

Chapter 4: Mortality, 2012-based NPP Reference Volume

Coverage: **UK**

Date: **28 March 2014**

Geographical Area: **Country**

Theme: **Population**

Introduction

Throughout the 20th century and into this century, the UK has experienced a continuation of the pattern of falling mortality rates that began in the 19th century. During this time there has been a change from a pattern of high infant and child mortality driven by the prevalence of acute and infectious diseases, to a new pattern in which adult mortality predominates and chronic and degenerative diseases are the most common causes of death.¹ The pattern has been broadly similar in England, Scotland, Wales and Northern Ireland.^{2,3,4}

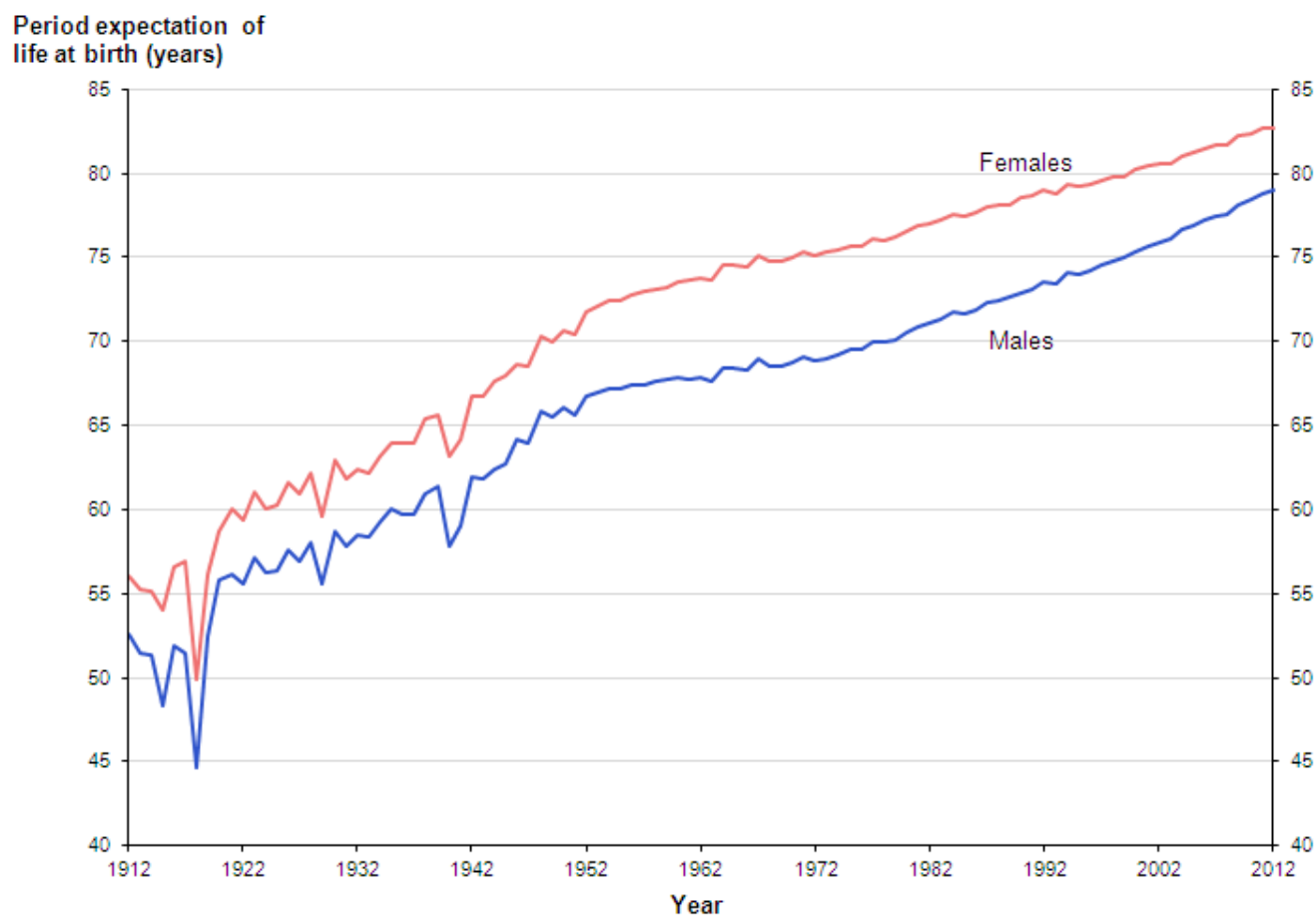
The 2012-based principal projection assumes that mortality rates will continue to improve into the future to an annual target rate of improvement from 2037 of 1.2% for most ages. This target rate was based on the examination of past rates of improvement and expert advice. The average annual rate of improvement over the last hundred years was around 1.1% for males and 1.2% for females.

This chapter summarises past trends in mortality and life expectancy and discusses the assumptions about future mortality made for the 2012-based population projections.

Past Trends in Life Expectancy

One measure of the mortality rates in a particular year is the period expectation of life at birth, which is the average number of years a new-born baby would live for, based on the mortality rates for the given year. Figure 4-1 shows that there was a relatively rapid increase in this measure throughout the first half of the 20th century and then a slower, steady year on year increase continuing into the 21st century.

Figure 4-1: Period expectation of life at birth according to mortality rates experienced in given years, 1912–2012, United Kingdom



Source: Office for National Statistics

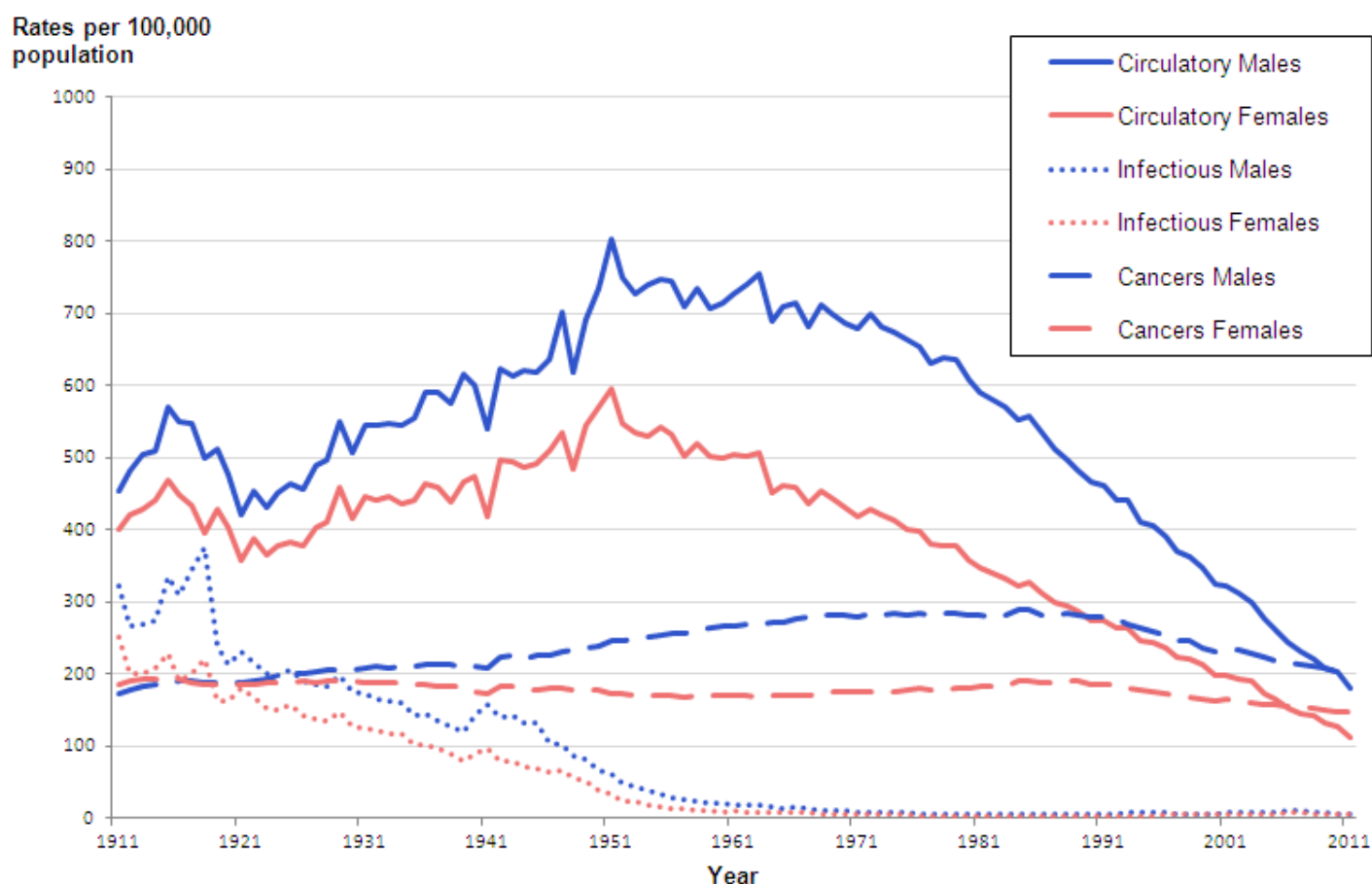
Notes:

1. Figures for 1921-1950 relate to England and Wales and figures for 1951-2012 are for the UK.
2. Scottish figures have not been revised to take account of the 2011 Census.

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Much of the increase in the period expectation of life at birth in the first half of the 20th Century can be attributed to the reduction of infant and child mortality to very low levels by about 1950. Infant and child mortality rates have now fallen to such low levels that further reductions can have little effect on the expectation of life at birth, which has thus come closer to being a measure of the normal life span. Since about 1940, the increasing control of infectious diseases, has considerably reduced the number of early adult deaths, and there has recently been a reduction in the number of those dying early from circulatory diseases (Figure 4-2).^{2,3,4} The greatest decline in mortality rates at advanced ages has occurred since the 1970s. However, in general, mortality rates at the oldest ages declined less over the 20th century in relative terms than those at younger ages.

