Past and projected data from the period and cohort life tables, 2014-based, UK, 1981 to 2064

Coverage: **UK**
Date: **11 December 2015**
Geographical Area: **Country**
Theme: **Population**

Main points

- In 2014 period life expectancy at birth in the UK was 79.3 for males and 83.0 for females.
- By 2039 period life expectancy at birth is projected to reach 84.1 years for males and 86.9 years for females, an increase of around 4 years since 2014.
- By 2039 cohort life expectancy at birth is projected to reach 93.9 for males and 96.5 for females, almost 10 years longer than period life expectancy.
- Period life expectancy at birth is projected to rise by 8 years for males and 7 years for females over the 50 years to 2064.
- By 2064, cohort life expectancy at birth for females in England is projected to reach 100 years, 99 in the UK, Wales, and Northern Ireland and 98 in Scotland.

Introduction

ONS have released today (11 December 2015) tables of life expectancy (ex), probability of death (qx) and numbers of persons surviving (lx) from the 2014-based National Population Projections (NPP). These tables contain historical and projected figures for 1981 to 2064 on a period and cohort basis from life tables calculated using observed and projected deaths and population estimates and projections.

Period and cohort life tables are produced biennially based on the assumptions for future mortality from the NPP. These tables give historical and projected statistics by single year of age and sex, from 1981 to the NPP base year (2014) and then 50 years into the future from the base year (2015 to 2064). The historical life tables are based on unsmoothed calendar year mortality rates and the

projected mortality rates from the NPP. This release relates to the 2014-based NPP published on the 29 October 2015.

Period life tables deal with current mortality rates only and no assumptions are made about future changes. Cohort life tables are calculated using age-specific mortality rates which allow for known or projected changes in mortality in later years.

Life tables and life expectancy figures provide users with an indicator of the health of the nation which can be used to inform policy, planning and research in both public and private sectors in areas such as health, population, pensions and insurance.

Key uses include:

- to study the course of mortality throughout the life cycle
- as an indicator of the health of the nation
- to inform policy regarding state pension age
- to assess risk for life assurance and pension liability

Public Sector users of life tables include the Government Actuary's Department, Department of Work and Pensions, HM Treasury, Department of Health, Public Health England and Health Trusts. Outside of government, users include academics and students, the news media, financial advisors/ consultants, insurance companies and actuarial professions, and members of the general public.

Mortality assumptions for recent projections have been determined by analysis of historical changes in mortality rates over differing periods of time and setting assumptions which produce similar improvements over the same periods in the future. The recent past trends (40 years) show average annual improvements of 1.9% for males and 1.5% for females. There has been an element of 'catching up' for males in this period with higher rates of improvement in mortality than for females. This is a result of a change in working and social behaviours. For example, relatively high numbers of men who started smoking earlier in the 20th century have now given up, with smoking prevalence lowest for the oldest age groups. Changes in patterns of male employment in heavy industry may also have had some effect. There continues to be much debate amongst demographers as to whether life expectancy will continue to increase at current rates indefinitely or whether lifestyle factors such as a rise in level of obesity and in antibiotic resistance may cause the rate of mortality improvement to stop or even decline.

Although life expectancy is still increasing each year, the 2014-based projections show a slower increase in improvements to mortality rates in the future than was projected in the 2012-based projections. This is because mortality rates at some ages were higher in 2012 and 2013 than we projected in the 2012-based projections. This resulted in higher mortality rates with lower annual rates of improvement in the 2014 base year than we had projected in the 2012-based projections. This means that life expectancies in the future are slightly lower than were projected last time.

