Office for National Statistics

Compendium

# Variants, 2014-based national population projections reference volume

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# 1 . Introduction

Population projections provide a consistent starting point for all government planning which is affected by the numbers in the population. The projections are based on assumptions considered to best reflect demographic patterns at the time they are adopted. Due to the inherent uncertainty of demographic behaviour, any set of projections will inevitably be proved wrong, to a greater or lesser extent, as a forecast of future demographic events or population structure. Therefore, in addition to the principal (main or central) projection, variant projections are produced based on alternative assumptions of fertility, mortality and migration. These variant projections are intended to provide an indication of uncertainty and sensitivity to alternative assumptions; they do not represent upper or lower limits of future demographic behaviour.

Variants can be grouped into 3 types. Single component variants look at the effect of varying one assumption at a time from the principal projection. For example, the high fertility variant uses mortality and migration assumptions consistent with the principal projections, but assumes a higher rate of fertility. Combination variants assume alternative rates for 2 or more of the assumptions. For instance, the young population variant assumes high fertility, low life expectancy and high net migration, which results in projections with a younger age profile than the principal projection. It is also sometimes useful to prepare special case scenarios or “what if” projections to illustrate the consequences of a particular, but not necessarily realistic, set of assumptions, such as zero net migration.

Aside from the principal projection, 9 standard variant projections were published on 29 October 2015. These included 6 possible “single component” variants, 2 “combination” variants producing the largest or smallest total population size, and one special case scenario of zero net migration (natural change only). A second National Population Projections 2014-based extra variants report on 26 November 2015 included 7 additional standard “combination” and special case scenario variants. A full list of 2014-based variant projections with their associated assumptions is available in Appendix A of the Extra Variants report.

This chapter summarises the results of the variant projections for the UK.

# 2 . Assumptions for fertility variants

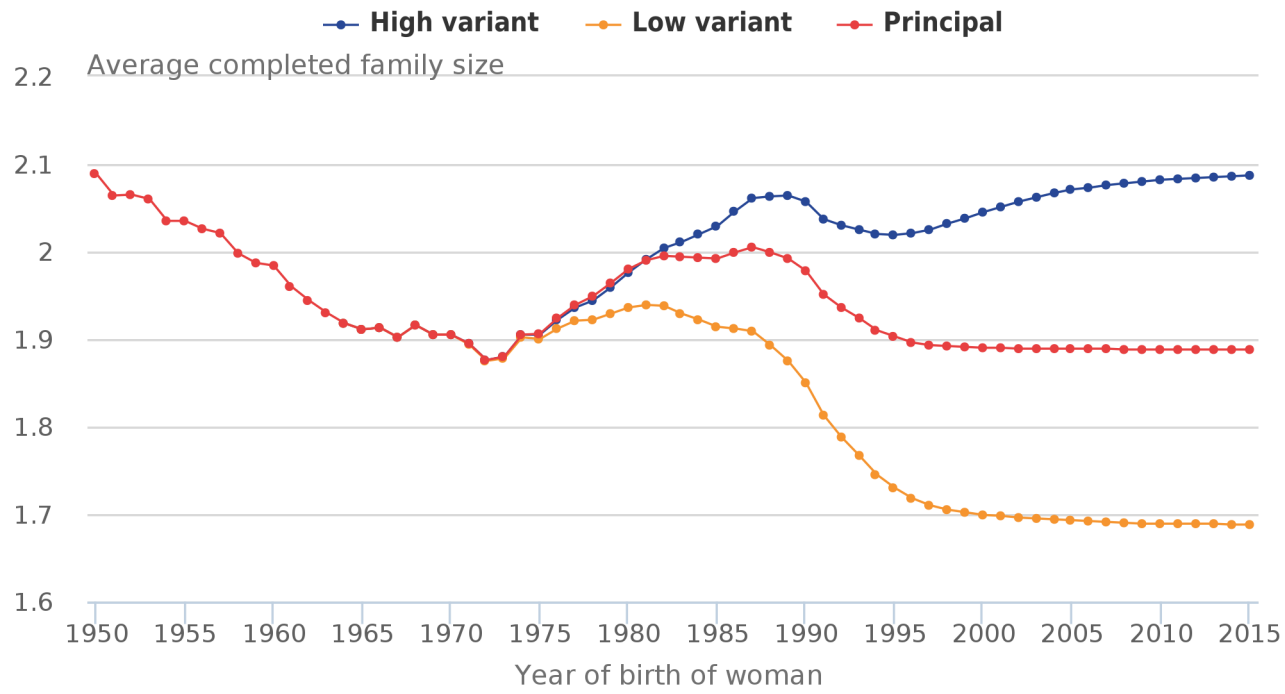
In the long-term, changes in the level of fertility are critical in determining the size of the population. For example, a sustained increase in the level of fertility would clearly increase the number of births. In a generation’s time, it would also increase the number of women of childbearing age, compounding the effect on births.

Cohorts of women who have already completed their childbearing have shown a wide range of completed family sizes. Therefore, assumptions for generations who have not yet entered the childbearing ages, or who have done so only recently, are necessarily highly speculative.

Figure 6.1 and Table 6.1 show the assumed completed family sizes for the principal, high fertility and low fertility variants for the UK. For the principal projection, the average completed family size is seen to rise for cohorts between 1975 and 1987, before falling to an ultimate level of 1.89 for women born from 2015 onwards. For the low fertility variant, the average completed family size is projected to start to fall from the 1983 cohort onwards to an ultimate level of 1.69. The high fertility variant is projected to become stable from the 1995 cohort onwards to an average completed family size of 2.09.

Over the past 10 years, fertility rates have generally been rising faster among women in their thirties and forties than for women in their twenties, so mean age at childbirth has continued to rise. The average age at motherhood for the UK as a whole is projected to increase from 28.4 years for women born in 1965 to its long-term level of 30.6 years for those born from 2010 onwards.

**Figure 6.1: Estimated and assumed completed family size, UK, women born 1950 to 2015**




**Source: Office for National Statistics**

Setting variant assumptions for fertility involves assuming higher or lower age-specific fertility rates, particularly at the younger end of the childbearing ages (under 30). For this reason the high variant does not differ greatly from the principal variant for women who are already through the majority of their childbearing years, that is, there is little scope for fertility rates to rise even more substantially than already projected in their remaining years (women born between 1974 and 1982). However, it is possible for these women to not have as many children as projected in their later years and the lower variant reflects this.

Variant assumptions for fertility are set using period age-specific rates. In the 2014-based projections there are instances where the high variant falls marginally below the principal variant (at the third decimal place) when the assumptions are translated to cohort-based measures. This is a facet of the assumption setting process where the focus was on smoothing period measures. We will consider a more optimal smoothing process in the next round of national population projections.

**Table 6.1: Estimated and assumed average number of children by age and year of birth of women, UK, women born 1950 to 2015**