Figure 4-2: Age-standardised mortality rates by major cause, England and Wales, 1911-2011

Source: Office for National Statistics

Notes:

1. Mortality rates are not available for the UK before 1951; for long historic trends England & Wales data are used.

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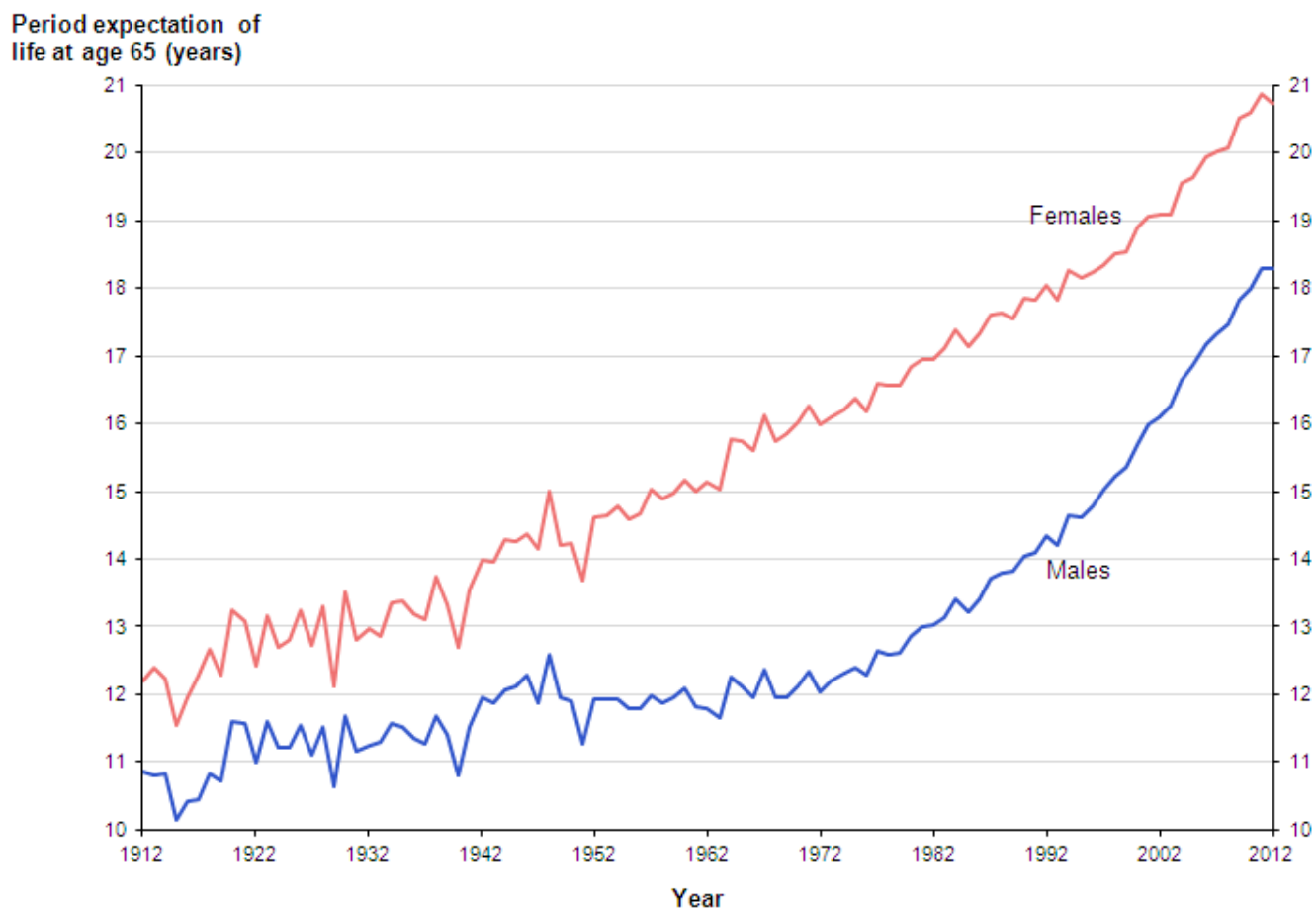
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Figure 4-3 shows that period life expectancy at age 65 has also risen during the 20th century and continues to rise in the 21st century. For females, the annual increase was relatively constant over this period whereas for males, after an initial period of increasing longevity, period life expectancy at 65 remained almost constant between 1940 and 1970. Since 1970 there has been a rapid decline in mortality rates at advanced ages, particularly for males for whom mortality is currently improving more rapidly than female mortality. As a result, the age differential in period life expectancy at age 65 between males and females has reduced from around 4.0 years during the 1970s and early 1980s to 2.4 years in 2012. A partial explanation for this may be the different historical patterns in cigarette smoking between men and women, with a higher proportion of males smoking in the past than females and the peak consumption for males being earlier (1940–1960) than for females (around

1960).^{5,6} This might suggest that the rate of increase in female expectation of life at 65 will continue to be slower than for males over the next few years.

Figure 4-3: Period expectation of life at age 65 according to mortality rates experienced in given years, 1912–2012, United Kingdom



Source: Office for National Statistics

Notes:

1. Figures for 1921-1950 relate to England and Wales and figures for 1951-2012 are for the UK. .
2. Scottish figures have not been revised to take account of the 2011 Census.

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A number of publications provide reviews of long-term mortality trends in the UK.^{1,2,3,4,7,8,9}

Future Prospects for Life Expectancy

Since the 1980s the period expectation of life at birth in the UK for females has increased by about 1.9 years per decade, while male life expectancy has increased by around 2.6 years per decade. However, there are diverse opinions amongst demographers as to the level of longevity that might reasonably be expected in the future.^{9,10,11,12} One can point to Japan, where the period expectation of life at birth in 2012 was about 86.4 years for females and 79.9 years for males,¹³ and to other countries in Europe, such as Italy, Norway, Sweden and Switzerland, which also currently have higher period expectations of life at birth than the UK for both males and females.¹⁴ There is also the possibility of lower incidences of cancer, heart disease and strokes through changes in lifestyle and, through medical advances, greater control of these when they do occur. In particular, mortality rates for heart disease and strokes have fallen quite rapidly and steadily over the 1990s for males and females aged 40 to 64 and to a lesser extent for older men and women.¹⁵ Since 2000, the falls in mortality rates from these causes have continued at around the same pace for the 40–64 age-group and have accelerated for older men and women (aged 65 and over). Mortality rates from circulatory diseases had fallen to similar levels as the all cancers mortality rate by 2008. In the future changes in mortality rates from causes other than circulatory diseases will have an increasingly greater effect on the rates of future mortality improvements.

On the other hand some demographers believe that, despite the possibility of advances in medical practices and of encouraging healthy lifestyles, a law of diminishing returns will apply to mortality rate reductions at advanced ages, partly because no more than a minority of the population will adopt truly healthy lifestyles. It is also possible that new diseases, or the re-emergence of existing diseases such as tuberculosis, may serve to temper future improvements in mortality.

Methodology and Derivation of UK Base Mortality Rates

When formulating the mortality assumptions for population projections the focus is on mortality rates and annual percentage change in the mortality rates by age and year rather than life expectancy. The annual percentage changes are also referred to as rates of improvement in mortality (or mortality improvements) because at most ages in most years mortality rates have improved. In this chapter, the assumptions for the projections are given in the form of central mortality rates (m_x). The difference between these and the probabilities of dying (q_x) used to carry out the actual projections is described in [Chapter 1](#). The latter figures can be accessed via the [NPP interactive table download tool](#) by selecting the assumed age specific mortality rates.

Age-specific mortality rates were calculated for each year using deaths data and mid-year population estimates for 1961 to 2011 (deaths data for 2012 did not become available until after the mortality assumptions for these projections were finalised). Population estimates by age for those aged 90 and over from 1979 onwards (and retrospective estimates for earlier years, back to when these persons were aged 80) were calculated using the [Kannisto-Thatcher survivor ratio method](#) which is a modified form of the method of extinct generations.¹⁶ The retrospective estimates to age 80 have been found to give more reliable results than using the official population estimates made at the time.

A [p-spline model](#) was then applied to the resulting crude mortality rates to produce a fitted, smoothed surface of mortality rates to the historical data for each gender.¹⁷ This was the same approach as used for the 2010-based national population projections. Comparisons of the annual percentage change in the smoothed mortality rates using different ranges of calendar years and ages found that the addition of an extra year's data or extending the age range can result in quite different rates of mortality improvement at some ages for the most recent years in the data used (this is often termed 'edge effects'). In particular, when an extra year's data are added improvements calculated for the final and penultimate years of the data range tend to be altered more than those for earlier years, which were usually not altered to a significant degree.

As a result of these analyses, smoothed mortality rates were calculated using data for years 1961 to 2011 and age ranges 0 to 100 for males and 0 to 105 for females. Percentage changes in mortality were then calculated by age for the year 2009 using the smoothed mortality rates for 2008 and 2009. These rates of percentage change for 2009 were then projected forward to 2012 by assuming that the same rates of change applied in 2010, 2011 and 2012. This projection was carried out by year of age (period) for those born in 1960 and later and by year of birth (cohort) for those born before 1960. Improvement rates (percentage change) in 2012 for ages where this methodology did not give an assumed rate were obtained by interpolation between the nearest ages where there were assumed rates.

Assumed age specific base mortality rates for 2012 were obtained by applying the resulting assumed rates of improvement to the smoothed age-specific mortality rates produced for 2009.

