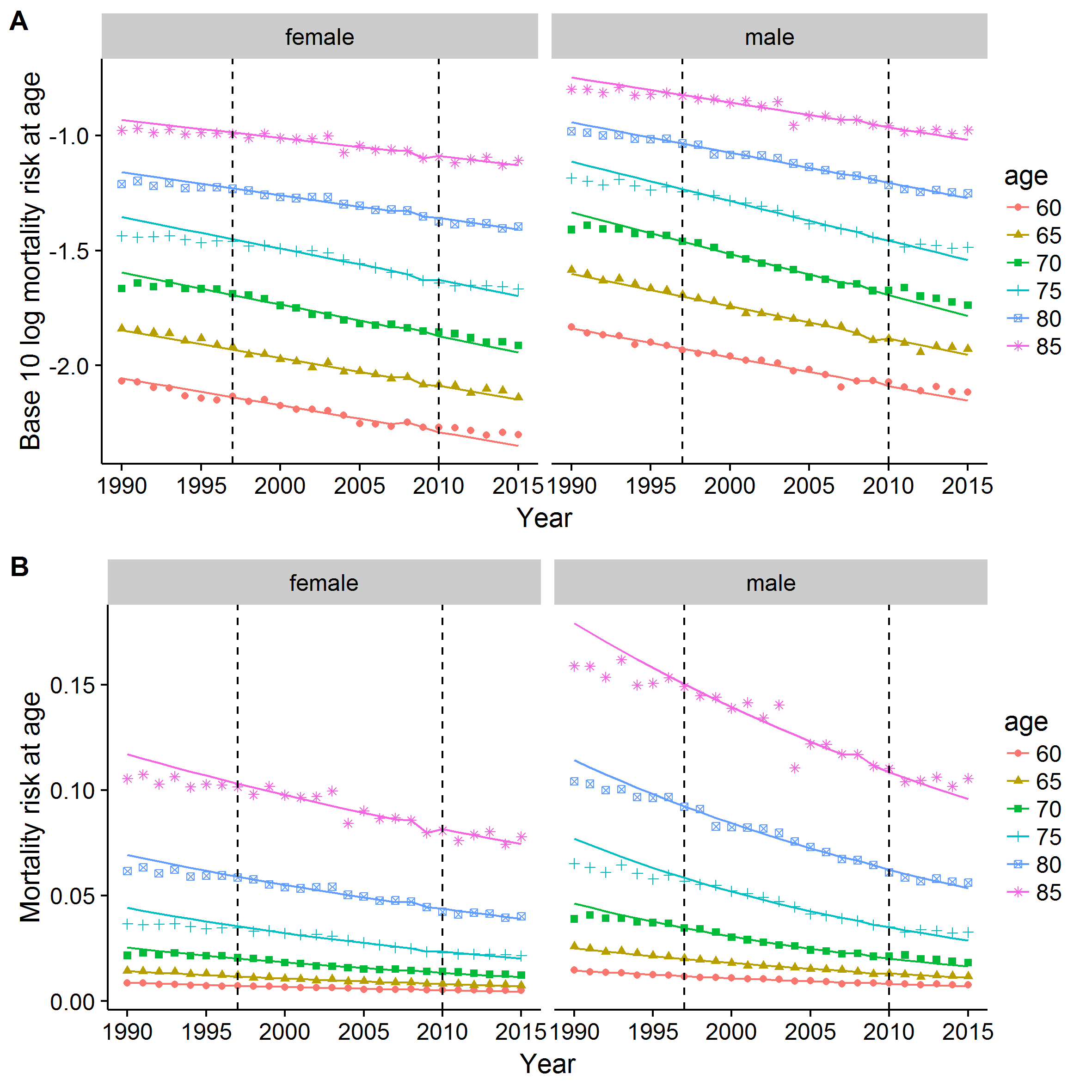
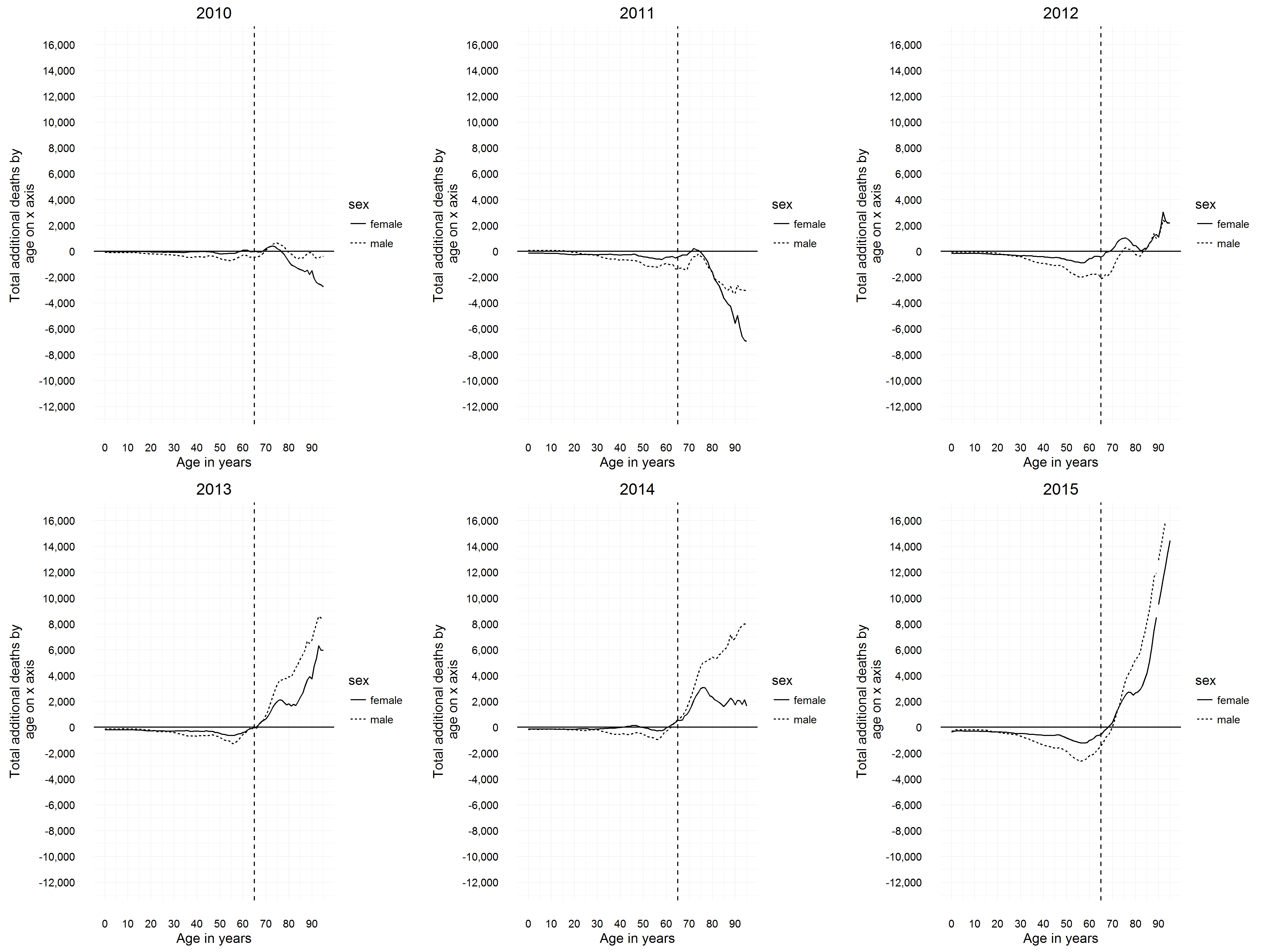
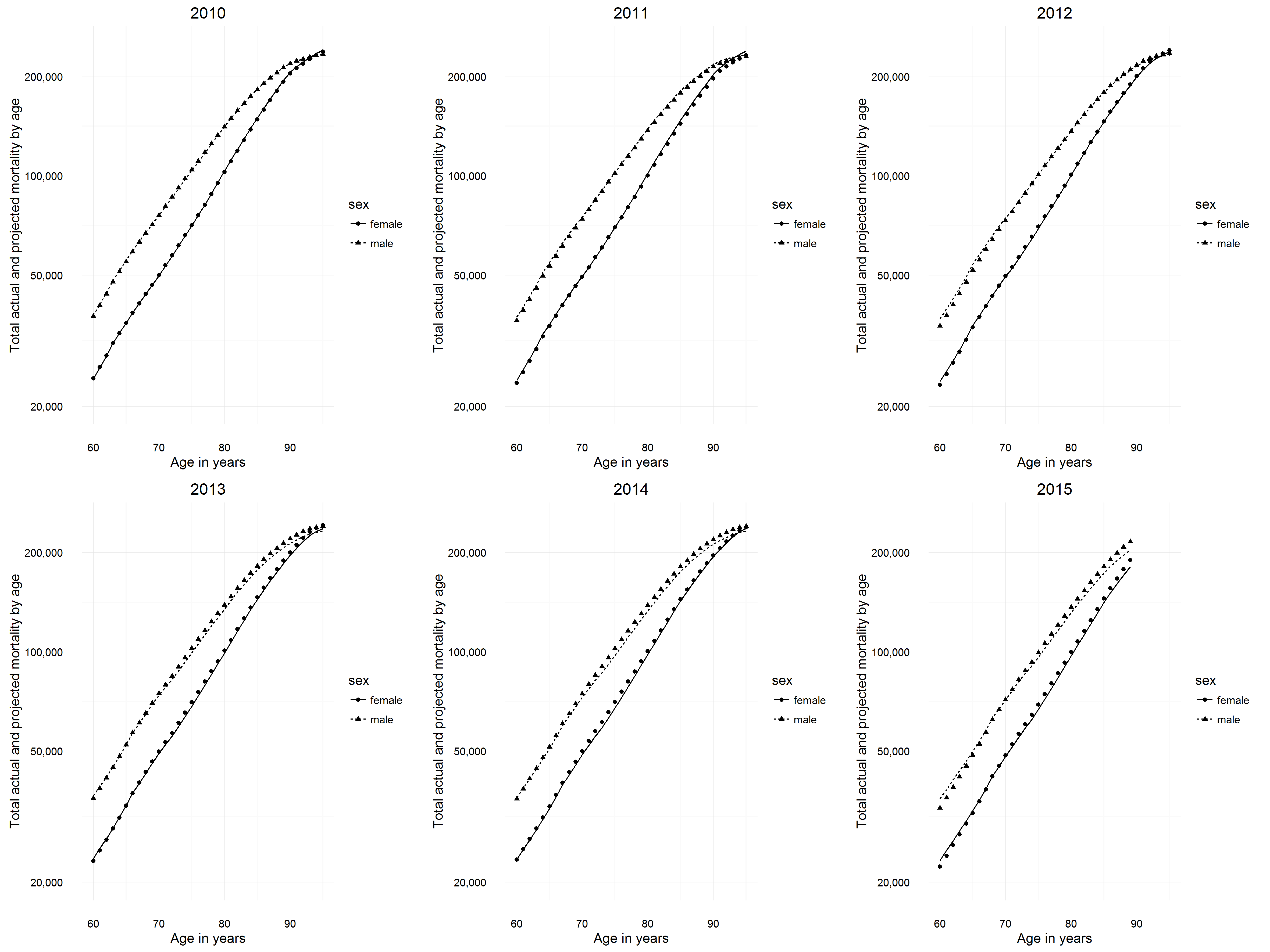
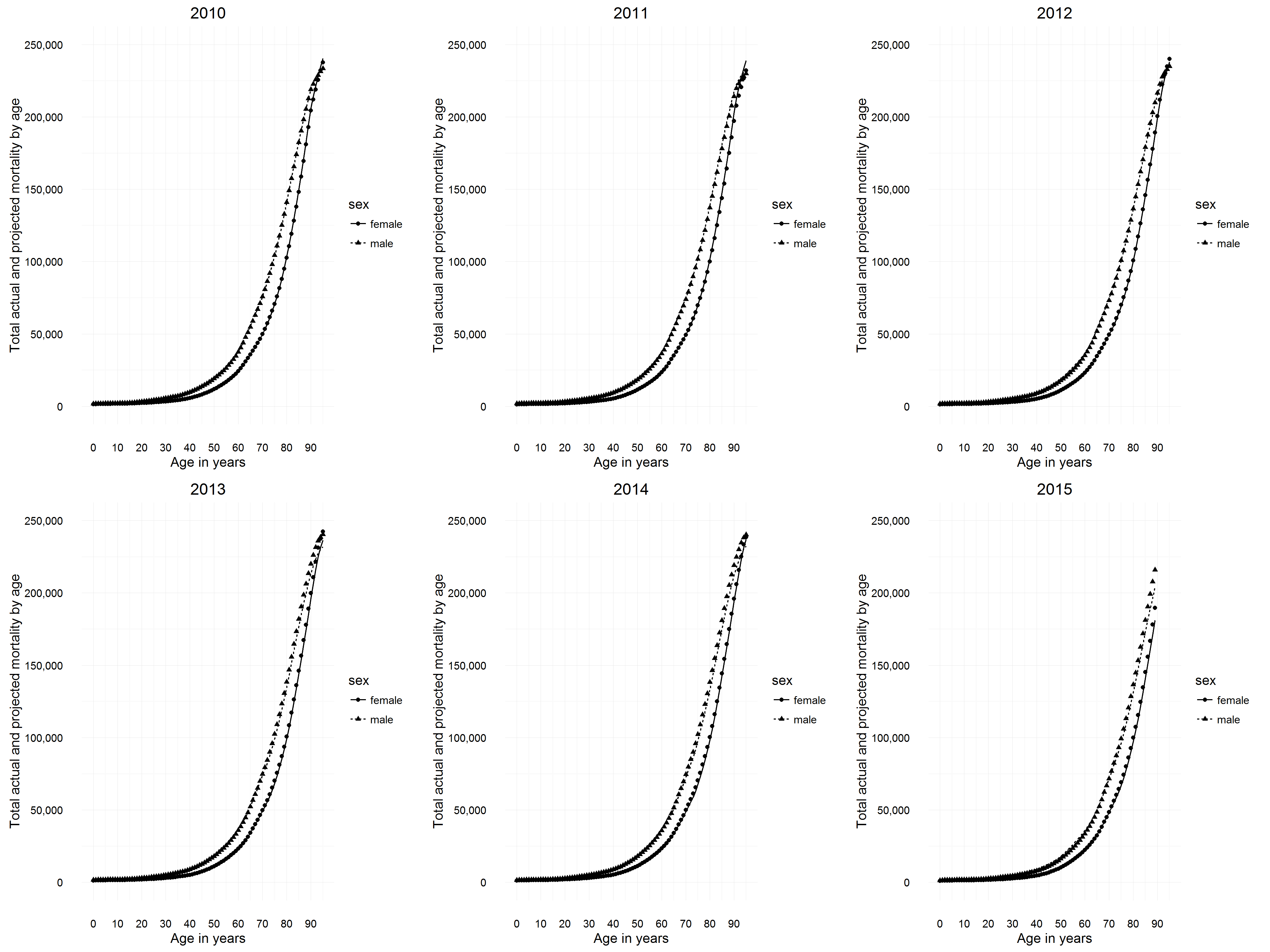


Figure (Colour online) Observed (points) and projected (lines) age specific mortality rates for selected ages. A) Log scale; B) Identity scale



# Discussion

## Limitations

Population estimates for ages over 90 years are not routinely available disaggregated by age in single years as part of standard UK population estimates, and are estimated by the ONS within the main dataset used in these analyses based on population and mortality rates at younger ages. Given our results indicated that much of the additional burden of excess mortality has been at some of the oldest ages, however, we considered it important to produce estimates of total excess deaths which include ages up to 95 years, despite these limitations. These limitations in the quality and availability of highly disaggregated data at some of the oldest ages are not just limitations affecting our analyses, but limitations which may hide some of the greatest mortality excesses which have occurred in England & Wales within the previous decade. Effective measurement and dissemination of age-disaggregated population and death counts at and above the age of 90 years should therefore be a national record keeping priority.

1. Accessed 1 July 2016 https://www.ons.gov.uk/file?uri=/peoplepopulationandcommunity/populationandmigration/populationestimates/adhocs/005825populationestimatesforenglandandwales1961to2014singleyearofage0to105/ewuksyoadeathspopdata19612014cmifilevaluesforissue10122015.xls [↑](#footnote-ref-1)
2. Accessed 1 July 2016 http://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/populationestimatesforukenglandandwalesscotlandandnorthernireland [↑](#footnote-ref-2)