| | | | Average number of children born to women at ages: | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Average family size | Mean age at motherhood (years) | Under 20 | 20–24 | 25–29 | 30–34 | 35–39 | 40+ |
| Estimated values | | | | | | | | |
| 1950 | 2.09 | 26.4 | 0.23 | 0.70 | 0.63 | 0.36 | 0.13 | 0.03 |
| 1955 | 2.03 | 27.1 | 0.22 | 0.56 | 0.65 | 0.40 | 0.16 | 0.04 |
| 1960 | 1.98 | 27.8 | 0.16 | 0.53 | 0.63 | 0.44 | 0.19 | 0.04 |
| 1965 | 1.91 | 28.4 | 0.13 | 0.46 | 0.59 | 0.45 | 0.22 | 0.06 |
| High variant | | | | | | | | |
| 1970 | 1.91 | 28.9 | 0.15 | 0.42 | 0.52 | 0.47 | 0.28 | 0.07 |
| 1975 | 1.91 | 29.5 | 0.15 | 0.36 | 0.47 | 0.53 | 0.32 | 0.08 |
| 1980 | 1.98 | 29.6 | 0.15 | 0.35 | 0.50 | 0.56 | 0.34 | 0.09 |
| 1985 | 2.03 | 29.8 | 0.14 | 0.36 | 0.51 | 0.57 | 0.36 | 0.09 |
| 1990 | 2.06 | 30.0 | 0.13 | 0.34 | 0.51 | 0.61 | 0.37 | 0.09 |
| 1995 | 2.02 | 30.5 | 0.09 | 0.29 | 0.53 | 0.64 | 0.38 | 0.09 |
| 2000 | 2.04 | 30.5 | 0.08 | 0.31 | 0.54 | 0.64 | 0.38 | 0.09 |
| 2005 | 2.07 | 30.4 | 0.08 | 0.32 | 0.55 | 0.65 | 0.38 | 0.09 |
| 2010 | 2.08 | 30.4 | 0.08 | 0.32 | 0.55 | 0.65 | 0.38 | 0.09 |
| 2015 and later | 2.09 | 30.4 | 0.08 | 0.32 | 0.55 | 0.65 | 0.38 | 0.09 |
| Principal projection | | | | | | | | |
| 1970 | 1.91 | 28.9 | 0.15 | 0.42 | 0.52 | 0.47 | 0.28 | 0.07 |
| 1975 | 1.91 | 29.5 | 0.15 | 0.36 | 0.47 | 0.53 | 0.32 | 0.08 |
| 1980 | 1.98 | 29.7 | 0.15 | 0.35 | 0.50 | 0.56 | 0.34 | 0.09 |
| 1985 | 1.99 | 29.7 | 0.14 | 0.36 | 0.51 | 0.55 | 0.35 | 0.09 |
| 1990 | 1.98 | 29.9 | 0.13 | 0.34 | 0.50 | 0.56 | 0.35 | 0.09 |
| 1995 | 1.90 | 30.4 | 0.09 | 0.28 | 0.51 | 0.57 | 0.36 | 0.09 |
| 2000 | 1.89 | 30.5 | 0.07 | 0.28 | 0.51 | 0.57 | 0.36 | 0.09 |
| 2005 | 1.89 | 30.6 | 0.07 | 0.28 | 0.51 | 0.57 | 0.36 | 0.09 |
| 2010 | 1.89 | 30.6 | 0.07 | 0.28 | 0.51 | 0.57 | 0.36 | 0.09 |
| 2015 and later | 1.89 | 30.6 | 0.07 | 0.28 | 0.51 | 0.57 | 0.36 | 0.09 |
| Low variant | | | | | | | | |
| 1970 | 1.91 | 28.9 | 0.15 | 0.42 | 0.52 | 0.47 | 0.28 | 0.07 |
| 1975 | 1.90 | 29.4 | 0.15 | 0.36 | 0.47 | 0.53 | 0.32 | 0.07 |
| 1980 | 1.94 | 29.4 | 0.15 | 0.35 | 0.50 | 0.56 | 0.31 | 0.07 |
| 1985 | 1.91 | 29.4 | 0.14 | 0.36 | 0.51 | 0.53 | 0.30 | 0.07 |
| 1990 | 1.85 | 29.6 | 0.13 | 0.34 | 0.48 | 0.53 | 0.31 | 0.07 |
| 1995 | 1.73 | 30.2 | 0.09 | 0.27 | 0.46 | 0.53 | 0.31 | 0.07 |
| 2000 | 1.70 | 30.3 | 0.07 | 0.26 | 0.45 | 0.53 | 0.31 | 0.07 |
| 2005 | 1.69 | 30.4 | 0.07 | 0.26 | 0.45 | 0.53 | 0.31 | 0.07 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2010 | 1.69 | 30.4 | 0.07 | 0.26 | 0.45 | 0.53 | 0.31 | 0.07 |
| 2015 and later | 1.69 | 30.4 | 0.07 | 0.26 | 0.45 | 0.53 | 0.31 | 0.07 |

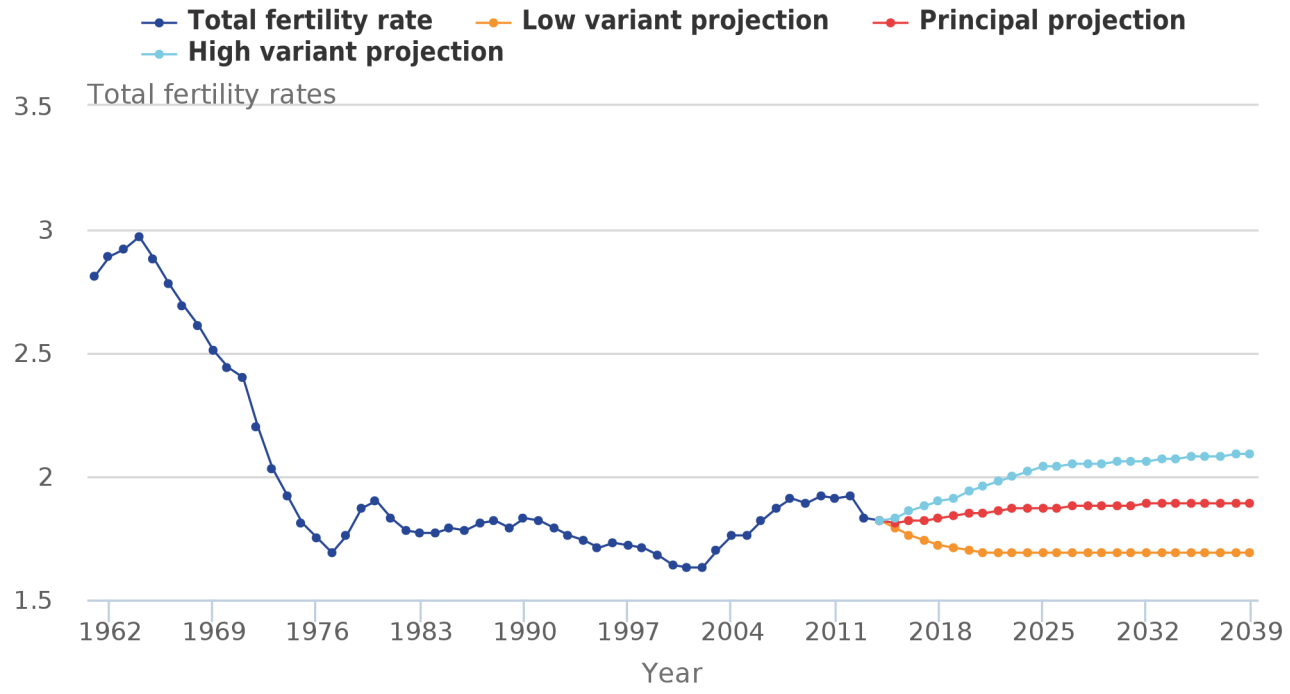
Source: Office for National Statistics

## Total fertility rates and numbers of births

The assumed total fertility rates and projected numbers of births resulting from these alternative assumptions of future fertility levels are shown in Figures 6.2 and 6.3. History shows that there can be quite sudden changes in period fertility. It is therefore important to demonstrate the effect of significant short-term changes, as well as the long-term effects that would result from sustained levels of fertility significantly above or below that assumed in the principal projection.

Figure 6.2 shows that the principal projection assumes the total fertility rate for the UK increases slightly from 1.81 in mid-2014 to mid-2033 then stabilises at 1.89 from then on. Longer-term, the high and low fertility variants assume total fertility rates of 0.2 children higher or lower than the principal assumptions, that is, 2.09 and 1.69 children per woman for the UK.