Base year mortality rates for individual countries

Mortality rates for the base year 2012 were initially calculated for the UK. Mortality rates for 2012 for the four individual countries of the UK were then obtained by adjusting the UK mortality rates at each age in proportion to the particular country's mortality experience relative to the UK mortality experience at that age for the three years 2009 to 2011. The resulting base year mortality rates for individual countries are shown for selected ages in Table 4-1. The country specific mortality improvement rates described later in this chapter were then applied to the projected base mortality rates for 2012 for each country to obtain the projected mortality rates for future years.

Table 4-1: Assumed base year mortality rates (mx) per 100,000 population, by selected ages, 2012

Age	Males				Females			
	England	Wales	Scotland	Northern Ireland	England	Wales	Scotland	Northern Ireland
0	469	443	429	513	381	344	340	408
2	14	11	13	16	13	12	12	13
12	10	12	8	11	8	9	8	9
22	53	66	79	101	22	23	32	30
32	81	112	149	111	44	50	70	40
42	175	204	268	203	103	108	139	121
52	366	399	490	418	252	282	333	289
62	914	971	1,179	999	600	665	790	659
72	2,440	2,643	3,103	2,668	1,571	1,737	2,058	1,745
82	7,143	7,539	8,374	7,653	5,137	5,499	6,177	5,418
92	21,288	22,309	21,359	22,786	17,251	17,963	18,488	18,392
102	51,832	51,832	51,832	51,832	44,793	45,014	47,239	46,122

Table source: Office for National Statistics

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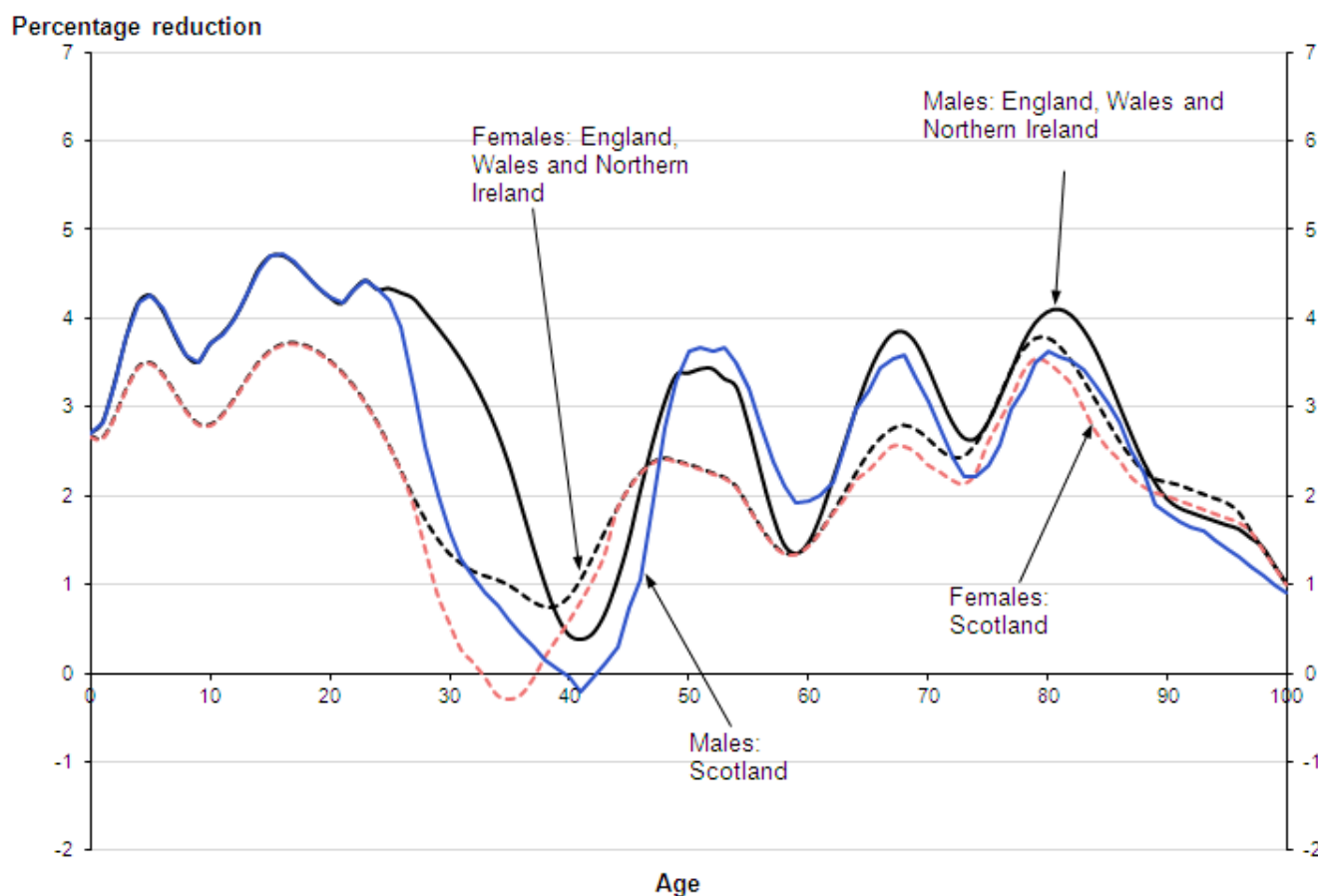
Trends in Mortality by Age

The smoothed mortality rates for the UK fluctuate between increases and reductions at older ages for men up to the mid-1970s, as well as temporary increases for middle-aged men in the 1960s and amongst young men in the 1960s and the early 1970s. Mortality rates for men aged 21 to 40 generally rose during the mid-1980s to the mid-1990s. These increases were partly attributable to deaths caused by HIV infection and AIDS.¹⁸ Suicide rates and alcohol-related mortality also increased for men at young ages until the late 1990s.¹⁹ Since the late 1990s mortality rates for men in this age-group have generally been declining. Apart from increasing mortality rates for women aged between 45 and 60 during the 1960s and early 1970s, mortality rates are generally falling for women of all ages. Mortality rates for women aged 15 to 30 generally showed little improvement, or even worsened, during the 1990s but since then this trend has reversed.

It was assumed that the trends apparent during the period 1961 to 2011 (mostly of improvement in mortality) would initially continue at similar rates with improvements for 2011 to 2012 being those derived as described earlier.

Comparisons of the rates of improvement experienced in each individual country with those experienced in the UK as a whole suggested that the assumed initial rates of improvement by age and sex for the UK could be adopted for each individual country, except for Scotland. Mortality for Scottish males and females at some ages has been improving more slowly or worsening at a faster rate than elsewhere in the UK in recent years. As a result, different initial rates of mortality improvement were assumed for Scottish males and females at several ages with lower rates of improvement for Scottish males aged 25 to 49 and 65 to 100 and for Scottish females aged 27 to 43 and 63 to 96 than for the rest of the United Kingdom. Conversely, higher rates of improvement were assumed for Scottish males aged 50 to 61. The improvement rates for the other countries were then adjusted so that the weighted country specific improvements by age were the same as those initially derived for the United Kingdom as a whole. The resulting assumed smoothed changes in mortality rates between 2011 and 2012 for each country are shown in Figure 4-4.

Figure 4-4: Assumed smoothed percentage changes in mortality rates between 2011 and 2012 by age, Scotland compared with combined figures for England, Wales, and Northern Ireland



Source: Office for National Statistics

Notes:

1. Scottish figures have not been revised to take account of the 2011 Census.

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The peak levels of improvement in mortality rates (of around 4% a year) for both males and females noted in previous projections for the cohorts born around 1931 (aged around 81 in 2012) have continued. It is not understood precisely why the members of the generation born around the early 1930s have been enjoying higher rates of mortality improvement throughout their adult life than preceding generations, or why the rate of improvement slowed down for following generations. It may, however, be relevant that this generation was the first to benefit from a combination of better childhood health, the conquest of infectious diseases affecting young and middle-aged adults and, in later middle-age, improvements in the treatment of circulatory diseases. Additionally, the men, in particular, stopped smoking cigarettes sooner than those in preceding generations.

Future improvements in age-specific mortality rates

Consideration was then given to how the trends might change in the future. The methodology used for mortality projections in the UK assumes 'target' rates of mortality improvement for a specific future year 25 years ahead of the base year for the projections.