Life expectancy (ex) at birth in the UK

Period life expectancy at birth is projected to rise by 8 years for males and 7 years for females over the 50 year projection period. A baby boy born in 2064 is projected to live to 87.2 years and a baby

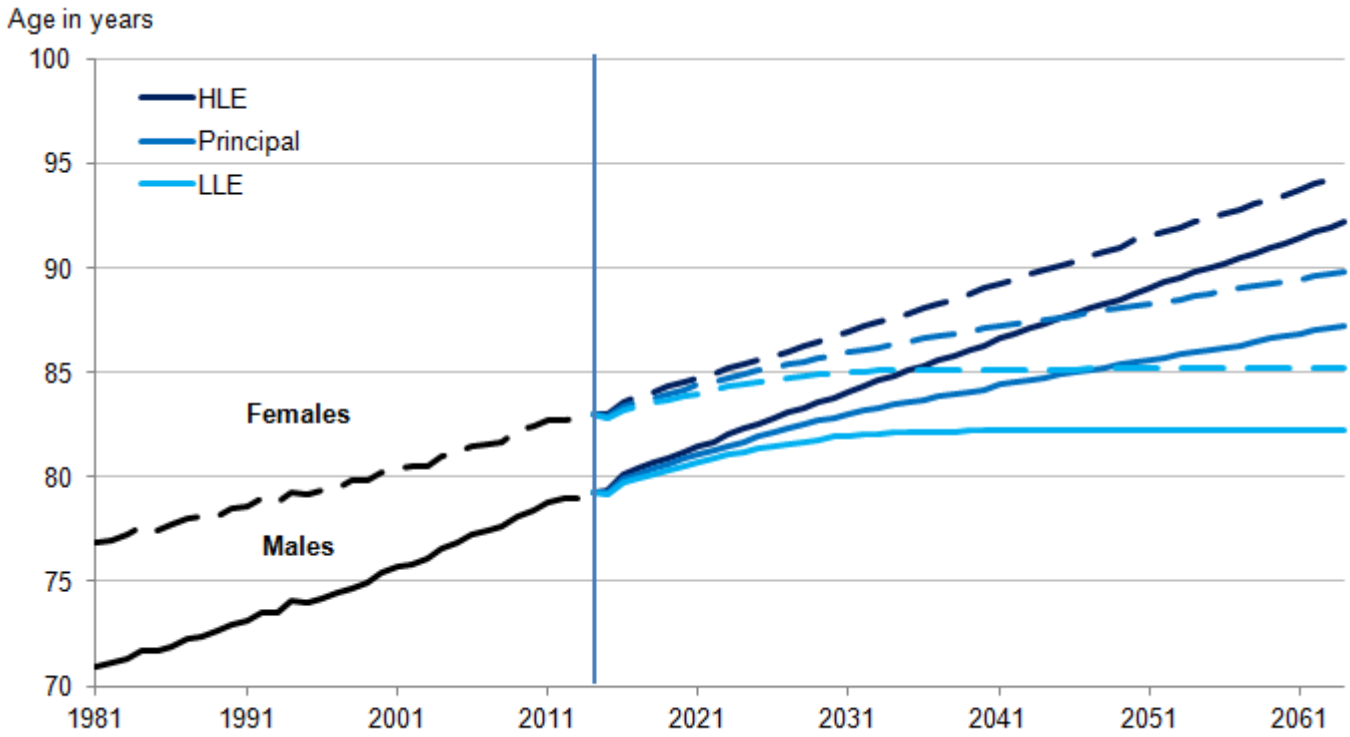
girl to 89.8 years. Over the last 33 years (1981 to 2014) period life expectancy at birth has increased by around 8 years for males and 6 years for females from 70.9 and 76.9 years respectively. The corresponding life expectancies in 2014 were 79.3 years for males and 83.0 years for females.

Figure 1 shows period life expectancy at birth for males and females 1981 to 2014 and then for each of the variant life expectancy projections to 2064.

In all three projections male life expectancy is lower than female life expectancy in the equivalent projection. However, there is some crossover of male and females across the variant projections. The life expectancies from the high life expectancy variant for males cross over the female principal projection in 2046 and the principal projection for males crosses the low life expectancy projection for females in 2049.