**Figure 6.2: Estimated and assumed total fertility rates, UK, 1961 to 2039**




**Source: Office for National Statistics**

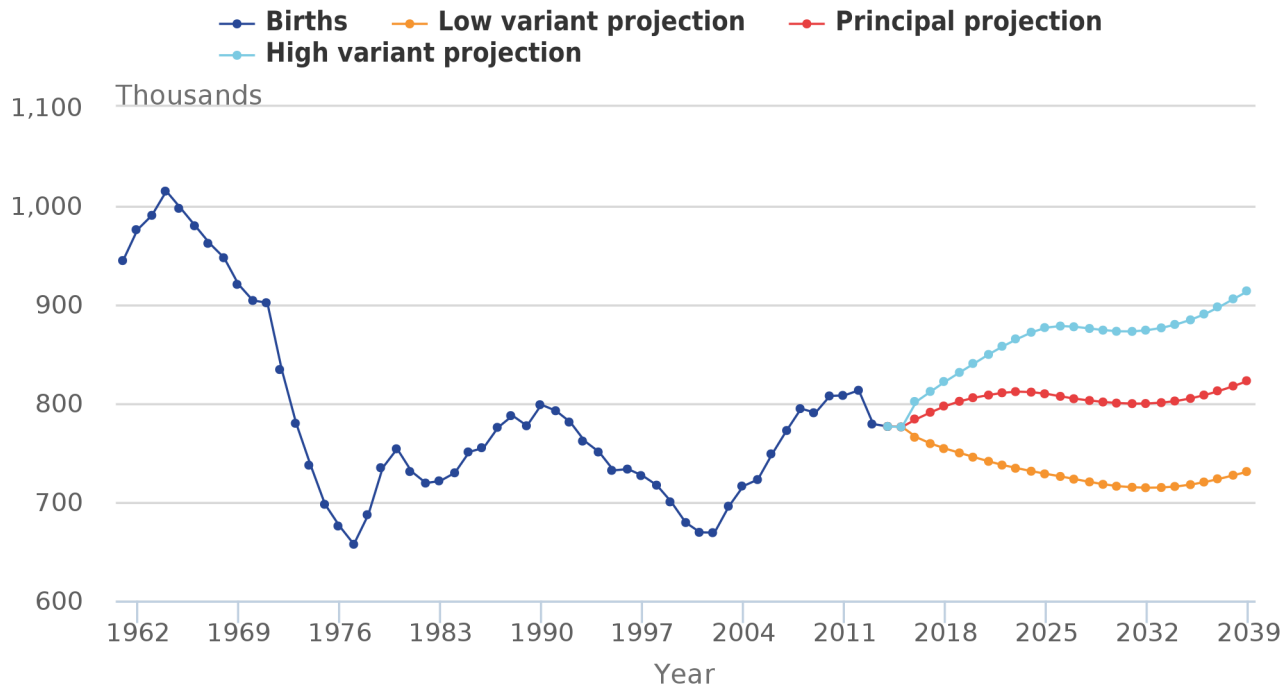
**Notes:**

1. All fertility data are displayed on a calendar year basis

Figure 6.3 shows that under the high fertility variant, the number of births is projected to rise year on year, from around 776,000 in mid-2014 to around 878,000 in mid-2026, dropping slightly to 873,000 by mid-2031 before rising to a level of 914,000 by mid-2039. However, under the low fertility variant, the number of births is projected to decrease in the short-term but from mid-2033 is projected to increase year on year (less sharply than for the high fertility variant).

In practice, variations in the timing of childbearing within women's lives are unlikely to produce considerable fluctuations in the total fertility rate and the annual numbers of births. However, even if trends in completed family size reflect the long-term assumptions underlying the principal projection or either the high or low fertility variants, for any individual year the number of births could differ considerably from those shown here.

**Figure 6.3: Estimated and projected number of births, UK, 1961 to mid-2039**




**Source: Office for National Statistics**

## Effect of fertility variants on population size

The differences between the projected population according to the high and low fertility variant projections and the principal projection are summarised in Table 6.2. For the high fertility variant, the projected population at mid-2039 would be 75.8 million compared with 74.3 million in the principal projection, while the low fertility variant would be 72.5 million.

Figure 6.7, later in this chapter, demonstrates how long-term total population size is sensitive to changes in the fertility assumptions.

**Table 6.2: Population differences between fertility variant projections and principal projection by age, UK, mid-2019 to mid-2039**

thousands

| | All ages | 0–4 | 5–9 | 10–14 | 15–19 | 20–24 |
|---|---|---|---|---|---|---|
| Difference between high fertility variant and principal projection | | | | | | |
| 2019 | 93 | 93 | - | - | - | - |
| 2024 | 329 | 236 | 93 | - | - | - |
| 2034 | 1,056 | 372 | 356 | 236 | 92 | - |
| 2039 | 1,481 | 425 | 372 | 355 | 236 | 92 |
| Difference between low fertility variant and principal projection | | | | | | |
| 2019 | -145 | -145 | - | - | - | - |
| 2024 | -502 | -357 | -145 | - | - | - |
| 2034 | -1,335 | -425 | -408 | -357 | -145 | - |
| 2039 | -1,780 | -446 | -425 | -408 | -357 | -145 |

Source: Office for National Statistics

Notes:

1. Figures may not sum due to rounding

# 3 . Assumptions for mortality variants

The mortality chapter discusses the current wide range of views about prospects for future longevity. To give some indication of these uncertainties, variant projections have been produced based on target improvement rates in mortality by mid-2039. The low life expectancy variant assumes slower improvements in mortality rates than in the principal projection, and the high life expectancy variant assumes faster improvements. In addition, a no mortality improvement variant projection has also been produced. This holds mortality rates at the same level as those used for 2014 to 2015.

Current annual improvements in mortality rates vary considerably by age and sex. In each of these variants it is assumed that, for most ages, the improvements will gradually converge to common target rates of improvement at each age and by both sexes by 2039, and continue to improve at that constant rate thereafter. However, as with the principal projection, these variant mortality projections also assume that those born between 1925 and 1938 (cohorts which have consistently experienced relatively higher rates of mortality improvement over the last 25 years than those born either side) will continue to experience higher rates of mortality improvement than the rest of the population.

The target rate assumptions (for most ages) are as follows.

## High life expectancy variant

Annual improvement is 2.4% at 2039, thereafter annual improvement will remain at 2.4%. For those born between 1925 and 1938, rates of annual improvement in and after 2039 will rise to a peak of 3.7% a year for those born in 1931 and 1932 and then decline back to 2.4% a year for those born in 1939 or later.

## Principal projection

Annual improvement is 1.2% at 2039, thereafter annual improvement will remain at 1.2%. For those born between 1925 and 1938, rates of annual improvement in and after 2039 will rise to a peak of 2.5% a year for those born in 1931 and 1932 and then decline back to 1.2% a year for those born in 1939 or later.

## Low life expectancy variant

Annual improvement is 0% at 2039, thereafter mortality rates will remain constant. For those born between 1925 and 1938, rates of annual improvement in and after 2039 will rise to a peak of 1.3% a year for those born in 1931 and 1932 and then decline back to 0% a year for those born in 1939 or later.

## No mortality improvement

In the first year of the projections, the mortality rates are adjusted to constrain the number of deaths in 2014 to 2015 to the provisional estimates. For the no mortality improvement variant, the mortality rates remain constant throughout the projection period at the adjusted levels assumed for 2014 to 2015 after constraining has taken place. Annual improvement is 0% at all ages.

Due to fluctuations in annual mortality rates, there is always some uncertainty about establishing the “real” current rate of mortality improvement. Furthermore, epidemics (there have been no major ones in recent years), or hard winters[1,2,3], can have a considerable effect on the number of deaths, although this may be partially offset by fewer deaths than normal in the following year.

## Expectations of life at birth and numbers of deaths

The resulting expectations of life at birth in the mortality variant projections are summarised in Table 6.3 and shown in Figure 6.4. These are period expectations of life, calculated on the basis of the mortality rates for a given calendar year. The projected number of deaths resulting from these different expectations of life at birth are shown in Figure 6.5.