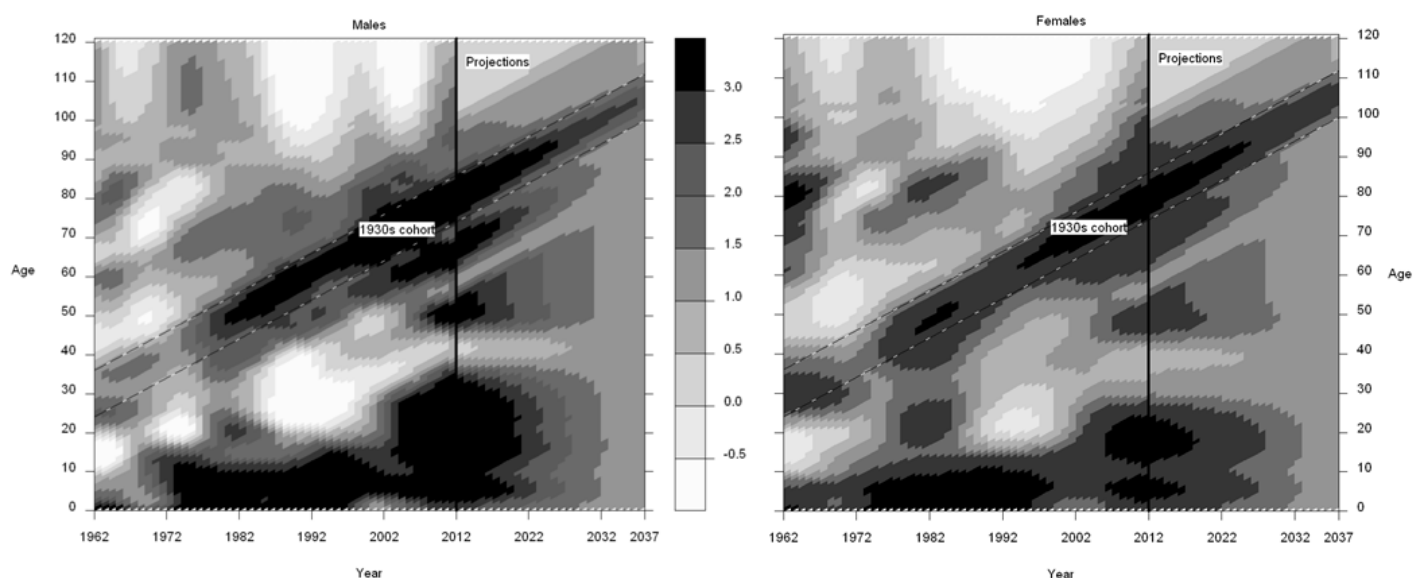
Over the 40-year period 1971–2011, the average annualised rate of improvement in aggregate standardised mortality rates in the UK has been around 2.0% for males and 1.5% for females. (These rates of improvement are derived from aggregate mortality rates for ages 0 to 99 calculated using the 2011 population estimates for the England and Wales as the standard population). The rate of improvement over the latter half of this period was higher for both males and females than over the first half, and particularly so for males. This appears to be partly due to differential trends in smoking behaviour between males and females. Relatively higher numbers of men have now given up smoking and mortality rates for males at older ages have shown large rates of improvement in recent years.^{5,6}

The average annual rate of improvement over the last hundred years was around 1.1% for males and 1.2% for females although the improvement rates vary by age. There is ongoing debate as to whether the impact of future technical, medical and environmental changes will have a greater or lesser effect on improvements in mortality in the future than they had over the 20th century. Taking these various factors into consideration together with the views of the expert panel, the rate of improvement for 2037 (the 25th year of the 2012-based projections) has been assumed to be 1.2% for most ages (that is, broadly equivalent to the average annual rate of improvement over the period 1911 to 2011).

However, those born after 1924 and before 1939 have exhibited greater rates of improvement over the last 25 years than those born on either side.²⁰ This is evident in the heat maps (Figure 4-5) where the highest improvements are shown by the dark areas. There is currently no evidence that these differentials are declining. As a result, it is now assumed that these cohorts will continue to

experience higher rates of improvement with the assumed rate of improvement in 2037 rising from 1.2% a year for those born before 1924 to a peak of 2.5% a year for those born in 1931 and 1932 and then declining back to 1.2% a year for those born in 1939 and later. However, there is little evidence of past mortality improvements at the very oldest ages in the UK. As a result, and in order to avoid implausible numbers surviving to extreme ages, the notional assumed rates of improvement in the 25th year of the projections are assumed to reduce to 1.0% for those born in 1922 and to reduce further from 1.0% for those born in 1912 to 0.1% for those born in 1904 and earlier. These are the same assumptions for the rates of future mortality improvement, by year of birth, in the target year as those assumed for the 2010-based projections (where the target year was 2035).

Figure 4-5: Historic and projected percentage change in smoothed mortality rates, UK



Source: Office for National Statistics

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Table 4-2 shows the reductions in mortality rates assumed for selected years in the future and the total reduction over the next 25 years from 2012 to 2037 for each country of the UK. Current rates of mortality improvement by age are assumed to converge to the target rates of 1.2% to 2.5% in 2037 more rapidly for males than females. For ages where the improvement rate in 2012 is higher than the target rate the cumulative reduction in mortality rates throughout the 25 year projection period is lower than would be given if a linear interpolation was assumed. The speed of convergence to the target rates is faster. Where the improvement rate is lower in 2012 than the target rate the cumulative reduction is higher this means the speed of convergence is slower.

There is also some evidence of cohort effects for those born after 1939. Therefore, in these projections, convergence to the assumed rate of improvement in 2037 has been done by cohort for those born before 1960 (shown in bold in Table 4-2). For those born in 1960 and later (that is, projections not in bold in Table 4-2), for whom there is little evidence of generational effects, the

changes in the rates of improvement to the target rate are projected by calendar year. Of course, at young ages mortality rates are already at low levels and the precise assumptions made for future mortality have a relatively minor impact on the projections.

The rates of improvement after 2037 are assumed to remain constant (by cohort or by age) at the rate assumed in 2037 for each year thereafter. So, for those born during the period 1925 to 1938, who are assumed to have higher rates of improvement than 1.2% in 2037, it is assumed that they will continue to experience these higher rates of improvement after 2037 for the remaining years of their lives.

Table 4-2: Assumed percentage change in mortality rates, mx, between consecutive calendar years in the projection period and the total reduction over 25 years (2012-2037)

Percentages

Age	2012 to 2013		2016 to 2017		2026 to 2027		2036 to 2037		Reduction over 25 years	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
England, Wales and Northern Ireland										
0	2.62	2.60	2.28	2.32	1.58	1.69	1.20	1.20	36.08	37.11
2	3.13	2.79	2.67	2.48	1.72	1.76	1.20	1.20	39.40	38.54
12	3.82	2.99	3.20	2.64	1.91	1.83	1.20	1.20	43.59	39.94
22	4.13	3.14	3.43	2.76	1.99	1.88	1.20	1.20	45.38	40.99
32	3.18	1.14	2.71	1.15	1.73	1.18	1.20	1.20	39.69	25.56
42	0.49	1.30	0.66	1.28	1.01	1.23	1.20	1.20	20.49	26.86
52	3.30	2.20	2.80	2.00	1.77	1.55	1.20	1.20	40.44	34.14
62	1.72	1.56	1.63	1.40	1.74	1.53	1.20	1.20	34.44	31.06
72	3.02	2.45	3.07	2.38	1.35	1.29	1.20	1.20	37.84	34.06
82	4.01	3.63	3.01	3.08	1.86	1.71	1.20	1.20	41.15	40.14
92	1.81	2.06	2.33	2.19	2.36	2.47	1.20	1.20	41.64	41.52
Scotland										
0	2.62	2.60	2.28	2.32	1.58	1.69	1.20	1.20	36.08	37.11
2	3.13	2.79	2.67	2.48	1.72	1.76	1.20	1.20	39.40	38.54
12	3.82	2.99	3.20	2.64	1.91	1.83	1.20	1.20	43.59	39.94
22	4.13	3.14	3.43	2.76	1.99	1.88	1.20	1.20	45.38	40.99
32	1.08	0.17	1.11	0.37	1.17	0.84	1.20	1.20	25.17	16.75
42	0.02	1.05	0.31	1.08	0.88	1.15	1.20	1.20	16.64	24.80
52	3.49	2.20	2.94	2.00	1.81	1.55	1.20	1.20	41.57	34.14
62	1.95	1.56	2.05	1.40	1.82	1.53	1.20	1.20	37.06	31.06
72	2.66	2.23	2.88	2.24	1.50	1.29	1.20	1.20	37.51	33.12

Age	2012 to 2013		2016 to 2017		2026 to 2027		2036 to 2037		Reduction over 25 years	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
82	3.51	3.36	2.70	2.84	1.79	1.65	1.20	1.20	38.76	38.53
92	1.66	1.90	2.19	2.03	2.25	2.37	1.20	1.20	39.82	40.02

Table source: Office for National Statistics

Table notes:

1. Projections made by cohort shown in bold (see text for further details), otherwise projections are made by calendar year.
2. The first column shows the reductions not from the actual death rates from 2012, but the base death rates for 2012, projected from trends in preceding years.

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The same future improvements are assumed for all countries of the UK except for some differences (generally, slightly smaller improvements) in the period to 2037 at some ages for males and for females in Scotland, as discussed earlier. Similar adjustments were made in recent past projections.

Taking account of the generally higher rates of improvement assumed prior to 2037 this produces an average annualised rate of mortality improvement of around 1.4% for males and around 1.5% for females over the next 79 years for England and Wales (Table 4-3) and slightly lower rates for Scotland, which, in all cases, are slightly higher than those experienced over the past 79 years. As Table 4-3 shows the new projections generally assume for males broadly similar annualised rates of improvement in the future and for females, higher annualised rates of improvement over future periods than experienced over corresponding periods in the past.

Table 4-3: Actual and assumed overall average annual rates of mortality improvement

	Percentages			
	Males		Females	
	Past (actual)	Future (assumed)	Past (actual)	Future (assumed)
England & Wales				
Last/next 29 years	2.18	1.85	1.59	1.93
Last/next 49 years	1.63	1.58	1.41	1.63
Last/next 79 years	1.29	1.44	1.31	1.47
Scotland				
Last/next 29 years	1.97	1.77	1.42	1.69
Last/next 49 years	1.44	1.54	1.35	1.49
Last/next 79 years	1.14	1.41	1.23	1.38

Table source: Office for National Statistics

Table notes:

1. Historic estimates are based on comparison of the 2009-11 interim life tables with English and Scottish Life Tables for 1930–32, 1960–62 and 1980–82, hence using the periods 29, 49 and 79 years. In all cases the rates of improvement shown are derived from aggregate mortality rates for ages 0 to 99 calculated using the 2011 population estimates for England and Wales as the standard population. Decennial tables are not available for the historical periods shown in the table for the UK or Northern Ireland.
2. Making projections of mortality rates is speculative and users must bear in mind that the range of possibilities is wide. Variant projections using alternative assumptions for the future improvement in mortality are considered in Chapter 6.
3. Scottish figures have not been revised to take account of the 2011 Census.