Figure 1: Period life expectancy at birth, United Kingdom, 1981 to 2064

2014-based principal projection and high and low life expectancy variant



Source: Office for National Statistics

Notes:

1. HLE - High Life Expectancy variant; LLE - Low Life Expectancy variant

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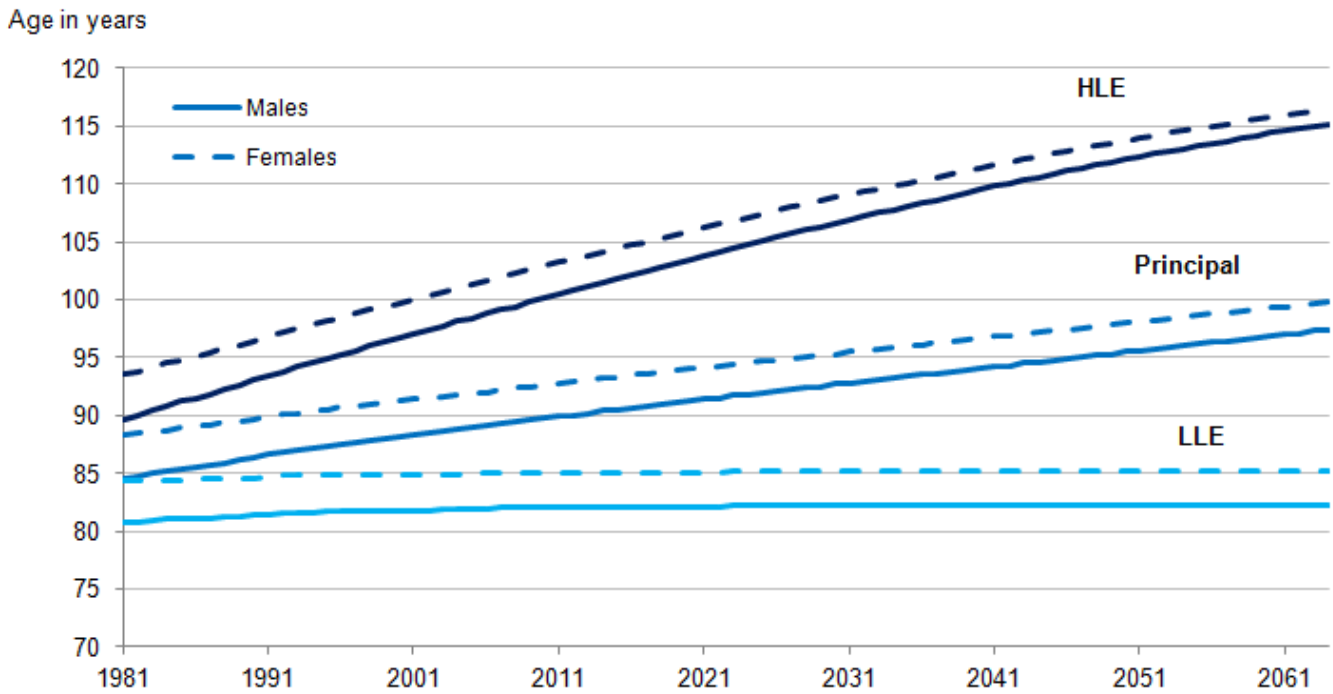
Cohort life expectancy at birth is about 10 years higher than period life expectancy at birth for both males and females in each year over the projection period (principal projection). A baby boy born in 2014 could expect to live for 90.4 years and a baby girl 93.2 years. This is projected to rise to 97.4 and 99.8 years respectively in 2064. Cohort life expectancy is always higher than period life expectancy because cohort life expectancy makes allowance for future mortality improvements.

Figure 2 shows cohort life expectancy at birth in the UK for the principal projection and the high and low life expectancy variants. Cohort life expectancy is projected to rise from 84.6 years for males and 88.3 for females in 1981, to 97.4 years and 99.8 years respectively in 2064. The high life expectancy variant shows cohort life expectancy rising above 115 years in 2064 for both males and females. However, one must be aware that these projections are for 50 years in the future and are projecting life expectancy from birth i.e. a further 100 years into future. These babies (born in 2064) will not reach their 100th birthday until 2164. The further ahead from the projection base year the more uncertain the statistics become, therefore these figures should be treated with caution.

Figure 2: Cohort life expectancy at birth, United Kingdom, 1981 to 2064

2014-based Principal projection and high and low life expectancy variants



Source: Office for National Statistics

Notes:

1. HLE - High Life Expectancy variant; LLE - Low Life Expectancy variant

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Table 1 gives the period and cohort life expectancy figures at birth from the principal projection for the UK and each of the constituent countries, in the base year 2014, in 2039 and 2064.