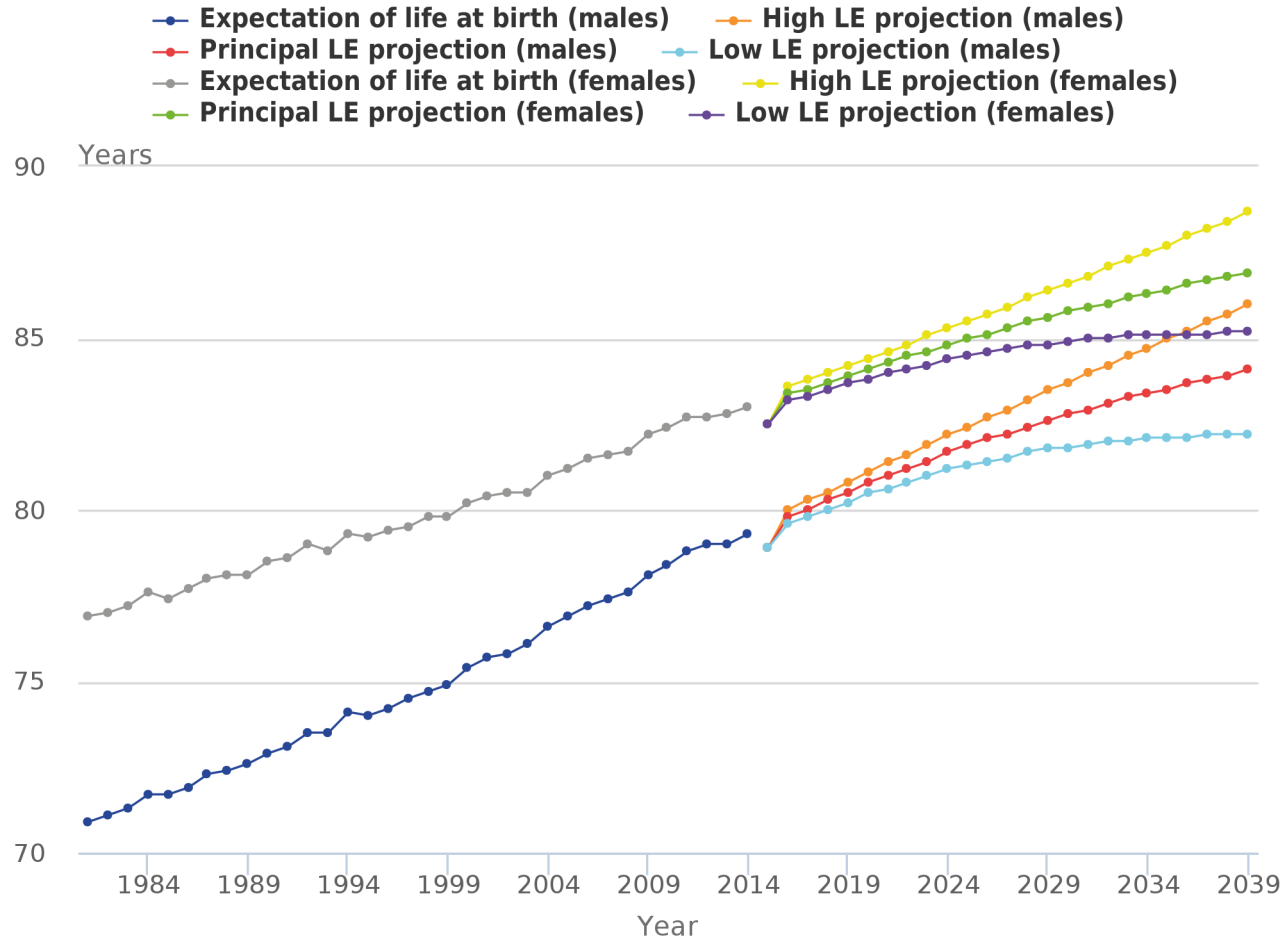
**Table 6.3: Period expectation of life at birth according to mortality rates assumed for selected years, variant mortality projections, UK, years to mid-2039**

years

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| | High life expectancy | Principal projection | Low life expectancy | High life expectancy | Principal projection | Low life expectancy |
| 2014 to 2015 | 78.9 | 78.9 | 78.9 | 82.5 | 82.5 | 82.5 |
| 2023 to 2024 | 82.2 | 81.7 | 81.2 | 85.3 | 84.8 | 84.4 |
| 2033 to 2034 | 84.7 | 83.4 | 82.1 | 87.5 | 86.3 | 85.1 |
| 2038 to 2039 | 86.0 | 84.1 | 82.2 | 88.7 | 86.9 | 85.2 |

Source: Office for National Statistics

**Figure 6.4: Estimated and projected period expectation of life at birth according to mortality rates for given years, UK, 1961 to mid-2039**

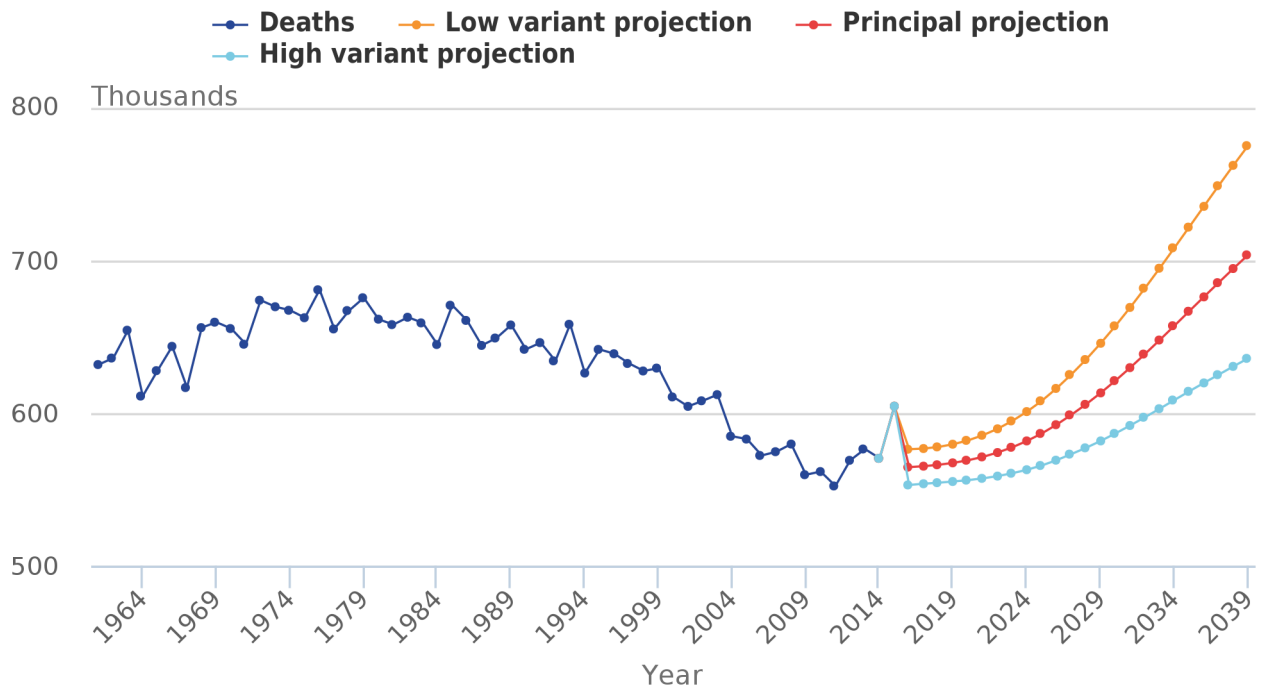



**Source: Office for National Statistics**

**Notes:**

1. Figures up to 2014 are displayed on a calendar year basis. Figures for 2014 onwards are as at year ending June

**Figure 6.5: Estimated and projected number of deaths, UK, 1961 to mid-2039**




**Source: Office for National Statistics**

**Notes:**

1. Figures up to 2014 are displayed on a calendar year basis. Figures for 2014 onwards are as at year ending June

In the high life expectancy variant, period expectation of life at birth for males is projected to increase by 7.1 years, from 78.9 years in mid-2015 (the first year of the projection) to 86.0 years in mid-2039 (25 years into the projection), while the corresponding increase for females is 6.2 years (from 82.5 years to 88.7 years). In the low life expectancy variant, period expectation of life at birth is projected to increase by 3.3 years for males and 2.7 years for females, reaching 82.2 and 85.2 years, respectively, by mid-2039.

