

# National population projections, mortality assumptions: 2018-based

The data sources and methodology used to produce mortality assumptions in the 2018-based national population projections.

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## Notice

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The calendar year 2018 period life expectancy figures in this report differ from those in the 2018-based [past and projected period and cohort life tables](#), published subsequently on 2 December 2019. This is because they were based on derived mortality rates for 2018, as observed rates were not available at the time. The 2018 figures in the past and projected period and cohort life tables are based on observed rates, so should now be used as the values for 2018.

# Table of contents

1. [Main points](#)
2. [Introduction](#)
3. [Methodological approach](#)
4. [Principal assumption](#)
5. [Assumptions for mortality variants](#)
6. [Previous projections of life expectancy](#)
7. [Links to further information](#)

# 1 . Main points

- 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.

## 2 . Introduction

This report provides detailed information on the principal and variant mortality assumptions used in the 2018-based national population projections (NPPs). It sets out our rationale for setting the long-term improvement rates and how these have changed from the 2016-based NPPs. Our principal assumption for the UK is that mortality improvement rates will converge to 1.2% by 2043 for almost all ages and will remain at 1.2% thereafter. Lower rates of improvement are assumed for ages 91 years and over. This means that period life expectancy is projected to increase to 82.6 years by 2043 for males and 85.5 years for females.

Life expectancy and mortality improvement rates are presented in this article on a calendar year-basis unless otherwise stated. The mortality assumptions underlying the population projections are on a mid-year basis so there may be small differences between the figures presented in this article and the national population projections [published datasets](#).

## 3 . Methodological approach

### Main terms

The mortality assumptions are the Office for National Statistics's (ONS's) estimates of future mortality trends. Based on our calculations, as well as external expert opinion, we estimate future age-specific mortality rates using an assumed annual percentage change of mortality rates that vary by age, sex and time. We refer to these assumed percentage changes as "mortality improvements" and they are given on an annual basis.

Life expectancy is calculated from mortality rates. Lower mortality rates lead to greater life expectancy and vice versa. When mortality improvements are given as a positive value, this indicates both lower mortality rates and a rise in life expectancy. The opposite is true if mortality improvements are given as a negative value.

In our projections of life expectancy, we derive age-specific mortality improvements in the base year and assume they will converge to a "target rate" of improvement in the 25th year of the projection. All future years' mortality improvements by age beyond the 25th year are assumed to be at the level of the target rate for that age.

All life expectancy figures given within this release are period life expectancies. Period life expectancy is calculated on the basis of the mortality rates for a particular calendar year and, unlike cohort life expectancy, does not allow for future assumed changes in mortality rates. The ONS has published a full explanation of [the differences between period and cohort life expectancy](#).

## General approach

When setting the mortality assumptions for the national population projections (NPPs), we consider mortality rates and annual percentage changes in mortality rates by age and year.

Rates of improvement by age and sex for 2018, the base year of the projections, were derived by projecting trends in mortality improvements observed from data for the period 1961 to 2017. These data were also used to derive assumed age- and sex-specific mortality rates for 2018. Target rates of mortality improvement were then set for 2043, the 25th year from the base year of the projections. Assumptions were also made on the method and speed of convergence from the base year improvement rates to the target rates and on levels of mortality improvement after the 25th year. These assumptions were based on analysis of past trends and expert advice from the NPPs expert advisory panel (a group of external demographic experts convened by the ONS). For more information about the expert advisory panel, please see [National population projections, how the assumptions are set: 2018-based](#).

For the first year of the projection (year ending mid 2019) the age- and sex-specific mortality rates derived for each country were adjusted pro rata to provide the provisional number of male and female deaths in the year ending mid 2019 for that country. This calculation only affects the derived mortality rates in the first year of the projection; those derived for later years are not affected. As a result of this calculation, the principal projection and low variant both appear to show a slight drop in life expectancy in the second year of the projection (year ending mid 2020). This is because there have been fewer deaths in the year ending mid 2019 than were initially projected, causing life expectancy in the first year of the projection to be higher, while the second year still has the same trajectory as had been assumed before including the provisional deaths data for the year ending mid 2019.

## Projecting for the UK's constituent countries

The assumptions for mortality improvements in the base year of the projections are initially made at the UK level. To assess whether it is reasonable to use the assumed base year improvement rates for the UK for each of the countries of the UK, we compare past trends in mortality improvement for each country of the UK and those for the UK as a whole. Following this comparison, the initial improvement rates were adjusted for Scotland for both males and females at some ages. The improvement rates for the UK at these ages were then adjusted to produce base year improvement rates for the UK excluding Scotland. The same long-term rates of improvement were assumed for all countries. The resulting projected improvement rates for the UK excluding Scotland are assumed to apply to England, Wales and Northern Ireland. The resulting mortality improvement rates are then applied successively to the assumed mortality rates for each country to produce projected country specific mortality rates by age, sex and calendar year.