Of the four countries in the UK, England has the highest life expectancy at birth for both males and females in all years and Scotland has the lowest (Table 1). By 2064, cohort life expectancy at birth is projected to reach 100 years for females in England. The differences between life expectancies in England and Scotland are projected to decrease slightly over the projection period.

Table 1: Life expectancy at birth, UK and constituent countries, principal projection

2014, 2039 and 2064

Life expectancy in years

	2014	2014	2039	2039	2064	2064
	Period	Cohort	Period	Cohort	Period	Cohort
Males						
United Kingdom	79.3	90.4	84.1	93.9	87.2	97.4
England	79.5	90.6	84.4	94.1	87.4	97.6
Wales	78.8	89.7	83.5	93.4	86.6	97.0
Northern Ireland	78.6	89.5	83.4	93.3	86.5	96.9
Scotland	77.3	88.6	82.3	92.4	85.6	96.1
Females						
United Kingdom	83.0	93.2	86.9	96.5	89.8	99.8
England	83.2	93.4	87.2	96.7	90.0	100.0
Wales	82.6	92.9	86.5	96.2	89.4	99.5
Northern Ireland	82.4	92.8	86.6	96.1	89.4	99.4
Scotland	81.3	91.3	85.0	94.8	88.0	98.3

Table source: Office for National Statistics

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Life expectancy at age 65

Table 2 presents life expectancy at age 65, that is the average number of years remaining once a person has reached age 65. Over the last 25 years (1989 to 2014) period life expectancy at age

65 has increased by 4.8 years for men, from 13.8 years in 1989 to 18.6 years in 2014. For women period life expectancy has increased by 3.5 years over the same period from 17.6 years to 21.1 years. Increases in cohort life expectancy at age 65 have been higher, at around 6 years for men and 5 years for women because they take into account any future improvements in mortality.

Over the next 25 years (2014 to 2039) period life expectancy for men aged 65 is projected to reach 22.3 years (principal projection) and 24.2 years for women. The corresponding projected cohort life expectancies at age 65 are 24.0 years and 26.1 years respectively.

Age 65 is currently the state pension age (SPA) for men and will be for all women by 2018. We often use age 65 as the age someone might retire from paid employment. However, not everyone will retire at age 65; some retire early, some carry on working beyond pension age and SPA is due to increase. For example, a person born on 1 July 1960 can currently expect to retire in October 2026[1], when they will be aged 66 years and 3 months. If they retire at age 66 in 2026 they can expect to live a further 20.0 years if they are men and 22.0 years if they are women. This is assuming the mortality rates remain the same as they were in 2026. If future assumed improvements in mortality rates are considered (cohort projections) then they can expect to live an additional 2 years. This would mean a further 21.7 years after retirement if they are men and 23.8 years further if they are women.

Table 2: Period and cohort life expectancy at Age 65, United Kingdom, 1989, 2014 and 2039

2014-based principal projection and high and low life expectancy variants

Life expectancy in years

	1989	1989	2014	2014	2039	2039
	Period	Cohort	Period	Cohort	Period	Cohort
Males						
Principal	13.8	15.3	18.6	21.2	22.3	24.0
High Life Expectancy	13.8	15.3	18.6	22.2	23.9	28.1
Low Life Expectancy	13.8	15.3	18.6	20.3	20.8	20.8
Females						
Principal	17.6	18.9	21.1	23.5	24.2	26.1
High Life Expectancy	17.6	18.9	21.1	24.6	25.7	30.3
Low Life Expectancy	17.6	18.9	21.1	22.5	22.8	22.8

Table source: Office for National Statistics

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Notes for Life expectancy at age 65

1. State pension age timetables

International comparison

Table 3 provides a comparison of period life expectancies in 2014 and projected period life expectancy in 2060 for a selection of countries selected purely by the accessibility of the relevant data. In 2014 the UK has the second lowest life expectancy at birth of the seven countries for both males and females (the lowest being the USA). From the countries shown in Table 3, in 2014 Sweden has the highest life expectancy for males and Japan has the highest for females. However, by 2060 the UK has the joint second highest projected life expectancy for males and third highest for females, with Japan and the Netherlands projecting higher life expectancies at birth for females. This suggests that the UK may be more optimistic than some other countries when setting the assumptions for future mortality.