## Effect of mortality variants on total population size

The differences between the projected populations according to the high and low life expectancy variant projections and the principal projections are summarised in Table 6.4.

The population at mid-2039 for the high and low life expectancy variants may be 767,000 higher or 797,000 lower than the principal projection of 74.3 million, with 75.1 million in the high life expectancy variant projection, but 73.5 million given the low life expectancy assumptions. Figure 6.7, later in this chapter, shows that by mid-2039, there is a difference of around 1.6 million between the total population in the high and low life expectancy variant projections.

**Table 6.4: Population differences between mortality variant projections and principal projection by age, UK, mid-2019 to mid-2039**

thousands

| | All ages | Under 60 | 60-74 | 75-84 | 85 and over |
|---|---|---|---|---|---|
| Difference between high life expectancy variant and principal projection | | | | | |
| 2019 | 47 | 5 | 10 | 13 | 19 |
| 2024 | 126 | 13 | 25 | 36 | 52 |
| 2034 | 465 | 38 | 82 | 116 | 229 |
| 2039 | 767 | 58 | 118 | 187 | 405 |
| Difference between low life expectancy variant and principal projection | | | | | |
| 2019 | -47 | -5 | -10 | -13 | -19 |
| 2024 | -127 | -13 | -26 | -36 | -51 |
| 2034 | -478 | -41 | -89 | -123 | -226 |
| 2039 | -797 | -65 | -132 | -204 | -396 |

Source: Office for National Statistics

Notes:

1. Figures may not sum due to rounding

# 4 . Assumptions for migration variants

For the principal projection, the new long-term assumption for international net migration to the UK is +185,000 each year from mid-2021 onwards. For the variant projections, in the first year of the projection annual net migration has been assumed to be 40,000 higher or lower than the principal projection. For all subsequent years it has been assumed to be 80,000 higher or lower. This results in the high and low annual long-term international net migration assumptions to the UK being 265,000 and 105,000 persons per year, respectively.

In the 2014-based projections, the high and low variant migration assumptions for the UK were produced as an aggregation of the international migration figures set for the constituent countries. This is different to the method used in previous projections where the high and low assumptions were set non-additively. The difference between the high and low migration assumptions and the principal in the 2014-based projections is higher than used in the 2012-based projections (which were 60,000 higher or lower than the principal in the long-term).

In addition to the high and low migration variants, 2 special case scenario projections are available. The zero net migration (natural change only) variant uses the principal assumptions of fertility and mortality and assumes that there will be zero net migration for every age for each sex. The long-term balanced net migration projection (available at UK level only) assumes that net migration will decline to zero in the long-term (from the year ending mid-2022 onwards), with in-migration and out-migration total flows being equal. However, although long-term total inflows and outflows are assumed to be equal at 250,000 each, inflows and outflows are not necessarily assumed to be equal for each individual age or sex (so a net inflow at one age might be offset by a net outflow at another age). For the 2014-based projections, the long-term balanced net migration variant follows the assumptions of the low migration variant, as published on 29 October 2015, in the run-in period to the long-term assumption (from the year ending mid-2015 to year ending mid-2021). In previous projections it followed the principal assumption; however, feedback at consultation showed users required the long-term balanced net migration to follow a lower level of migration.

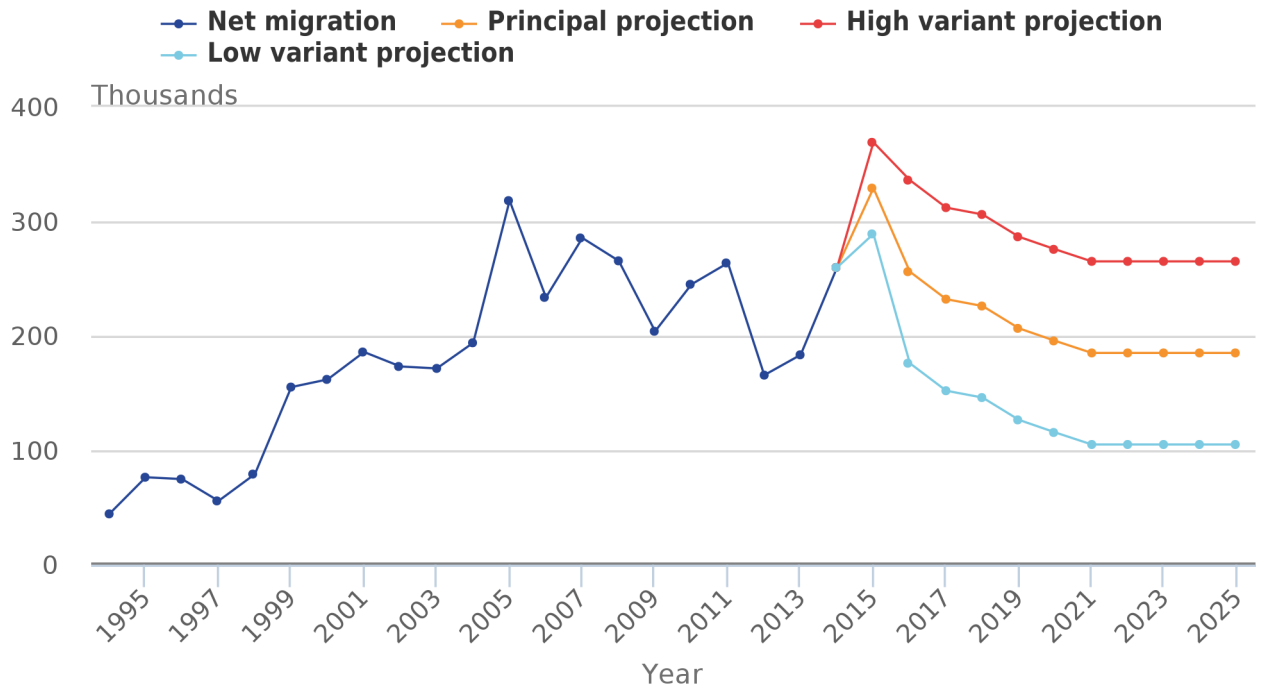
Special assumptions have been applied for the first few years of the projections (mid-2015 to mid-2020). These assumptions have been formulated to represent a transition from the last year of actual data to the constant long-term assumptions. They also take into account the following factors:

1. further information on migration from the Migration Statistics Quarterly Report, published in August 2015

2. a short-term armed forces flow, which has been included to account for the planned return of home armed forces personnel and their dependants from Germany

The variant assumptions are shown in Figure 6.6.

**Figure 6.6: Estimated and assumed total net migration, UK, year ending mid-1994 to mid-2025**




**Source: Office for National Statistics**

**Notes:**

1. All data are displayed on a mid-year basis

The equivalent figures for the constituent countries of the UK can be found in the migration assumptions report published on 29th October 2015, under appendices A to D.

Variants are not intended to represent limits for future demographic behaviour. Indeed, in the case of migration, whatever average level occurs in the future, it is possible that there will be some years when net migration exceeds the level of the high variant and others where it will be below the level of the low variant. Therefore, these migration variants should be regarded as giving an indication of the implications for the future if average migration levels were to differ significantly from those assumed in the principal projection.

## Effect of migration variants on total population size

The differences between the population according to the high and low migration variant projections and the principal projection are summarised in Table 6.5. Unlike the fertility and mortality variants, the migration variants are broadly symmetrical with respect to the principal projection.

With annual international net migration assumed to be 80,000 a year more (or fewer) than the principal projection after the first year, this would lead to just under 2.0 million more (or fewer) international migrants over the next 25 years. Because migration is concentrated at young adult ages, there is also a significant second generation effect with the different number of migrants changing the number of women of childbearing age and hence the future number of births. The effect on the number of deaths over this period is considerably smaller as migrants are predominantly young.