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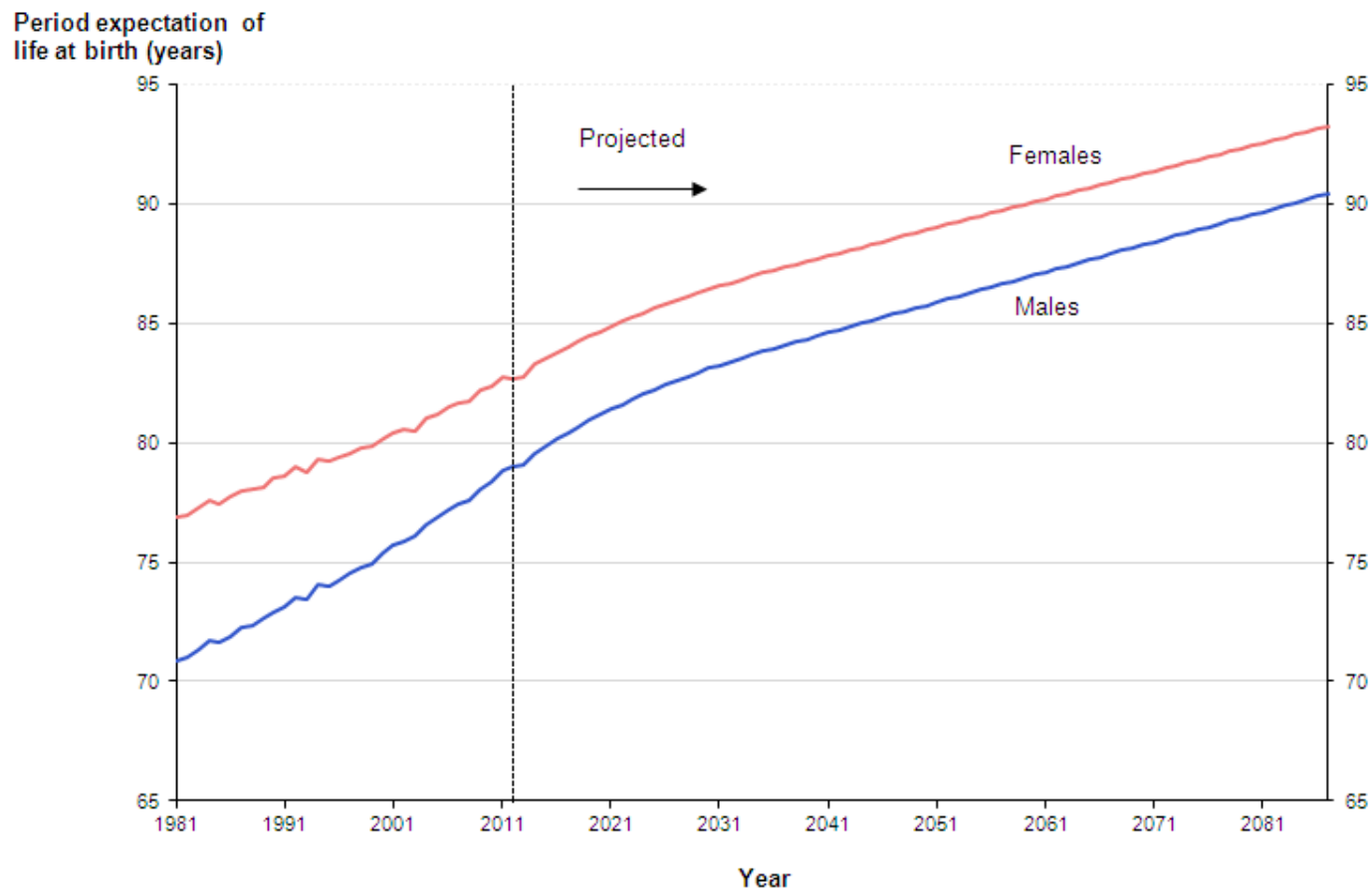
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Effect of Assumptions

The implications of these assumptions in terms of the period expectation of life at birth and at age 65 are shown in Figure 4-6 and Figure 4-7 respectively.

Figure 4-6: Actual and projected period expectation of life at birth according to mortality rates for given year, 1981–2087, United Kingdom



Source: Office for National Statistics

Notes:

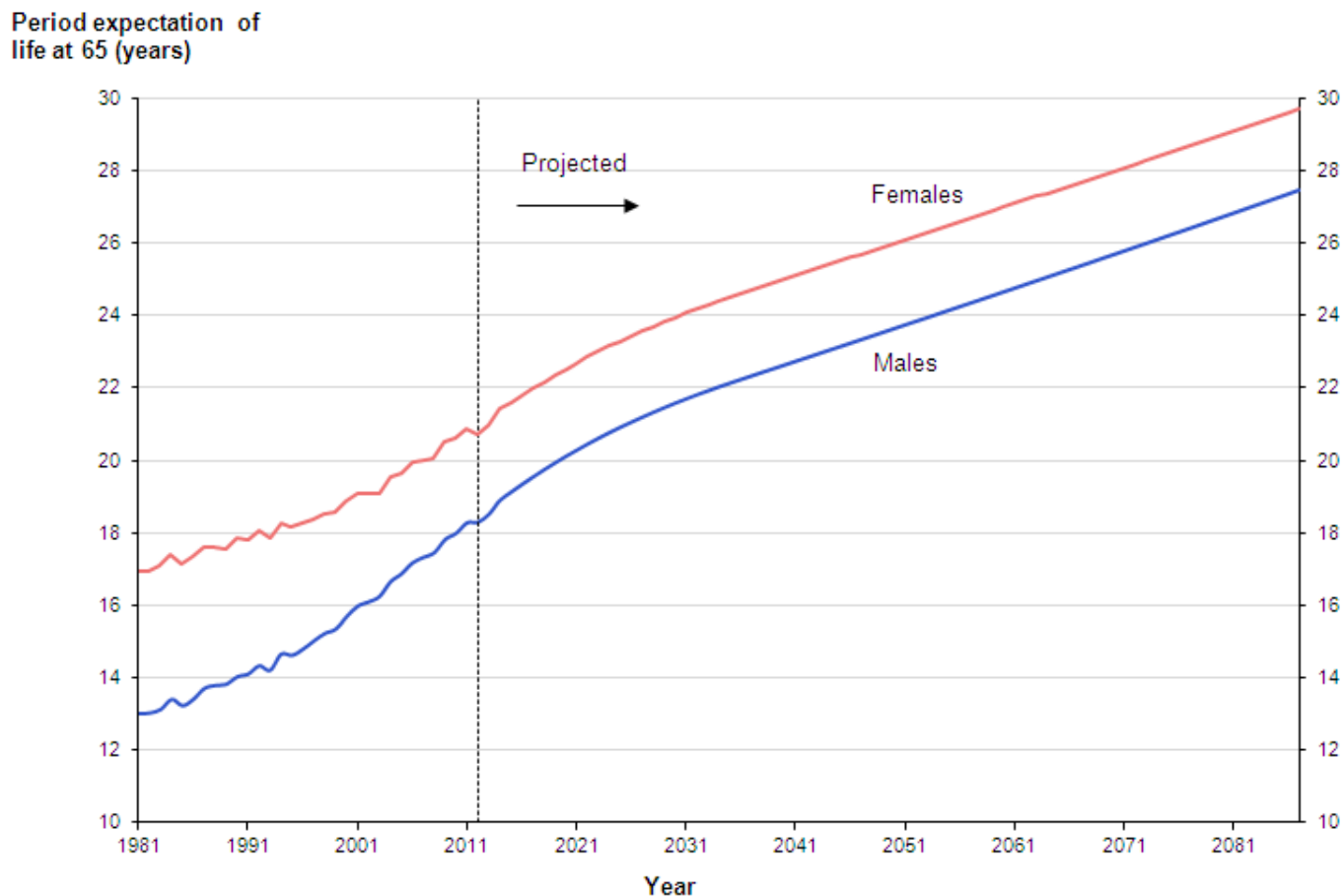
1. Scottish figures have not been revised to take account of the 2011 Census.

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Figure 4-7: Actual and projected period expectation of life at age 65 according to mortality rates for given year, 1981–2087 United Kingdom



Source: Office for National Statistics

Notes:

1. Scottish figures have not been revised to take account of the 2011 Census.

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In 2037, period expectation of life at birth for the UK is around 0.4 years higher for males and 0.1 years higher for females compared to the previous projections. These differences are mainly due to the age-specific mortality rates for 2012 being assumed to be lower at many ages below 70 and the rates of mortality improvement between 2012 and 2013 assumed to be higher at many ages below 90 compared to those projected for the same period in the 2010-based projections.

Expectation of Life for Cohorts

So far in this report, expectations of life have mainly been calculated on the basis of the mortality rates for a particular calendar year (period life expectancies). In many contexts it is more meaningful

to calculate the average life expectancy which allows for future known or assumed changes in mortality rates (referred to as cohort life expectancy). Further information on the difference between period and cohort life expectancies is available on the [ONS website](#)²¹. Table 4-4 shows projected period and cohort expectations of life at selected ages for four different years.

Table 4-4 shows that the projected period expectation of life at birth for a male in the UK was 79.0 years on the basis of the mortality rates for 2012. However, taking into account assumed mortality improvements in later years, that is cohort life expectancy, a male born in that year would be expected to live for 90.6 years. Similarly, the average man aged 65 in 2012 would live for a further 18.3 years based on the mortality rates for 2012 (period). However, taking account of the assumed further mortality improvement after 2012 (cohort), he would actually be expected to live for a further 21.2 years.