Table 3: Period life expectancy at birth in selected countries, 2014 and 2060

Principal projection

Life expectancy in years

Country	2014	2014	2060	2060
	Males	Females	Males	Females
United Kingdom	79.3	83.0	86.7	89.3
The Netherlands	79.4	83.0	87.0	89.9
Sweden	80.4	84.0	86.7	88.8
Norway	80.0	84.1	86.5	89.1
USA (2013)	76.4	81.2	84.0	87.1
Japan (2013)	80.2	86.6	84.2	90.9
Australia	80.3	84.4	85.2	88.3

Table notes:

1. Sources: Office for National Statistics; CBS Statistics Netherlands; SCB Statistics Sweden; SSB Statistics Norway; U.S. Census Bureau; Australian Bureau of Statistics; and Ministry of Health, Labour and Welfare Japan.

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Probability of dying (qx)

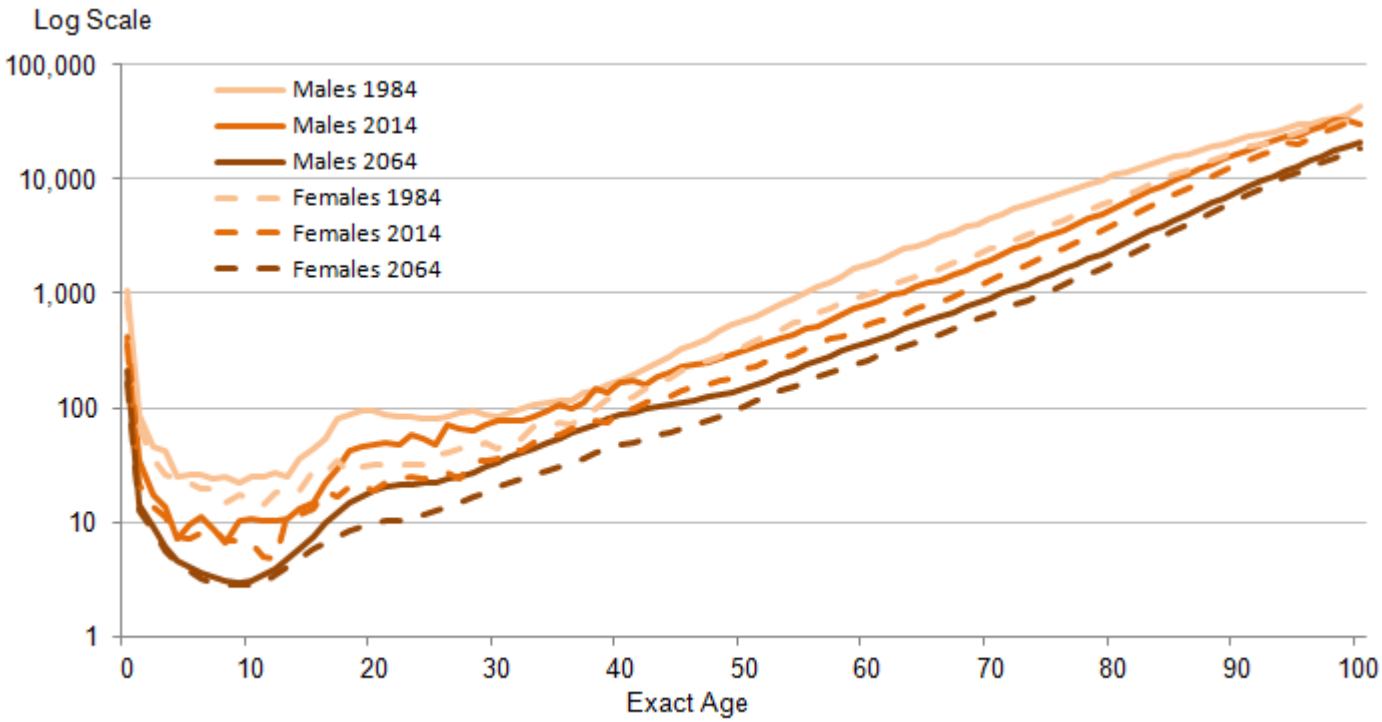
The mortality rate (qx) measures the proportion of people reaching a given birthday within a calendar year who die before their next birthday, that is, the probability that a person aged x will die before reaching age (x + 1). Once all the qx mortality rates have been calculated, a life table can be constructed, as the qx rates are required in order to calculate a life expectancy figure.