Mortality improvement rates are projected for all constituent countries of the UK. Mortality rates for the base year were derived from projecting past trends of smoothed mortality rates for the UK. Base year mortality rates for each UK country were then derived by multiplying the UK mortality rates by conversion factors for each constituent country based on comparisons of mortality rates for each country with those for the UK, by age and sex, derived from the latest national life tables.

## 4 . Principal assumption

### Principal assumption of mortality improvements

For the 2018-based projections, the assumption is that annual rates of mortality improvement converge to 1.2% for ages 0 to 90 years by 2043 (the 25th year of the projections) and remain constant thereafter. For ages above 90 years, annual improvement rates are set to decline linearly from 1.2% to 0% between ages 91 and 109 years. For ages above 110 years, we assume a 0% improvement rate because there is little historical evidence of past mortality improvements at the oldest ages.

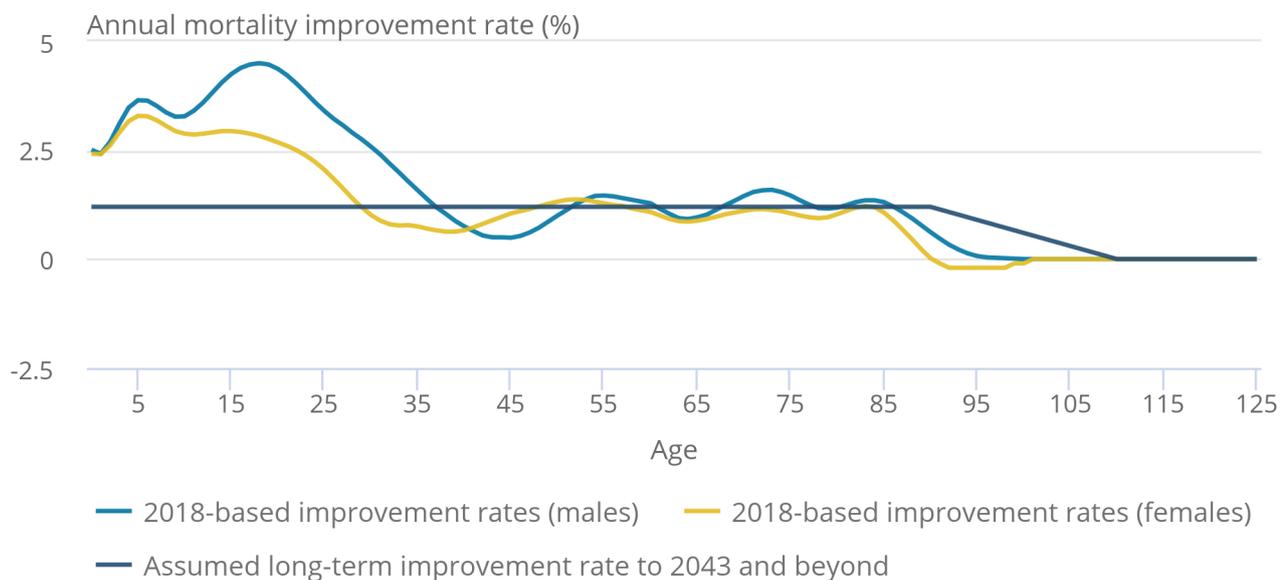
For 2018, the mortality improvement rates are derived rather than observed, as data for 2018 were not available at the time of setting the assumptions. Figure 1 shows the projected UK 2018-based annual mortality improvement rate for males and females in 2018, set against the assumed long-term target rate of mortality improvement in 2043.

**Figure 1: The projected annual mortality improvement is 1.2% for most ages for both sexes by 2043**

**Projected annual mortality improvement rate in 2018 and assumed long-term improvement rates in 2043 and beyond, males and females, UK**

**Figure 1: The projected annual mortality improvement is 1.2% for most ages for both sexes by 2043**

Projected annual mortality improvement rate in 2018 and assumed long-term improvement rates in 2043 and beyond, males and females, UK



**Source: Office for National Statistics – National population projections**

The 2043 target rates of improvement were set based on external demographic advice from the national population projections (NPPs) expert advisory panel and analysis by the Office for National Statistics (ONS) of past rates of improvement. The 2018 improvement rates are generally set at rates lower than were projected for 2018 in the 2016-based projections. This is particularly the case for ages 40 to 90 years, which see average reductions of approximately one percentage point in the projected base improvement rates. These have been reduced as a result of the lower improvement rates in those age categories that were observed in 2016 and 2017.