Table 4-4: Period and cohort expectation of life by selected ages, United Kingdom, for the years 2012, 2013, 2023, 2033 and 2037

	Males					Females				
	2012	2013	2023	2033	2037	2012	2013	2023	2033	2037
Period expectation of life										
0	79.0	79.0	81.8	83.5	84.1	82.7	82.8	85.2	86.8	87.3
15	64.5	64.5	67.2	68.9	69.4	68.1	68.2	70.6	72.1	72.6
60	22.3	22.6	24.8	26.2	26.6	25.0	25.2	27.3	28.7	29.1
65	18.3	18.5	20.6	21.9	22.3	20.7	21.0	23.0	24.3	24.7
75	11.2	11.4	13.2	14.3	14.6	12.9	13.1	14.9	16.1	16.5
85	5.8	5.9	7.2	8.1	8.4	6.7	6.9	8.3	9.3	9.5
Cohort expectation of life										
0	90.6	90.7	92.2	93.7	94.3	93.9	94.0	95.4	96.8	97.3
15	73.9	74.1	75.5	77.0	77.5	77.3	77.5	78.8	80.1	80.7
60	25.8	25.9	27.2	28.4	28.9	28.7	28.8	30.0	31.2	31.6
65	21.2	21.4	22.6	23.7	24.1	23.9	24.0	25.2	26.3	26.7
75	12.9	13.1	14.3	15.2	15.6	15.0	15.1	16.3	17.2	17.6
85	6.3	6.5	7.8	8.6	8.8	7.4	7.6	9.0	9.8	10.0

Table source: Office for National Statistics

Table notes:

1. Scottish figures have not been revised to take account of the 2011 Census.

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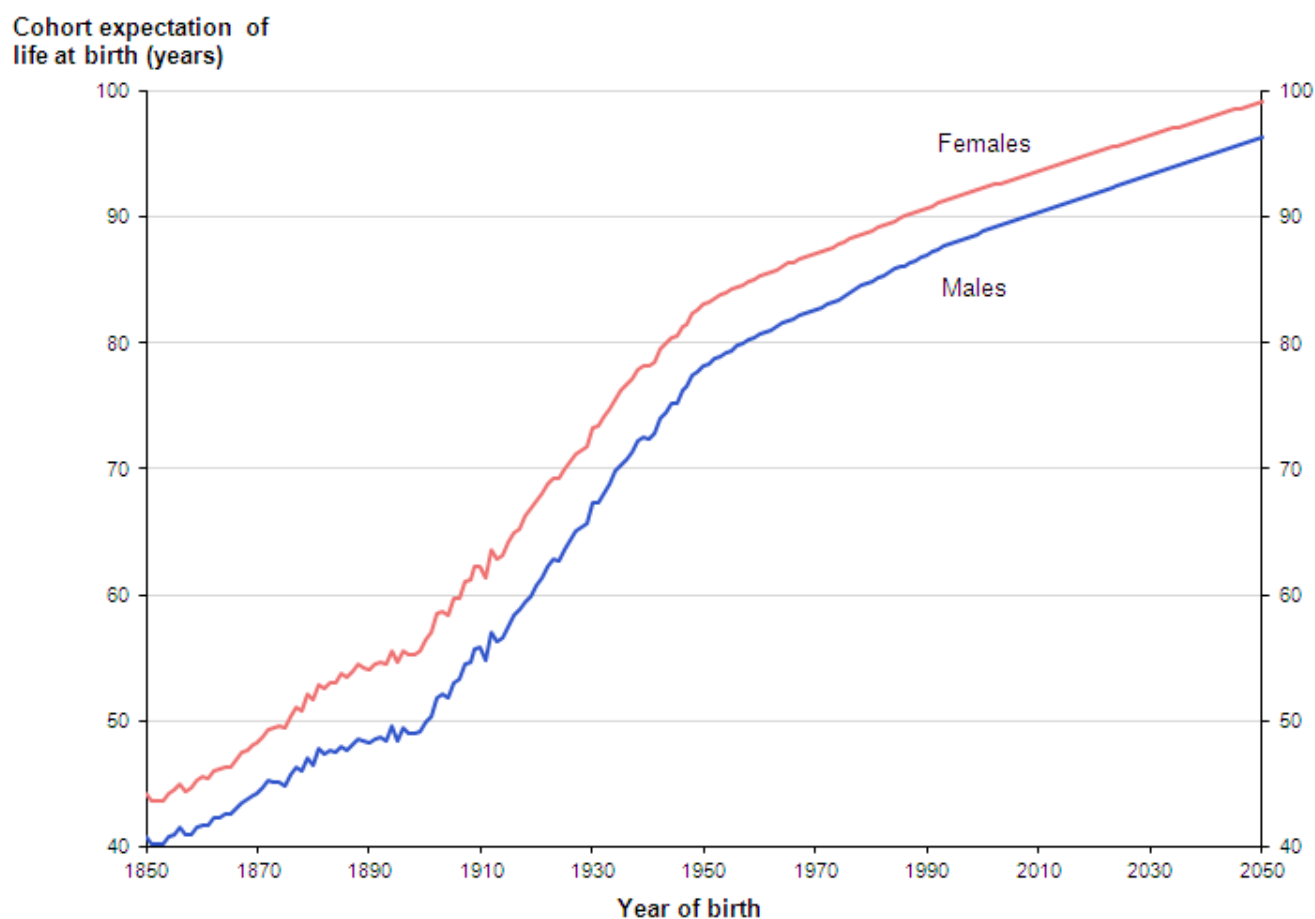
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Figure 4-8 shows the cohort expectation of life at birth for England and Wales for generations born from 1850 to 2050 and Figure 4-9 shows the cohort expectation of life at age 65 for those reaching age 65 in 1850 to 2050 based on the actual mortality rates experienced in the past or assumed for the future.

About half of the increase in cohort life expectancies at birth between generations born in 1850 and 1945 was due to the reduction in infant and child mortality to very low levels. Subsequent generations have benefited particularly from the almost complete elimination of deaths from acute and infectious diseases. Figure 4-8 illustrates the point that, while current reductions in mortality rates at the older ages will continue to extend the average lifetime, once this reaches around 78 years for males and 83 years for females (that is, for men and women born in 1950), further progress is likely to be much slower. The great majority of deaths will then be attributable to chronic and degenerative diseases.

Figure 4-8: Cohort expectation of life at birth according to historic and projected mortality rates, for persons born from 1850 to 2050, England & Wales



Source: Office for National Statistics

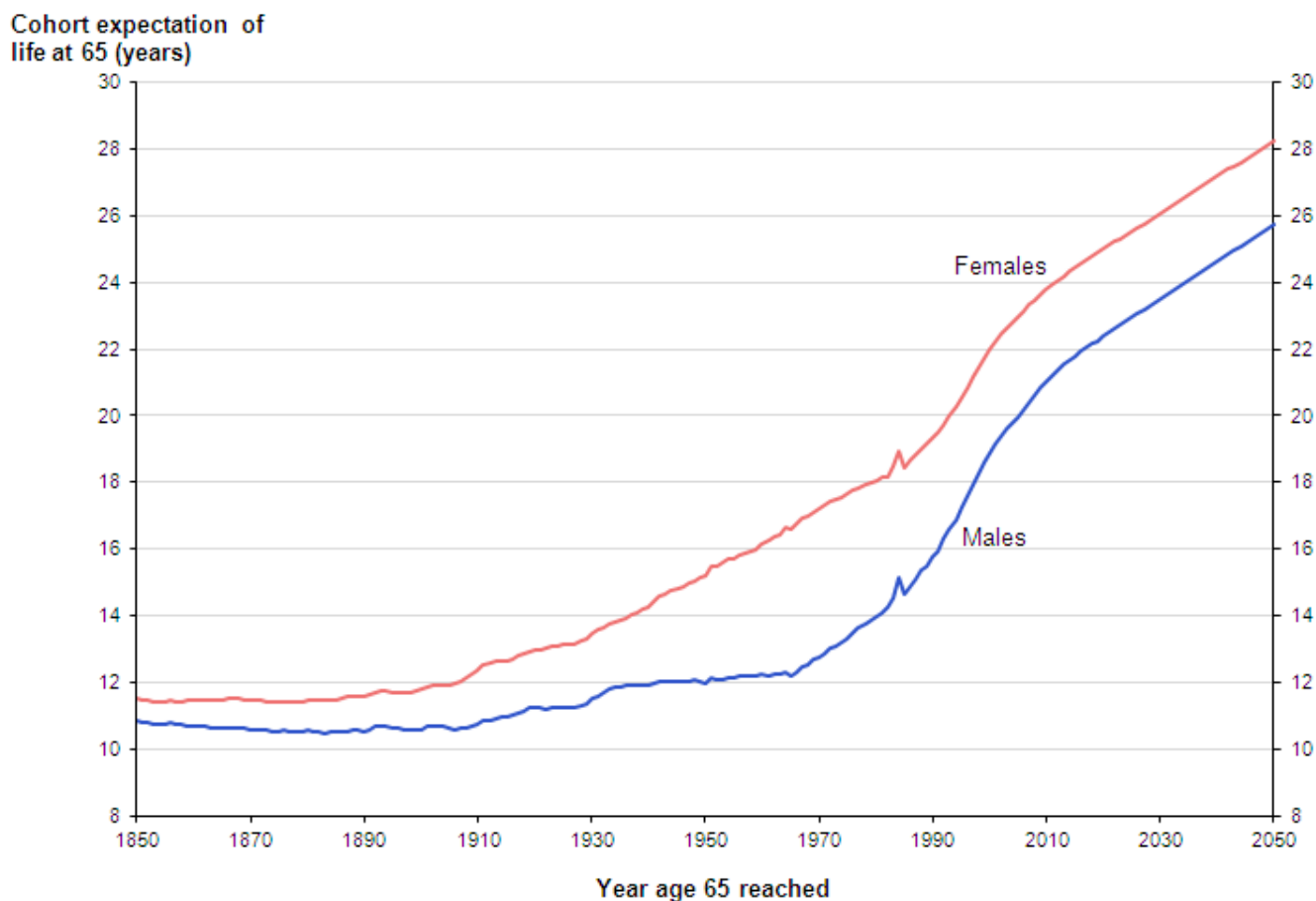
Notes:

1. Life expectancy figures are not available for the UK before 1951; for long historic trends England & Wales data are used.