Figure 3 presents qx mortality rates plotted on the logarithmic scale for males and females for the years 1984, 2014 and 2064 for the principal projection. The graph shows period data by age for the UK. The main feature is that the mortality rates are lower in 2064 than in 2014 at every age for both males and females.

In each of the three years shown the pattern of initially high mortality at birth can be seen: from the age of one, mortality falls and remains low until around the age of 16. Mortality rates then begin to increase steadily throughout the rest of the life course. Males have higher mortality rates during the life course than females. Note the bulge for males between the ages of 16 and 25 where the probability of dying between birthdays increases sharply before returning to the steady increase by age. The increase in mortality rates at these ages is associated with the ‘high risk’ behaviours of young adults such as road accidents[1], alcohol consumption and drug use[2]. This bulge in male deaths remains in the projections for 2064. In contrast, for females, mortality at this age is lower in 2014 than for males and the bulge appears to have almost disappeared by 2064.

Figure 3: 2014-based period mortality rates (qx), United Kingdom, 1984, 2014, 2064

Principal projection



Source: Office for National Statistics

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Publishing the qx tables enables users to produce their own life tables or their own projections of mortality, which is particularly useful for pension and insurance analysis.

Notes for Probability of dying (qx)

1. Youth and Road Safety, WHO, 2007

2. An overview of prevention of multiple risk behaviour in adolescence and young adulthood, Jackson C A et al, Journal of Public Health, 2012

Numbers of survivors (lx)

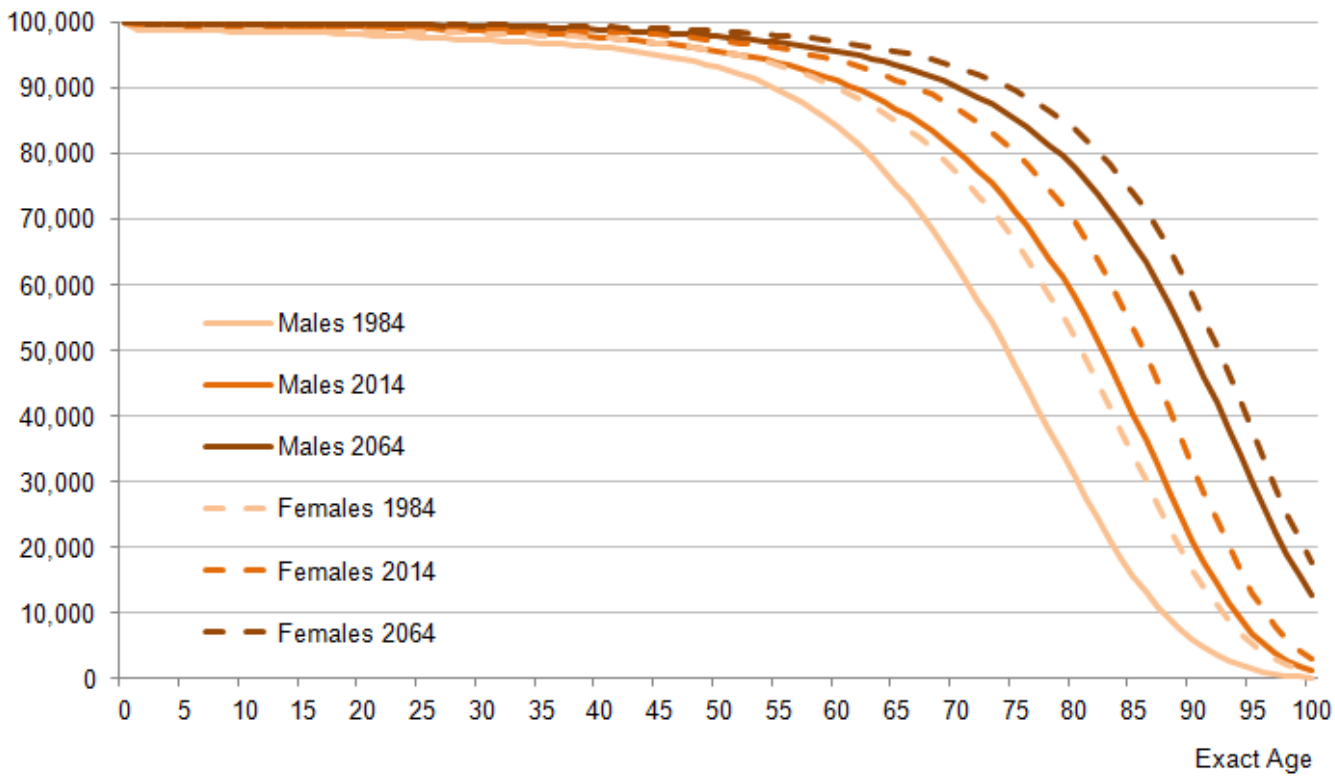
The numbers of survivors by age in the life table are the numbers alive at an exact age from a starting population of 100,000 (at age 0). The starting population at age zero is an arbitrary number called the radix, and since everybody ultimately dies, the lx is a curve which takes the value 100,000 (at age 0) and falls to zero at whatever age represents the maximum attainable human life-span.