Previous rounds of projections have highlighted that cohorts born before 1946 have consistently shown particularly high improvement rates when compared with their predecessors and successors. This was especially the case for the generation born around the early 1930s. These cohorts have now reached old ages and we no longer observe high improvement rates for these cohorts in recent years and so, as in the 2016-based projections, no longer account for these in our assumptions.

## Principal assumption of life expectancy

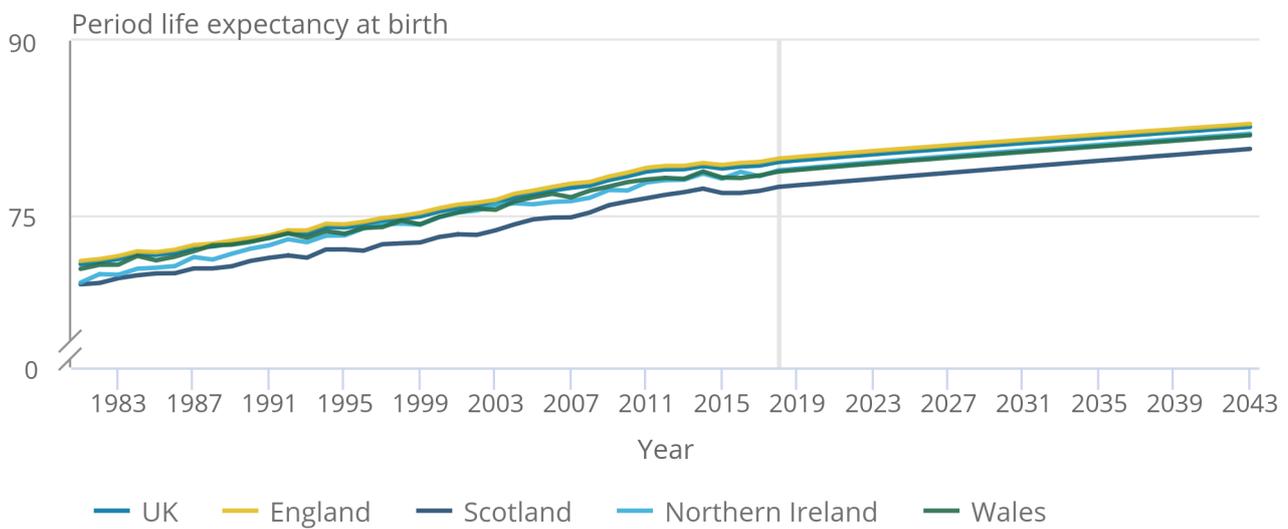
Figures 2a and 2b show how period life expectancy at birth is projected to increase under the principal 1.2% long-term rate for the UK and its constituent countries.

### Figure 2a: Male life expectancy is projected to increase in all countries of the UK over the next 25 years

Historical and projected male period life expectancy at birth for UK and its constituent countries under the principal 1.2% long-term improvement rate, 1981 to 2043

## Figure 2a: Male life expectancy is projected to increase in all countries of the UK over the next 25 years

Historical and projected male period life expectancy at birth for UK and its constituent countries under the principal 1.2% long-term improvement rate, 1981 to 2043