**Table 6.5: Population differences between variant migration projections and principal projection by age, UK, mid-2019 to mid-2039**

thousands

| | All ages | 0-9 | 10-19 | 20-29 | 30-39 | 40-49 | 50-59 | 60-69 | 70 and over |
|---|---|---|---|---|---|---|---|---|---|
| Difference between high migration variant and principal projection | | | | | | | | | |
| 2019 | 381 | 42 | 20 | 149 | 97 | 39 | 18 | 11 | 5 |
| 2024 | 857 | 131 | 42 | 234 | 260 | 105 | 46 | 25 | 15 |
| 2034 | 1,935 | 328 | 175 | 280 | 512 | 371 | 152 | 70 | 49 |
| 2039 | 2,501 | 381 | 285 | 324 | 536 | 536 | 255 | 110 | 75 |
| Difference between low migration variant and principal projection | | | | | | | | | |
| 2019 | -381 | -42 | -20 | -149 | -97 | -39 | -18 | -11 | -5 |
| 2024 | -857 | -131 | -42 | -234 | -260 | -105 | -46 | -25 | -15 |
| 2034 | -1,935 | -328 | -175 | -280 | -512 | -371 | -152 | -70 | -48 |
| 2039 | -2,501 | -381 | -285 | -324 | -536 | -535 | -254 | -110 | -74 |

Source: Office for National Statistics

Table 6.5 shows that the alternative migration assumptions would lead to 2.5 million more (or fewer) people in the population at mid-2039, compared with the principal projection. However, even 25 years ahead, these alternative assumptions would have little effect on the number of people aged over 60. By mid-2039, the population would be 76.8 million in the high migration variant compared with 74.3 million in the principal projection, but 71.8 million under the low migration variant assumptions.

An interesting feature of these migration variants is that, although it is assumed that migration will continue to be concentrated at working ages, there is comparatively little effect on long-term dependency ratios. In the principal projection, the “pensionable age dependency ratio”[4] (defined as the number of persons of pensionable age per 1,000 persons of working age[5]), would be 370 per 1,000 at mid-2039. However, this ratio is not greatly different under the alternative migration assumptions; in the high and low migration variants, the ratios at mid-2039 are 357 and 383 per 1,000 persons of working age, respectively.

Previous work has shown that any realistic assumption of future migration could only have a very limited effect on population ageing[6]. In contrast, the raising of the State Pension age has a much greater effect. If State Pension age remained at 65 for men and 60 for women, the pensionable age dependency ratio at mid-2039 would be 487 per 1,000 persons of working age, rather than 370.

### Relationship between UK level projections and individual country level projections for migration variants

The assumptions for the flows between the countries of the UK are now set as rates instead of fixed numbers of migrants. Annual age and sex-specific migration rates for each cross-border flow are calculated as the number of migrants at the end of the year divided by population of the country of origin at the start of the year. An average of the rates for the last 5 years of actual data (year ending mid-2010 to year ending mid-2014) is then taken and applied to the population of the country of origin at the beginning of each projection year to calculate the projected number of migrants for each flow.

The UK projection is calculated “additively”, simply as the sum of the projections for the 4 constituent countries (England, Wales, Scotland and Northern Ireland). Therefore, the projected population numbers, deaths at each age, and births at each age of mother for the UK are simply the sum of the 4 individual countries. The “assumed” UK fertility and mortality rates are then “back-calculated” from these projected births, deaths and population numbers. The only exception to this is the UK long-term balanced net migration variant, which is calculated at the UK level only. For this variant projection, the “back-calculated” fertility and mortality rates for the UK principal projection are used.

## 5 . Combination variants

For particular applications, users may also be interested in projections combining 2 or more of these alternative scenarios, for example, the largest total population size, or the “high population” variant projection (high fertility, high life expectancy and high migration assumptions). With this combination of assumptions, the population would be 79.1 million by mid-2039, whereas the lowest total population size, (“low population” variant, which combines the low variant assumptions for fertility, mortality and migration) projects 69.3 million. Some main summary statistics from selected combination variants are given in Table 6.6.

Over the 25 year period to mid-2039, the highest dependency ratios (the total number of children and those of pensionable age per 1,000 persons of working age) amongst the single component and standard combination variants occur given high fertility, high life expectancy and high migration (the “high population” variant). The lowest dependency ratios occur where there is low fertility, low life expectancy and low migration (the “low population” variant).

**Table 6.6: Measure of population structure under the principal projection, standard variant projections and special case scenarios, UK, mid-2039**

| | Total population (mid-2014 = 64,597) | % of population aged under 16 (mid-2014 = 18.8) | % of population aged 65 & over (mid-2014 = 17.7) | Dependants per 1,000 persons of working age * (mid-2014 = 614) |
|---|---|---|---|---|
| Projection | mid-2039 | mid-2039 | mid-2039 | mid-2039 |
| Principal projection | 74,284 | 17.8 | 24.3 | 666 |
| SINGLE COMPONENT VARIANTS | | | | |
| High fertility | 75,765 | 19.0 | 23.8 | 689 |
| Low fertility | 72,504 | 16.4 | 24.9 | 642 |
| High life expectancy | 75,051 | 17.6 | 25.0 | 680 |
| Low life expectancy | 73,488 | 18.0 | 23.6 | 652 |
| High migration | 76,786 | 18.0 | 23.7 | 654 |
| Low migration | 71,783 | 17.6 | 25.0 | 679 |
| COMBINATION VARIANTS | | | | |
| High population (high fertility, high life expectancy, high migration) | 79,090 | 19.0 | 23.8 | 691 |
| Low population (low fertility, low life expectancy, low migration) | 69,273 | 16.4 | 24.9 | 640 |
| Young age structure (high fertility, low life expectancy, high migration) | 77,514 | 19.4 | 22.5 | 664 |
| Old age structure (low fertility, high life expectancy, low migration) | 70,825 | 16.0 | 26.3 | 670 |
| SPECIAL CASE SCENARIOS | | | | |
| Replacement fertility | 76,600 | 19.1 | 23.6 | 683 |
| Constant fertility | 73,637 | 17.2 | 24.5 | 656 |
| No mortality improvement | 71,568 | 18.4 | 21.9 | 617 |
| Zero migration (natural change only) | 67,658 | 16.8 | 26.3 | 690 |
| No change (constant fertility, no mortality improvement) | 70,921 | 17.8 | 22.1 | 607 |
| Long-term balanced net migration | 70,419 | 17.5 | 25.4 | 685 |

Source: Office for National Statistics

Notes:

1. Figures may not sum due to rounding

2. * Dependants are children under 16 and people of state pensionable age and over. Working age and pensionable age populations are based on State Pension Age (SPA) for the given year. Between 2012 and 2018, SPA will change from 65 years for men and 61 years for women, to 65 years for both sexes. Then between 2019 and 2020, SPA will change from 65 years to 66 years for both men and women. Between 2026 and 2027 SPA will increase to 67 years and between 2044 and 2046 to 68 years for both sexes. This is based on SPA under the 2014 Pensions Act

### Special case scenarios

It is also sometimes useful to prepare special case scenarios or “what if” projections to illustrate the consequences of a particular, but not necessarily realistic, set of assumptions. Six additional variant projections have been produced based on the following special case assumptions:

- replacement fertility
- constant fertility
- no mortality improvement
- zero net migration (natural change only)
- no change
- long-term balanced net migration

More information on these 6 special case variant projections can be found in releases published on 29 October and 26 November 2015.