The data in the tables published alongside this statistical bulletin stop at age 100 and, as Figure 4 shows, the curves do not quite fall to zero by age 100, particularly in 2064.

Figure 4 presents the lx values from the male and female period life tables for selected years. The graph shows two main features. Firstly, there is the survival to older ages. This is shown by the increasing age over time at where the slope begins its rapid decline. For example, the age at which the number of survivors falls below 90,000 is increasing; in 1984 for males it was age 55, in 2014 it is projected to be age 62, and in 2064 it is projected to be age 71. Secondly, the gap between numbers of males and females surviving to older ages is narrowing. This is particularly noticeable at age 70; in 1984 the gap between numbers of men and women surviving to age 70 was just over 14,000 per 100,000 born; by 2064 this is projected to reduce to around 3,000.

Figure 4: Numbers of survivors by age, from the period life tables, United Kingdom, 1984, 2014 and 2064

Principal projection



Source: Office for National Statistics

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The lx is often used to calculate the probability of surviving from one age to an older age.

Mortality projections

The National Population Projections are produced primarily to provide an estimate of the future population of the UK and its constituent countries as a common framework for use in national planning. Usually, a new set of projections is made every 2 years based on assumptions which are judged to be the most appropriate from the statistical evidence available at the time. The projections are made for successive years running from one mid-year to the next using the cohort component method. For each age, the starting population plus net inward migrants, less the number of deaths, produces the number in the population, aged one year older, at the end of the year. To this has to be added survivors of those born during the year.

Mortality projections are based largely on extrapolation of past trends in rates of mortality improvement. Expert opinion is used to inform the assumptions made about future mortality rates.

The assumptions used in the 2014-based projections are that annual rates of improvement in mortality rates would converge to 1.2 per cent for most ages in 2039 (the 25th year of the 2014-based projections), and remain constant at 1.2 per cent a year thereafter. However, those born after 1922 and before 1939 have exhibited greater rates of improvement over the last 25 years than those born earlier or later. There is currently no evidence that these differentials are declining. Similar cohort effects seen in other countries suggest that these differentials may persist well into the oldest ages. As a result, it is assumed that these cohorts will continue to experience higher rates of improvement, rising from 1.0 per cent a year for those born in 1922 to a peak of 2.5 per cent a year for those born in 1931 and 1932 and then declining back to 1.2 per cent a year for those born in 1939 and later. For those born before 1922, rates of improvement are assumed to be lower than 1.2 per cent in 2039. These are the same assumptions for the rates of mortality improvement in the target year as those used in the 2010-based and 2012-based projections (where the target years were 2035 and 2037 respectively).