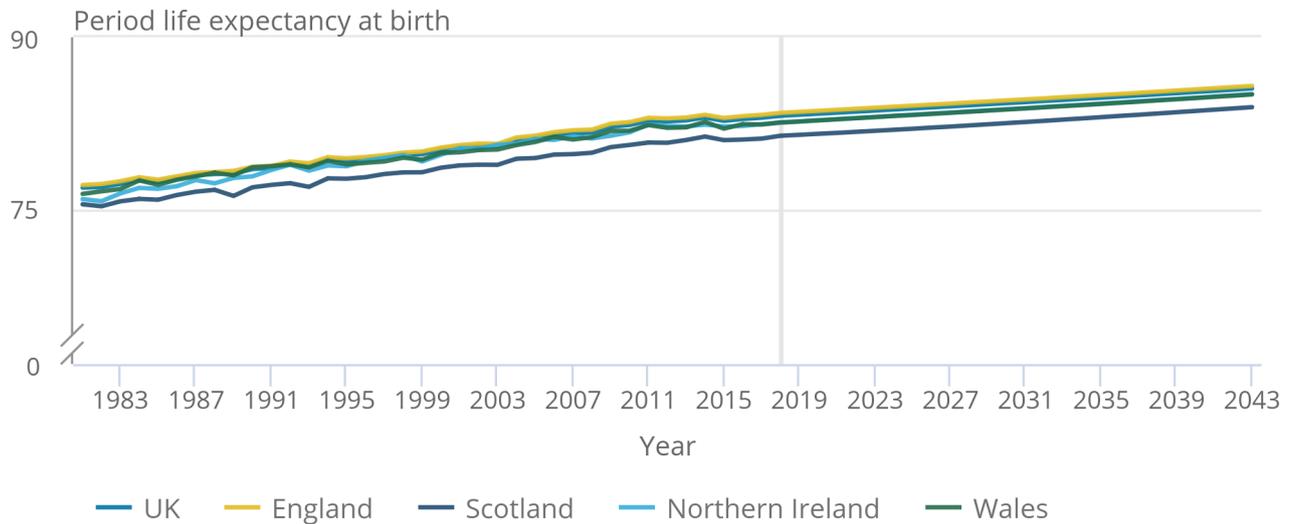
Source: Office for National Statistics – National population projections

## Figure 2b: Female life expectancy is projected to increase in all countries of the UK over the next 25 years

Historical and projected female period life expectancy at birth for UK and its constituent countries under the principal 1.2% long-term improvement rate, 1981 to 2043

### Figure 2b: Female life expectancy is projected to increase in all countries of the UK over the next 25 years

Historical and projected female period life expectancy at birth for UK and its constituent countries under the principal 1.2% long-term improvement rate, 1981 to 2043



Source: Office for National Statistics – National population projections

The principal projection shown in Figures 2a and 2b project life expectancy to follow historical long-term patterns. From 2018 to 2043, period life expectancy in the UK is projected to increase by 3.0 years for males and 2.4 years for females.

## Principal mortality assumptions for Scotland

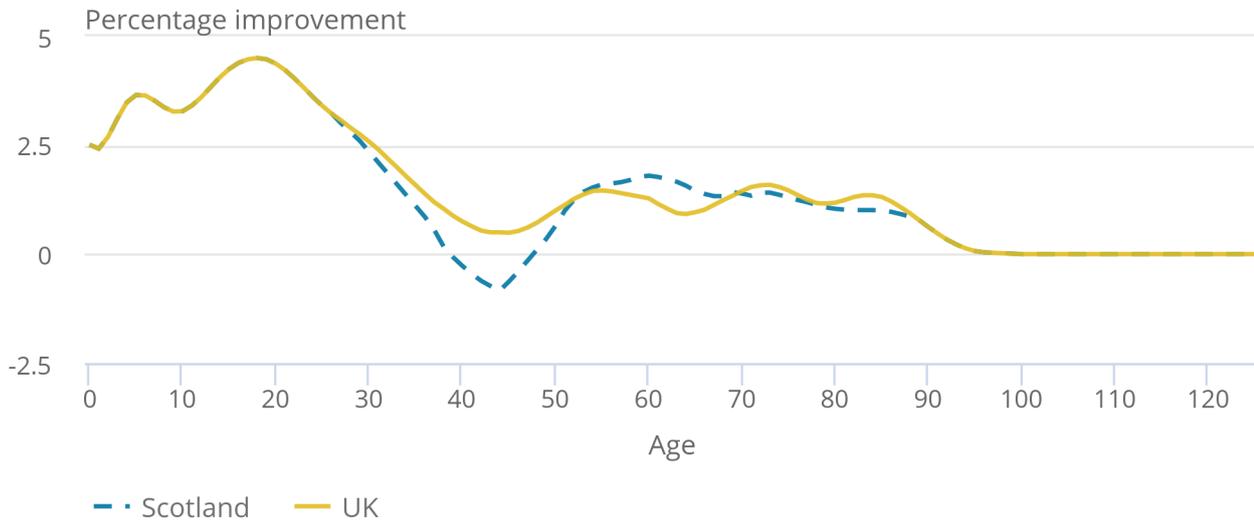
The recent historical rates of improvement experienced in the UK's constituent countries, in comparison with those experienced in the UK as a whole, suggest that the same assumed initial rates of improvement by age and sex for 2018 can be adopted for each individual country, except for Scotland. Scotland has historically experienced higher mortality rates at all but the very youngest ages, compared with the UK as a whole. Proposed smoothed rates of improvement for Scottish males and females are shown in Figures 3a and 3b respectively. The proposed UK rates are used for males until age 26 years and for females until age 30 years, after which the differing improvement rates derived for Scotland are proposed up to age 88 years for males and age 90 years for females. This also includes higher assumed rates of improvement in Scotland for males aged 53 to 69 years and females aged 58 to 70 years. Figures 3a and 3b also show the proposed base rates of improvement for males and females in the UK and Scotland.