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Figure 4-9: Cohort expectation of life at age 65 according to historic and projected mortality rates, for persons who reach age 65 in the years 1850 to 2050, England & Wales



Source: Office for National Statistics

Notes:

1. Life expectancy figures are not available for the UK before 1951; for long historic trends England & Wales data are used.
2. The 'blip' in the trend lines in 1984 relates to the birth cohorts of 1918-1920, where the births were not evenly distributed throughout the year.

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While the cohort expectation of life at age 65 for females has been increasing at a fairly steady rate since the 1930s, the cohort expectation of life at age 65 for males showed relatively little increase between 1930 and 1970 after which it began to increase more rapidly than for females. As

discussed earlier, a partial explanation for this may be the different historical patterns in cigarette smoking between men and women. This is likely to have delayed mortality rates for older males falling to the levels they would have reached had they followed the improvements in female mortality rates experienced during the 1950s and 1960s.

Constituent Countries of the UK

The projected mortality rates and expectations of life vary between countries because of the differing starting mortality rates and, for Scotland, the different rates of mortality improvement at some ages, as discussed earlier. The resulting life expectancies are shown in Table 4-5; of the four countries, England shows the highest life expectancy and Scotland the lowest.

Table 4-5 also shows the comparable life expectancies from the 2010-based projections. The 2012-based period expectations of life at birth are a little higher for males and broadly similar for females compared to the 2010-based projections over the period 2012 to 2037 for all the constituent countries. In 2037, period expectations of life at birth for females are projected to be very similar with only differences of 0.1 year in England, Scotland and Wales. The differences in 2037 are larger for males with period life expectancies at birth around 0.8 years higher in Scotland, 0.6 years higher in Northern Ireland and 0.4 years higher in the UK, England and Wales.

Cohort life expectancies at birth for both males and females are projected to be slightly higher than in the previous projections for each country of the UK for all years except for English males and females and Welsh males. In England cohort life expectancy at birth in the 2012-based projections is broadly similar or slightly lower than in the 2010-based projections. Cohort life expectancy for Welsh males is higher in the 2012-based projections than the 2010-based projections in the early years of the projections but is 0.2 years lower by 2037.

Table 4-5: Period and cohort expectation of life at birth for the years 2012, 2013, 2023, 2033 and 2037, 2012-based and 2010-based projections

	Years									
	2012	2013	2023	2033	2037	2012	2013	2023	2033	2037
Period expectation of life at birth										
Males										
England	79.3	79.2	79.4	79.5	82.1	81.8	83.8	83.4	84.4	84.0
Wales	78.3	78.3	78.4	78.6	81.4	80.9	83.1	82.6	83.6	83.2
Scotland	76.8	76.5	76.9	76.7	79.6	78.9	81.4	80.6	82.0	81.2
Northern Ireland	78.1	77.9	78.2	78.2	81.0	80.5	82.8	82.1	83.3	82.7
United Kingdom	79.0	78.9	79.0	79.2	81.8	81.4	83.5	83.1	84.1	83.7
Females										
England	82.9	83.0	83.1	83.3	85.5	85.4	87.1	87.0	87.6	87.5
Wales	82.1	82.4	82.3	82.6	84.9	84.7	86.5	86.4	87.0	86.9
Scotland	80.8	81.0	80.9	81.2	83.4	83.2	85.0	84.9	85.5	85.4
Northern Ireland	82.3	82.4	82.3	82.7	84.8	84.8	86.3	86.4	86.9	86.9
United Kingdom	82.7	82.8	82.8	83.0	85.2	85.1	86.8	86.7	87.3	87.3
Cohort expectation of life at birth										
Males										
England	90.8	90.8	91.0	90.9	92.5	92.5	93.9	94.1	94.5	94.7
Wales	90.0	89.3	90.2	89.5	91.6	91.0	92.7	92.6	93.0	93.2
Scotland	88.6	87.3	88.7	87.5	90.4	89.1	92.0	90.8	92.6	91.4
Northern Ireland	89.9	88.6	90.0	88.8	91.5	90.3	93.1	91.9	93.7	92.5
United Kingdom	90.6	89.8	90.7	89.9	92.2	91.5	93.7	93.0	94.3	93.6
Females										
England	94.1	94.1	94.2	94.3	95.6	95.7	97.0	97.1	97.5	97.6
Wales	93.5	92.8	93.7	93.0	95.1	94.4	96.5	95.7	97.0	96.3
Scotland	92.2	91.4	92.3	91.6	93.8	93.0	95.2	94.5	95.8	95.0
Northern Ireland	93.4	92.8	93.5	92.9	94.9	94.3	96.3	95.7	96.9	96.2

	2012		2013		2023		2033		2037	
United Kingdom	93.9	93.2	94.0	93.3	95.4	94.7	96.8	96.1	97.3	96.6

Table source: Office for National Statistics

Table notes:

1. Corresponding results from the 2010-based projections are shown in italics.
2. Scottish figures have not been revised to take account of the 2011 Census.

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Mortality differences between males and females

In common with other Northern European countries,¹ the difference in period life expectancy at birth for females over males rose in the UK during the period 1900 to 1970, before declining in more recent years. In the UK the differential has fallen from 6.0 years in 1980 to 3.7 years in 2012; it is projected to fall to about 3.3 years by 2037. In contrast, although the difference in period life expectancy at age 65 for females over males fell from the late 1980s to 2.4 years in 2012 it is projected to remain broadly the same in 2037.

The Changing Life Table

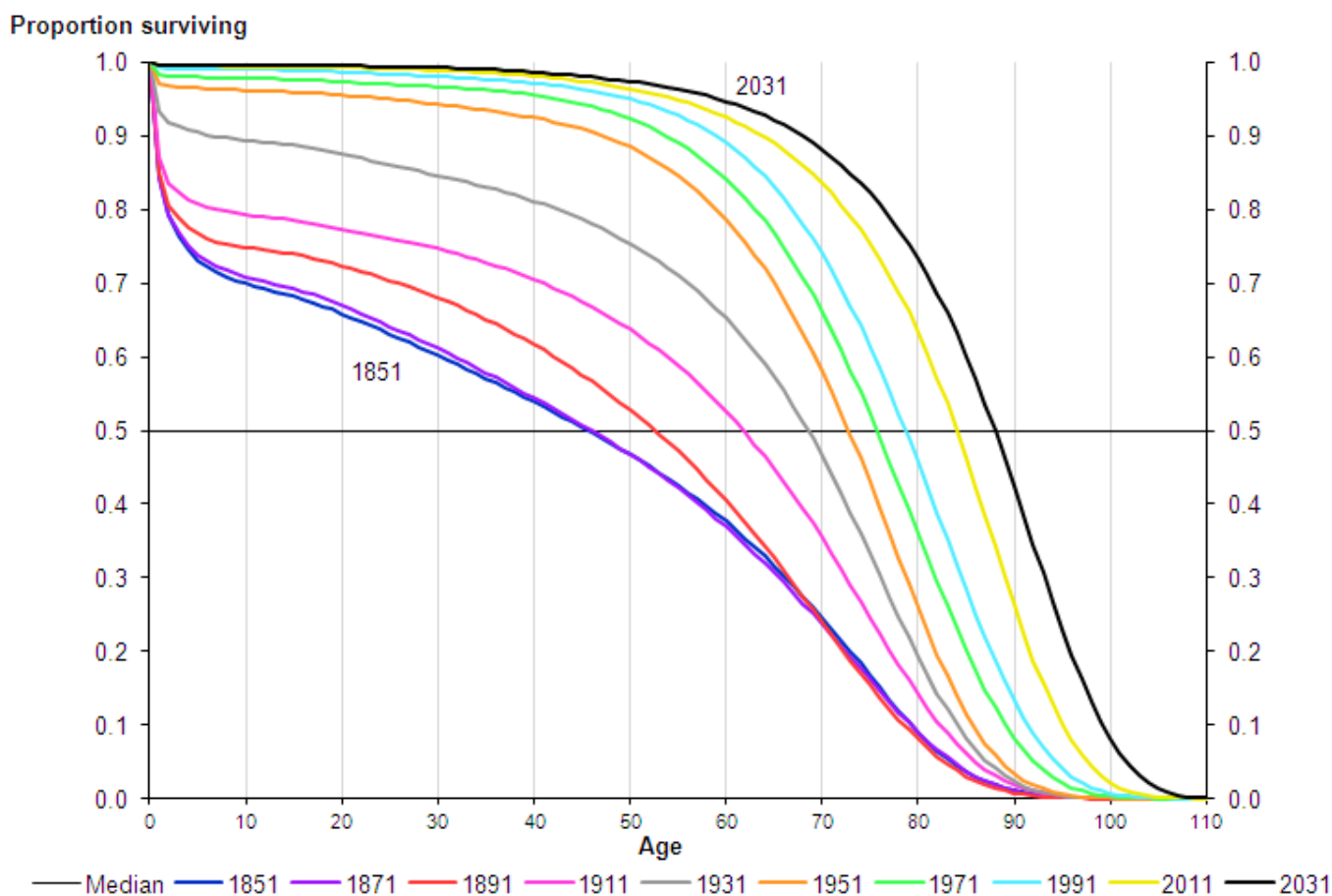
Figures 4-10 and 4-11 illustrate how the survival curve, which shows the proportion of those born in a given year who survive to each age, is getting progressively more rectangular in shape as more deaths occur at advanced ages. The charts are based on the average of male and female mortality in England and Wales. In Figure 4-10, the survival curves are calculated on a period basis and show the percentages who would survive to successive ages if they experienced the mortality rates of the year shown with no allowance for known or projected changes in mortality rates for the years thereafter. The first, least rectangular, curve represents the life table according to the mortality rates of the year 1851 and successive curves are given at 20 year intervals, with the uppermost being the projected life table for the year 2031. From this chart it can be seen that the median age at death, that is, the age to which half of those born survive, was about 46 on the basis of the mortality rates of 1851; this is projected to increase to about age 88 by the year 2031.