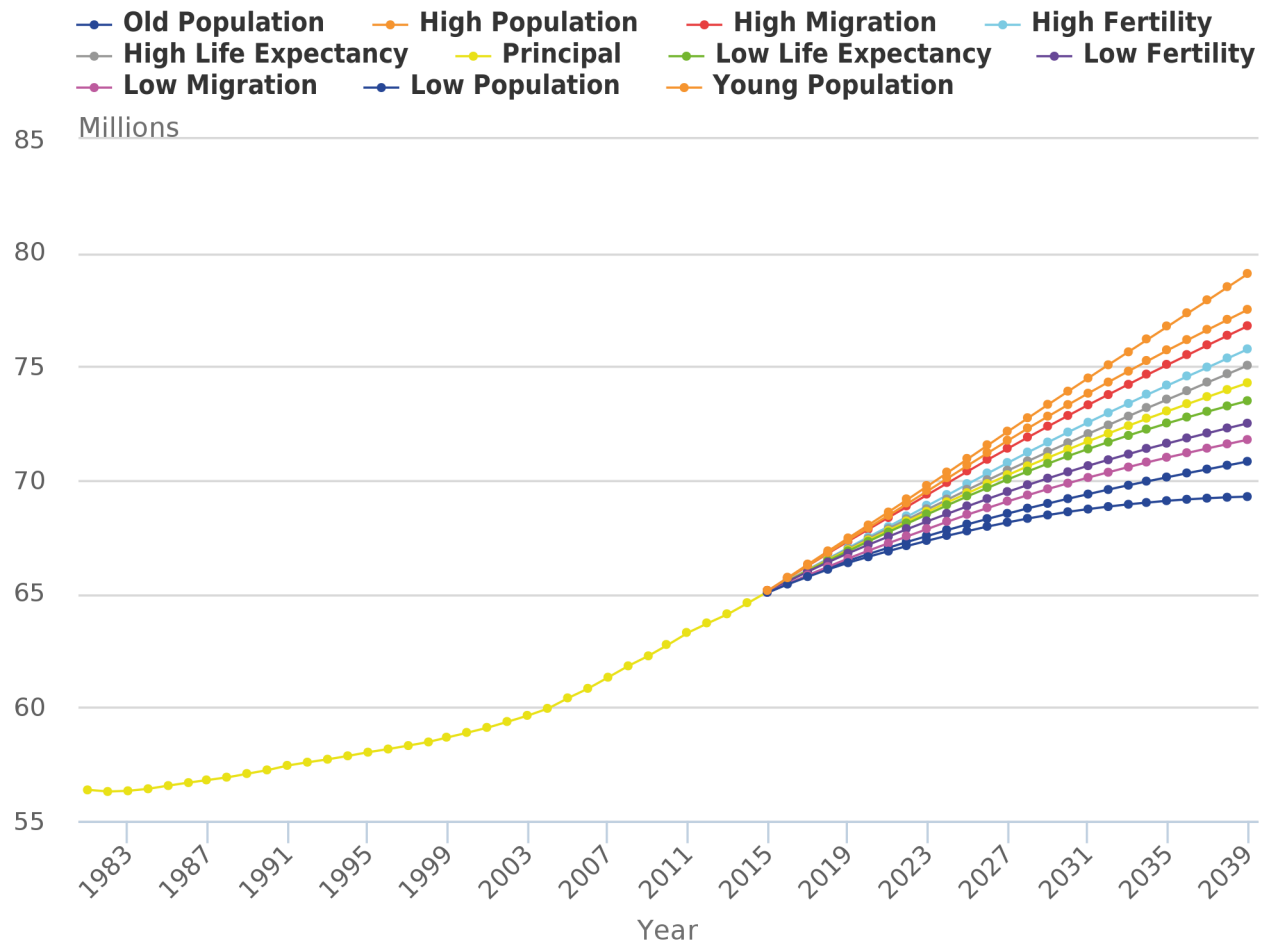
## 6 . Comparison of variant projections

### Total population size

Figure 6.7 shows the implications for future population growth under each of the single component and standard combination variant projections. The chart demonstrates the uncertainty about the future size of the population and that uncertainty widens over time.

For the majority of projections, the total population of the UK is projected to continue growing throughout the projection period. However, the low population variant shows that continuing population growth is not inevitable longer-term.

**Figure 6.7: Estimated and projected total population, UK, mid-1981 to mid-2039**




**Source: Office for National Statistics**

**Notes:**

1. Figures up to and including the year ending mid-2014 are mid-year population estimates. Figures for year ending mid-2015 onwards are population projections

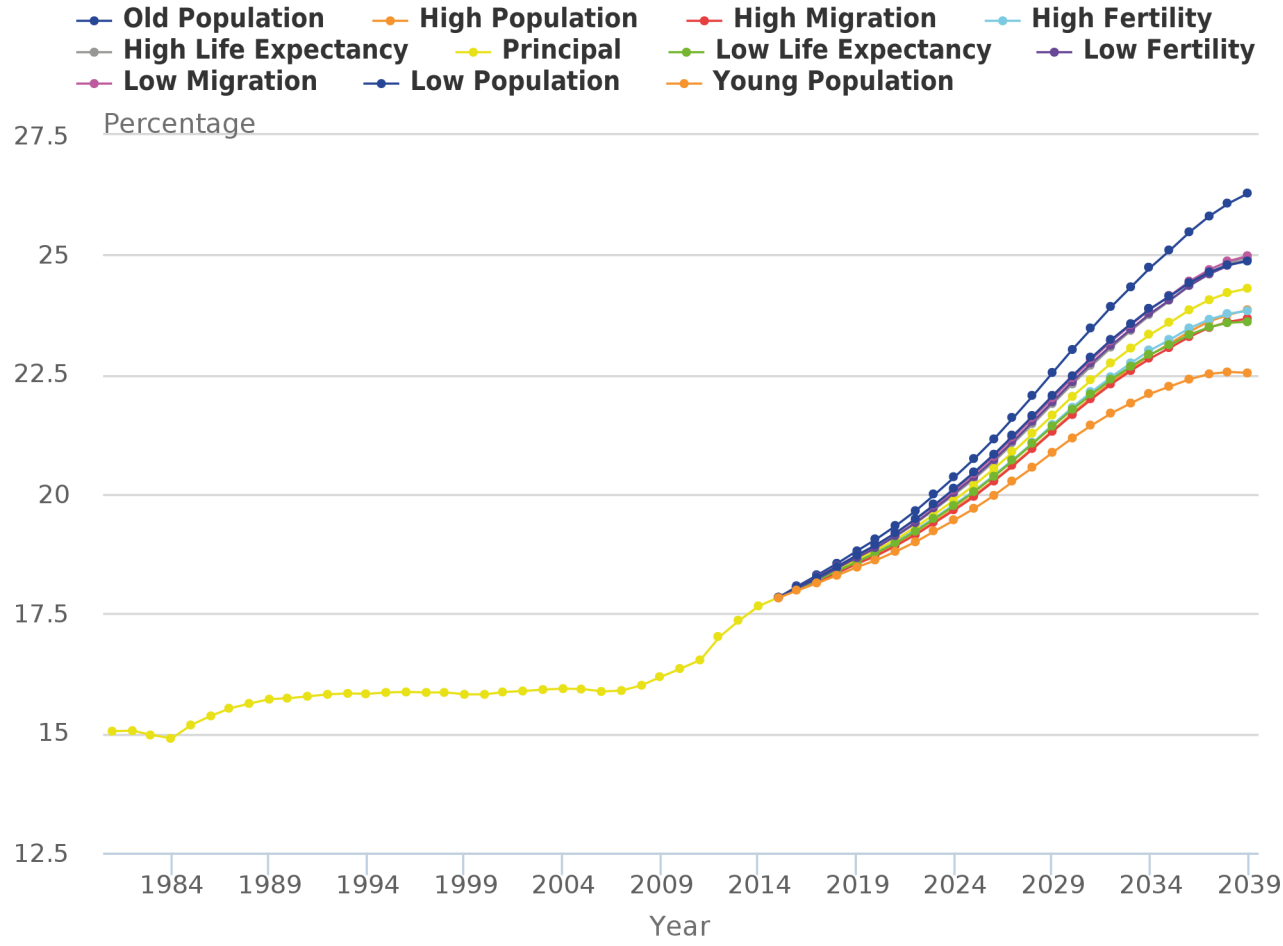
The equivalent figures for the constituent countries of the UK can be found in the results report published on 29th October 2015, under appendices A to D.