**Figure 3a: Mortality improvements for males in their 30s and 40s are lower in Scotland than in the UK as a whole**

Comparison of assumed 2018-based UK and Scotland mortality improvements for 2018, the base year of projections, males

**Figure 3a: Mortality improvements for males in their 30s and 40s are lower in Scotland than in the UK as a whole**

Comparison of assumed 2018-based UK and Scotland mortality improvements for 2018, the base year of projections, males



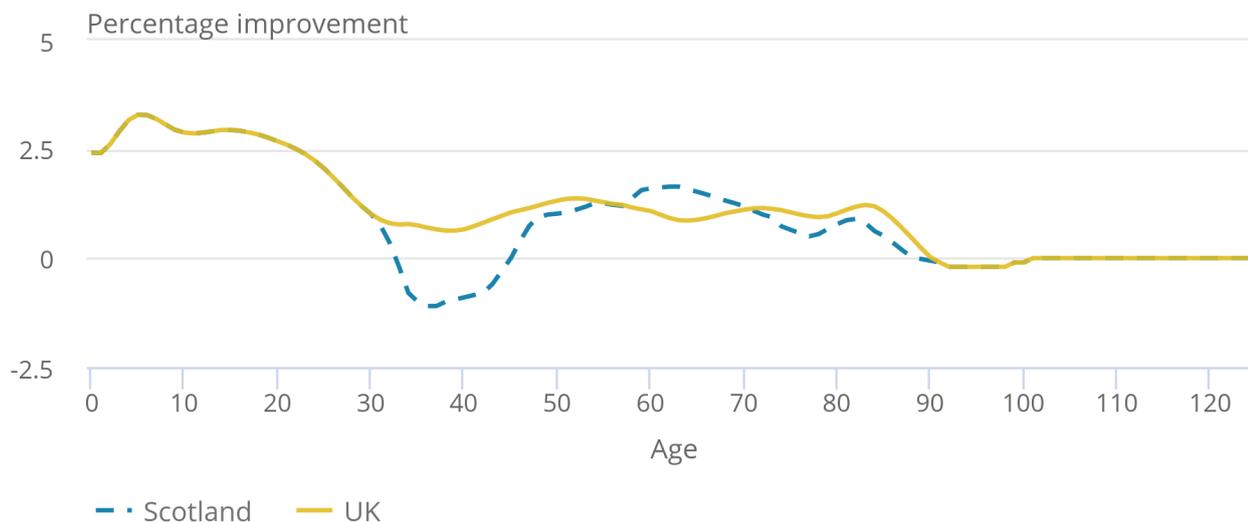
Source: Office for National Statistics – National population projections

### Figure 3b: Mortality improvements for females in their 30s and 40s are lower in Scotland than in the UK as a whole

Comparison of assumed 2018-based UK and Scotland mortality improvements for base year of projections, females

### Figure 3b: Mortality improvements for females in their 30s and 40s are lower in Scotland than in the UK as a whole

Comparison of assumed 2018-based UK and Scotland mortality improvements for base year of projections, females



Source: Office for National Statistics – National population projections

Projected period life expectancy at birth for the UK in 2043 is 1.1 years and 0.9 years lower than was projected in the 2016-based projection for males and females respectively. There are two reasons for this. First, the base mortality rates derived for 2018 are generally higher compared with those projected for 2018 in the 2016-based projections. Secondly, we are assuming lower long-term assumptions for people at the oldest ages than we did in the 2016-based projections.

## 5 . Assumptions for mortality variants

Variant projections are created to indicate the sensitivity of results to changes in the assumptions of future mortality improvements. For example, the low mortality variant assumes lower levels of annual mortality improvement and results in lower projected life expectancies over the projection period. The variants illustrate how life expectancy may change under different future demographic scenarios.

Although current annual improvements in mortality rates vary considerably by age and sex, it is assumed that these improvements will gradually converge to common “target rates” of improvement by the year 2043, at most ages and for both sexes. It is assumed that mortality improvement rates will then continue at these target rates from 2043 onwards.

The target rate assumptions for the variant mortality projections for the UK and its constituent countries are as follows.