It is clear from Figure 4-10 that recent improvements in period expectation of life at birth have been due primarily to increases in survival to older ages. However, the increase in the maximum age to which people can survive has been comparatively small. There is limited scope for further reduction in mortality rates in young and middle age. Any continuation of recent increases in expectation of life will only be achieved through major falls in mortality at older ages.

Figure 4-11 shows the survival curves calculated on a cohort basis, that is, allowing for known and projected future changes in mortality after the cohort's year of birth. Since mortality rates have, in general, been improving over past years and are projected to continue to improve, the survival curve

for a given year in Figure 4-11 lies further to the right than that for the corresponding year in Figure 4-10. From this chart it can be seen that, on a cohort basis, the median age at death for those born in 1851 was actually about 48, this is projected to increase to about age 98 for those born in 2031.

Figure 4-10: Proportion of persons surviving (on a period basis) to successive ages, according to mortality rates experienced or projected, persons born 1851–2031, England & Wales



Source: Office for National Statistics

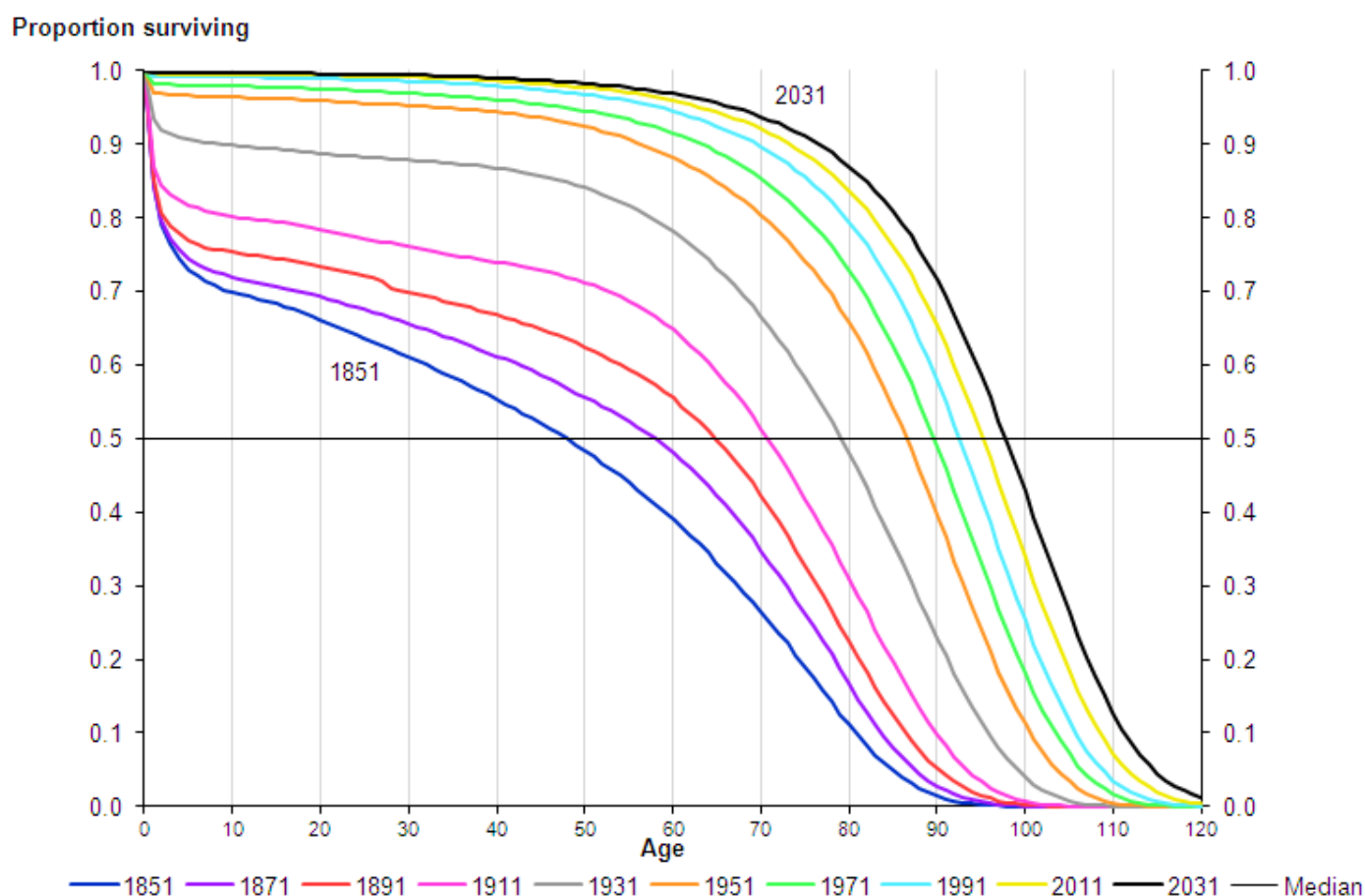
Notes:

1. Life expectancy figures are not available for the UK before 1951; for long historic trends England & Wales data are used.

Download chart

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(56 Kb)

Figure 4-11: Proportion of persons surviving (on a cohort basis) to successive ages, according to mortality rates experienced or projected, persons born 1851–2031, England & Wales



Source: Office for National Statistics

Notes:

1. Life expectancy figures are not available for the UK before 1951; for long historic trends England & Wales data are used.

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Further details

Projected numbers of deaths and comparisons with the previous (2010-based) projections are discussed in [Chapter 2](#) while [Chapter 6](#) presents the results of variant projections based on alternative assumptions about future mortality. The detailed age specific rates assumed in the principal and variant projections for each country are given on the ONS website.

Views on Future Levels of Mortality Improvements and Expectations of Life

Mortality projections prepared in other countries and by other agencies tend to be based largely on extrapolation of past trends either in mortality rates, rates of mortality improvement or in expectations of life. Expert opinion is often used to inform the assumptions made. It is therefore perhaps helpful to summarise some of the current arguments put forward by experts regarding future levels of mortality improvements and life expectancy, for the UK and for other developed countries.

For the UK, several factors have been identified amongst the likely drivers of future mortality change including the 'cohort effect', the 'ageing of mortality improvement' (where the ages at which the highest rates of improvement have occurred have been increasing over time), increased uncertainty at younger ages, changes in prevalence of cigarette smoking, the effects of other lifestyle changes, medical advances, possible increased resistance to antibiotics and the potential re-emergence of old diseases and climate change.

[Appendix A in background and methodology](#) reports a meeting of the National Population Projections Expert Advisory Group at which members were asked their views on the validity of a large range of arguments which might be thought likely to influence future mortality trends. In general the UK experts felt that the current high rates of mortality improvement were likely to continue into the future, although there was disagreement as to whether improvements would converge for males and females over time. It was felt that factors such as medical and biotechnological advances, more effective health care systems and better health information and changes in lifestyle behaviour which have occurred and have been identified as increasing the chances of longevity would continue. It was also felt that society would be able and willing to afford new treatments. However, there were factors which would work in the opposite direction and not all sectors of the population may choose to adopt lifestyle behaviours leading to increasing longevity. Smoking has been a large explanatory factor in changing mortality trends and it is possible to be reasonably confident about its effects. However, behavioural factors and their effects were harder to predict. For example, it was agreed that there would be an increase in obesity levels and that this would have an effect on morbidity but there was less agreement as to the subsequent impact of this on mortality and whether any increase might be reversible in the medium-term. Also, there might be a protective effect if some weight was gained at older ages. Some believed rising levels of obesity would lead to large downward influence on life expectancy but others believed the effect would be relatively small.

It was acknowledged that there are elements influencing mortality improvement in both directions and that these need to be considered together to determine if the overall effect will be positive or negative. However, it was felt that those factors tending to increase longevity would outweigh negative influences and that the increase in life expectancy over the next 25 years would be similar to that experienced over the preceding 25 years.

Oeppen and Vaupel¹² have noted that record life expectancy (the highest life expectancy observed in any country of the world at any particular time) has increased at a steady pace over the last 160 years or so and suggest that this is likely to continue into the future. However, Olshansky¹¹

and others have argued that there will be countervailing trends to the high rates of mortality improvements seen in recent years, driven by increasing levels of obesity, sedentary behaviours and other adverse lifestyle factors.

Given this disparity of views as to the likely future course of longevity, users of the projections can gain some insight into the sensitivity of their results to the various views on future mortality by considering the high and low life expectancy variants (see [Chapter 6](#)). However, these are intended to represent plausible alternative assumptions and are far from reflecting the extremes of thinking on future mortality.

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Background notes

1. The 2012-based Population Projections for United Kingdom and constituent countries were published on [6 November 2013](#) (main release) and [10 December 2013](#) (extra variants).
2. Details of the policy governing the release of new data are available by visiting www.statisticsauthority.gov.uk/assessment/code-of-practice/index.html or from the Media Relations Office email: media.relations@ons.gsi.gov.uk

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