## Population aged 65 and over

Figure 6.8 shows the projected proportion of the population aged 65 and over using various alternative assumptions. In this case, as well as the single component variants, the chart also shows the results of the “old age structure” and “young age structure” combination variants.

The chart shows that an ageing population will occur under any plausible set of future assumptions. In mid-2014, 17.7% of the population were aged 65 and over. This is projected to rise to 24.3% by mid-2039 in the principal projection, 26.3% in the old age structure variant and even a rise to 22.5% with the young age structure variant.

**Figure 6.8: Estimated and projected percentage of the population aged 65 and over, UK, mid-1981 to mid-2039**




**Source: Office for National Statistics**

**Notes:**

1. Figures up to and including the year ending mid-2014 are mid-year population estimates. Figures for year ending mid-2015 onwards are population projections

The equivalent figures for the constituent countries of the UK can be found in the extra variants report published on 26th November 2015, Appendix C.

# 7 . Describing uncertainty in population projections

Variant population projections are produced to provide an indication of the effect of alternative assumptions on the future size and structure of the population. This deterministic approach however does not provide an indication of how likely any scenario might be.

One way to understand the uncertainty in projections is to consider the accuracy of past projections as predictors of future populations. A National Population Projections accuracy report was published in July 2015 which focuses on projections produced in the past 40 years, although where possible it also analyses data from further back.

Describing uncertainty in projections has been identified as one of our research priorities.

## Relative uncertainties of fertility, mortality and migration

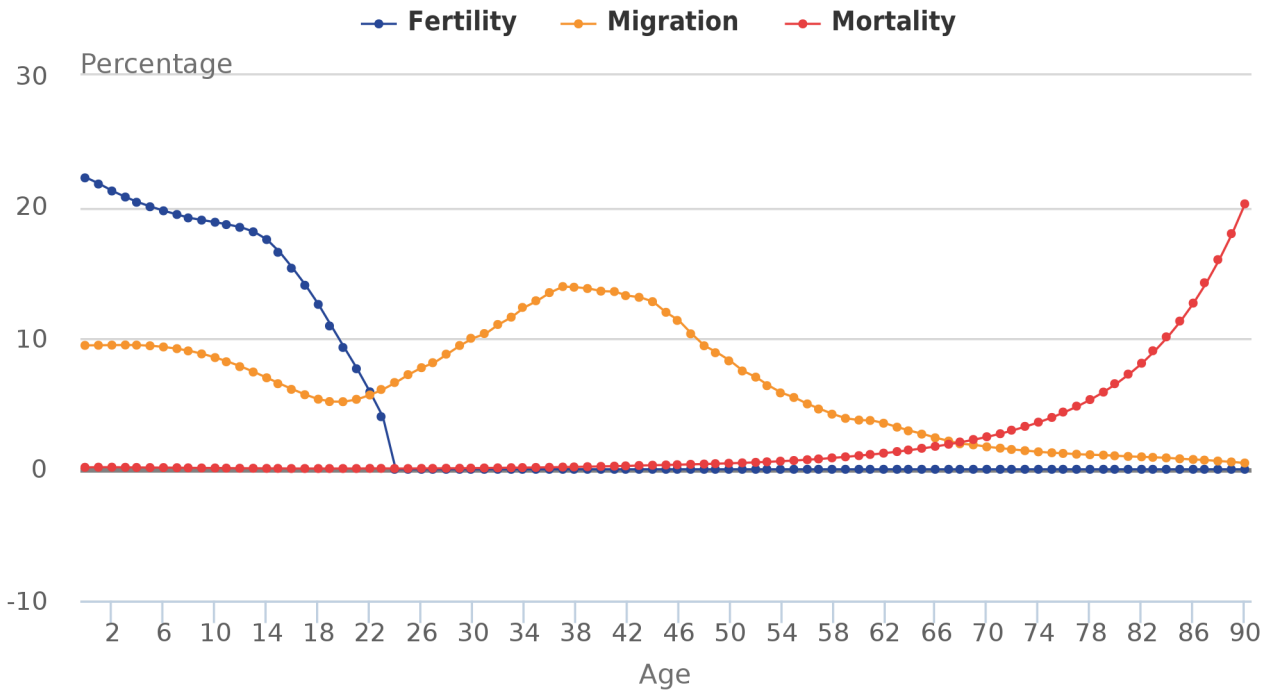
As precise probability statements cannot be ascribed to the variant assumptions, strictly the indication of uncertainty given for fertility, mortality and migration are not directly comparable. Nevertheless, it is possible to make some general comments about the relative importance of fluctuations in fertility, mortality and migration for particular users of the projections.

The majority of users are interested principally in the first 20 years of the projections, over which period possible variations in migration numbers or fertility patterns are likely to have a greater impact on projected size and age structure of the population than variations in mortality rates. However, for applications concerned primarily with the elderly such as planning health and social care services, interest will centre on variations in mortality. In areas such as long-term social security benefit planning, the effect of both mortality and fertility variants has to be considered, whilst for other applications, such as those concerned with the size of the workforce and the numbers of households, future migration levels are of particular importance.

Another way of indicating uncertainty is to consider the accuracy of previous sets of projections. A detailed study of the accuracy of past UK national population projections[8] has been published. The analysis was based on the extensive database of past national projections. This report concluded that fertility had tended to be over-projected whilst life expectancy and net inward migration had generally been under-projected.

Figure 6.9 gives an indication of the relative importance of the assumptions regarding fertility, mortality and migration for the population at each age in mid-2039. It shows (for each component) the difference between the populations in the high and low variant projections at each age, expressed as a percentage of the population in the principal projection. The greatest cause of uncertainty at younger ages is fertility. Migration is the most important variable in determining the size of the working age population in 25 years' time, while mortality only begins to become the dominant factor after age 65.

**Figure 6.9: Population differences between high and low variants as a percentage of the population in the principal projection by age, UK, mid-2039**




**Source: Office for National Statistics**

# 8. References


1. Excess winter mortality in England and Wales available at: http://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/excesswintermortalityinenglandandwales/previousReleases

2. Excess winter mortality in Scotland available at: http://www.gro-scotland.gov.uk/statistics-and-data/statistics/statistics-by-theme/vital-events/deaths/winter-mortality

3. Excess winter mortality in Northern Ireland available at: http://www.nisra.gov.uk/demography/default.asp32.htm

4. 2014-based projected pensionable age dependency ratios are available in the “components of change and summary indicators” datasets, avvailable at: http://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/bulletins/nationalpopulationprojections/2015-10-29/relateddata?page=1

5. Working age and pensionable age populations based on the changed definitions of State Pension age under the Pensions Act 2011. Between 2012 and 2018, State Pension age will change from 65 years for men and 61 years for women, to 65 years for both sexes. Then between 2019 and 2020, State Pension age will change from 65 years to 66 years for both men and women. Between 2034 and 2046, State Pension age will increase in 2 stages from 66 years to 68 years for both sexes.

6. Shaw C (2001) United Kingdom population trends in the 21st century. Population Trends 103, pp37-46. Available at: http://webarchive.nationalarchives.gov.uk/20150904113534/http://ons.gov.uk/ons/rel/population-trends-rd/population-trends/no--103--spring-2001/index.html

7. Office for National Statistics (Quarter 3 2009) Progress report on developing stochastic population forecasts for the United Kingdom. Available at: http://webarchive.nationalarchives.gov.uk/20160204094749/http://ons.gov.uk/ons/guide-method/method-quality/imps/updates-and-reports/historical-updates-and-releases/updates-and-releases-from-2009/index.html

8. National Population Projections Accuracy Report (July 2015). Available at: http://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/methodologies/nationalpopulationprojectionsaccuracyreport


# 9. Background notes

1. These National Statistics are produced to high professional standards and released according to the arrangements approved by the UK Statistics Authority.