## **High life expectancy variant**

This has a convergence to 1.9% annual improvement by 2043 for ages up to age 90 years. For ages above 90 years, assumed long-term rates of improvement are 0.7 percentage points higher than those assumed for the principal projections, reducing to 0.7% at ages 110 years and over. Thereafter, annual improvement by age is assumed constant at the rate assumed for 2043.

## **Principal projection**

This has a convergence to 1.2% annual improvement by 2043 for ages up to age 90 years and running off to 0.0% at age 110 years. Thereafter, annual improvement by age is assumed constant at the rate assumed for 2043.

## **Low life expectancy variant**

This has a convergence to 0% annual improvement by 2043 for all ages, thereafter annual improvement is constant at 0%.

## **No mortality improvement variant**

This is where there is a 0% annual improvement from the base year.

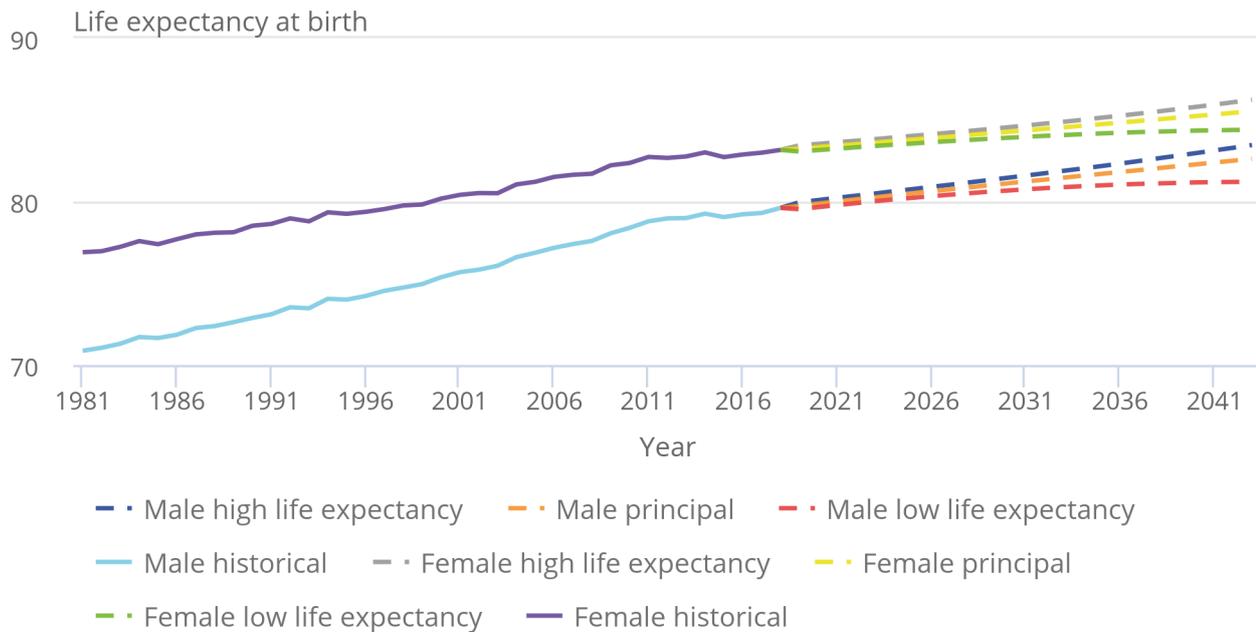
Figure 4 shows historical and projected period life expectancy at birth from 1981 to 2043, based on the principal and variant assumptions from 2018 to 2043.

**Figure 4: The high variants show a faster increase in life expectancy while the low variants show a slower increase**

2018-based period life expectancy at birth, principal projection compared with high and low life expectancy variants, UK, 1981 to 2043

Figure 4: The high variants show a faster increase in life expectancy while the low variants show a slower increase

2018-based period life expectancy at birth, principal projection compared with high and low life expectancy variants, UK, 1981 to 2043



Source: Office for National Statistics – National population projections

In addition to analysis conducted by the Office for National Statistics (ONS), we used feedback from the national population projections (NPPs) expert advisory panel to derive the long-term rates of improvements required to produce the principal and variant projections. The expert advisory panel provided views on the anticipated impacts on future life expectancy of a range of factors as well as estimates of life expectancy in 2043. The panel's consensus was that the annual long-term rate of mortality improvement should be equal for males and females.