ONS produces two additional variants to the principal projection; high life expectancy and low life expectancy. The variants differ from the principal projection in the assumed annual rates of improvement, by plus or minus 2% at the base year (2014) and plus or minus 1.2% at the target year (2039). These give alternative scenarios and show how projected life expectancy could vary over the projection period.

More information on the assumption setting process for future mortality patterns are outlined in: 4. Mortality assumptions: 2014-based national population projections.

Method

A life table is purely a hypothetical calculation. It is a statistical tool typically used to portray expectation of life at various ages. The basic assumption is that a given cohort of births (100,000 born in a given year) are subject, as the survivors pass through each year of age, to the mortality rates prevailing for each age.

Period life tables deal with current mortality rates only and no assumptions are made about future changes. The mortality rates for each age are used to calculate how many of the cohort will reach

each year of age until eventually all members of the cohort have died. This enables the total number of years lived by the cohort to be calculated. When this total is divided by the number of persons in the cohort (100,000), the result is the average number of years lived in the cohort or the mean expectation of life at birth. The total number of years lived by the cohort from any given age can also be calculated and when divided by the number of survivors in the cohort entering that year of age, the figure obtained is the expectation of life in years for those persons.

Cohort life tables are calculated using age-specific mortality rates which allow for known or projected changes in mortality in later years. A cohort life table provides mortality rates that vary over time for each age. For example, cohort life expectancy at age 65 in 2014 would be worked out using the mortality rate for age 65 in 2014, for age 66 in 2015 for age 67 in 2016 and so on. This uses observed mortality rates in 2014 and projected mortality rates from 2015. Therefore, cohort figures are regarded as a more appropriate measure of how long a person of a given age would be expected to live on average than period life expectancy.

Life tables are usually constructed separately for males and females because of their very different mortality patterns. A life table describes the course of mortality throughout the life cycle. A life table contains:

m_x The central rate of mortality, defined as the average annual number of deaths at age x last birthday in the year or years to which the life table relates divided by the average population at that age over the same period.

q_x The mortality rate between age x and (x + 1), that is the probability that a person aged x exactly will die before reaching age (x + 1).

l_x The number of survivors to exact age x of 100,000 live births of the same sex who are assumed to be subject throughout their lives to the mortality rates experienced in the year or years to which the life table relates.

d_x The number dying between exact age x and (x + 1) described similarly to l_x, that is $d_x=l_x- l_x+1$.

e_x The average period expectation of life at exactly age x, that is the average number of years that those aged x exactly will live thereafter based on the mortality rates experienced in the year or years to which the life table relates.

The method of constructing a life table is widely available in demographic text books, for example, Hinde A, Demographic Methods[1].

Background notes

1. Population projections are not forecasts and do not attempt to predict the impact that future government policies, changing economic circumstances or other factors (whether in the UK or overseas) might have on demographic behaviour. They simply provide the population levels and age structure that would result if the underlying assumptions about future fertility, mortality and migration were to be realised.

2. In addition to the principal assumptions, high and low variant assumptions are published for each of the three components of demographic change – fertility, life expectancy (mortality) and migration. These variant assumptions are intended as plausible alternatives to the principal assumptions and not to represent upper or lower limits for future demographic behaviour.

3. Following the publication of the 2014-based National Population Projections, ONS prepares databases for the UK and each of the constituent countries containing mortality data used in the calculation of past and projected life tables.

4. The ONS life expectancy calculator uses data from the 2012-based historical and projected cohort life tables for the UK. This calculator will be up-dated in early 2016 to take account of the 2014-based projections.

5. 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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Statistical contacts

Name	Phone	Department	Email
Julie Mills	+44 (0)1329 444681	Demographic Analysis Unit	lifetables@ons.gsi.gov.uk
Rebecca Wright	+44 (0)1329 447863	Demographic Analysis Unit	lifetables@ons.gsi.gov.uk

Issuing Body:
Office for National Statistics

Media Contact Details:
Telephone: 0845 604 1858
(8.30am-5.30pm Weekdays)

Emergency out of hours (limited service): 07867 906553

Email:
media.relations@ons.gsi.gov.uk