The long-term annual rates of improvement of 0.0% for the low variant and 1.9% for the high variant are the same target rates that were used in the 2016-based projections. These rates were derived with reference to the upper and lower confidence bounds that the NPP expert advisory panel provided around their estimates of life expectancy improvements in 2043. The improvement rates suggested by the members of the expert advisory panel indicated that the most representative long-term annual rates were 0.0% and 1.9% for the low and high variants respectively.

The view of the expert advisory panel was that the setting of the principal projection should not be disproportionately influenced by the [slowdown in life expectancy improvements observed since 2011](#). This is because the projections consider long-term data and trends rather than solely focusing on recent changes. The projected life expectancy improvements under the low variant can be considered as similar to those that would be expected if the slowdown in improvements continued indefinitely. While there is no consensus as to whether the recent slowing of life expectancy improvements is likely to end or continue, the low variant can be used as a future mortality scenario where the slowdown continues over the next 25 years.

The no mortality improvement variant is a projection of no improvement to life expectancy, which assumes that mortality rates will remain constant at the values assumed for the first year (mid-2018 to mid-2019) of the principal projection. This produces a control variant that can be used for sensitivity testing against other projection variants.

## 6 . Previous projections of life expectancy

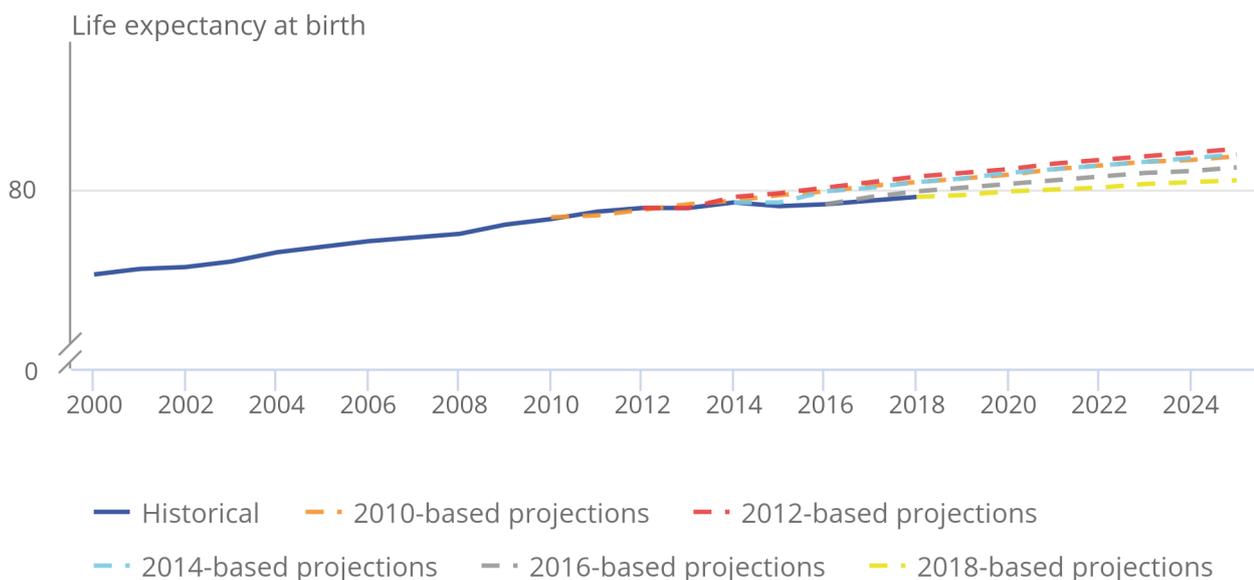
Figures 5a and 5b show previous projections of principal period life expectancy at birth for males and females respectively, together with the 2018-based projection. The figures shows that lower life expectancies have been projected in successive sets of projections since the 2012-based projections, reflecting the slower increases in life expectancy in recent years. The proposals for the 2018-based projections represent a continuation of this trend.

**Figure 5a: Lower base-year improvement rates in 2018 lead to a lower projection of life expectancy than in previous years**

Base year principal period life expectancy at birth, changes between 2010-based and 2018-based projections, UK, males

### Figure 5a: Lower base-year improvement rates in 2018 lead to a lower projection of life expectancy than in previous years

Base year principal period life expectancy at birth, changes between 2010-based and 2018-based projections, UK, males



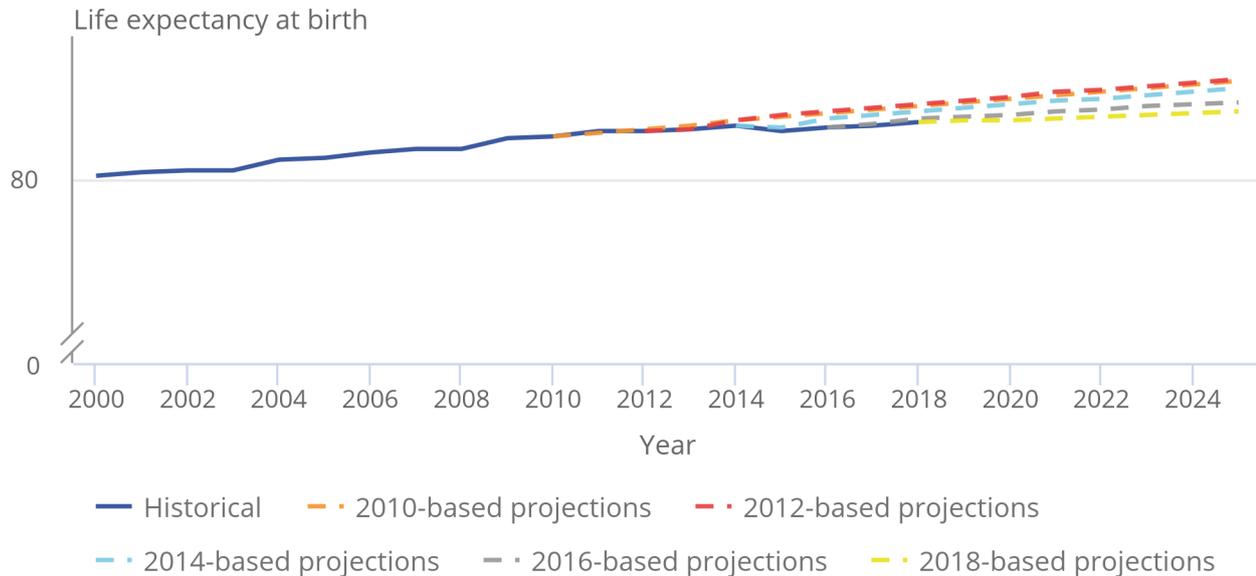
Source: Office for National Statistics – National population projections

**Figure 5b: Lower base-year improvement rates in 2018 lead to a lower projection of life expectancy than in previous years**

Base year principal period life expectancy at birth, changes between 2010-based and 2018-based projections, UK, females

Figure 5b: Lower base-year improvement rates in 2018 lead to a lower projection of life expectancy than in previous years

Base year principal period life expectancy at birth, changes between 2010-based and 2018-based projections, UK, females



Source: Office for National Statistics – National population projections

The slowdown of life expectancy improvements, which the UK has experienced since 2011, [has also been observed in several other countries](#) in Europe as well as in North America and Australia. There has been considerable public debate about the causes of the slowdown of life expectancy improvements and whether it represents an abnormality in the long-term pattern of improvement or a change of direction in the underlying trend. Researchers have suggested a range of possible explanations for the slowdown. Much of the research literature suggests that several factors are at play, none of which can be singled out as being the most important with any certainty. The Office for National Statistics (ONS) has published [a report on the recent slowdown of life expectancy improvements](#), which explores this topic further.

Table 1 shows the 2018-based projected principal period life expectancies for the UK in comparison with the 2016-based projection.

Table 1: 2018-based principal projection of period life expectancy at birth and at age 65 years, UK, 2018 to 2053

Year	Males				Females			
	Age 0		Age 65		Age 0		Age 65	
	2018-based LE	Change over 2016-based projection						
2018	79.61	-0.35	18.8	-0.23	83.15	-0.25	21.1	-0.18
2028	80.87	-0.84	19.61	-0.65	84.07	-0.67	21.71	-0.57
2043	82.61	-1.1	20.84	-0.92	85.53	-0.93	22.81	-0.84
2053	83.75	-1.14	21.7	-0.97	86.54	-0.99	23.62	-0.91

Source: Office for National Statistics – National population projections

#### Notes

1. LE means life expectancy, and it refers to number of years a person is expected to live from a given age.  
[Back to table](#)

## 7 . Links to further information

Also available from the Office for National Statistics (ONS) are:

- the latest trends in period life expectancy for the UK and its constituent countries, which are presented in the [National life tables, UK: 2016 to 2018](#).
- the 2018-based projected cohort life expectancies, which are due to be published in our [past and projected life tables publication](#) in early December
- a guide on [how to interpret these tables](#)
- additional guidance on mortality releases, which is available in the [User guide to mortality statistics](#) and [Life Expectancy releases and their different uses publications](#)