

# Life Expectancy for Scotland and Healthy Life Expectancy for Scotland: Methodology Guide



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## 1. Introduction

This paper describes the methodology used to produce life expectancy figures by the National Records of Scotland (NRS) for areas within Scotland. These figures are produced every year based on data from the previous three (or five) years for various geographical areas within Scotland.

NRS publish the definitive sub-Scotland level life expectancy figures. The definitive Scotland-level life expectancy estimates are published by the Office for National Statistics (ONS) on behalf of NRS. These can be found in the [National Life Tables](#) section on the ONS website and on the [NRS website](#).

NRS also publish healthy life expectancy estimates for areas within Scotland. Previously these were published by the Information Services Division (ISD) within the NHS National Services, Scotland. Responsibility for production passed to NRS in 2018 as part of a programme of work to harmonise life expectancy and healthy life expectancy estimates across the UK.

## 2. An introduction to life expectancy figures

### 2.1 Coverage of life expectancy figures

The latest life expectancy figures can be found within the [Life Expectancy](#) Section on the NRS website.

The available figures are split under two sections:

#### **Life Expectancy at Scotland Level**

This section contains the Scottish National Life Tables (previously known as Interim Life Tables) and Scottish Decennial Life Tables. The National Life Tables are published annually and give statistics on period life expectancy by age and sex. From 2017, the Scottish life tables are published by NRS in a statistical bulletin available on their website. In previous years the results were published as part of the registrar general's annual report.

The Decennial Life Tables were published every now and then and are based on the mortality experience of Scotland's population during the three years centred on a census year. These are no longer published.

#### **Life Expectancy in Scottish Areas**

Life expectancy report on figures for administrative areas within Scotland (Council and NHS Board areas) and special areas (Urban/Rural and Deprivation). Life expectancy data is also published for Scottish Parliamentary Constituency Areas and Scottish Council Areas split by Deprivation.

All of NRS published life expectancy data includes life expectancy at birth for males and females with confidence intervals. The report for life expectancy at administrative areas and special areas also include abridged life tables for the geographical areas covered within the reports.

The Scotland-level life expectancy estimates given in the Scottish areas publication are

for use only as a comparator for the corresponding sub-Scotland-level figures. The definitive Scotland-level life expectancy estimate is the one published in the National Life tables for Scotland publication.

The differences occur because of the differences between complete (single year of age) and abridged (grouped years) life tables, as well as the number of years of data used in calculating the life expectancy figures.

The life expectancy figures produced by NRS are all period life expectancies. Period life expectancies are calculated using age specific mortality rates for a given period, with no allowance for any actual or projected future changes in mortality. This means that period life expectancy at birth for a given time period and area is an estimate of the average number of years a new born baby would survive if he/she experienced the particular area's age specific mortality rates for that time period throughout his/her life. The figures reflect mortality among those living in the area in each period, rather than the mortality among those born in each area. Life expectancy at birth is not the number of years a baby born in the area during the specified time period is expected to live (although the term 'can expect to live' is often used for ease of reading), both because death rates are likely to change in the future and because many of the new-borns may live elsewhere for at least some part of their lives.

Cohort life expectancies are worked out using age-specific mortality rates which allows for known or projected changes in mortality rates from relevant year based population projections. Cohort life expectancies can be accessed from the [ONS website](#).

Life expectancy figures used for international comparisons are taken from the [Statistics](#) area of the Eurostat website.

## **2.2 Uses of life expectancy figures**

Life expectancy at birth provides a useful summary of mortality rates actually experienced over a given time period.

Life expectancy also provides an objective means of comparing trends in mortality, over time, between areas of a country and with other countries. This is of particular use in monitoring and investigating health inequality issues across Scotland and in setting public health targets.

Life expectancy figures are also used to help deliver local and national health services, as well as for teaching and research.

### 3. Methodology for producing life expectancy statistics

#### 3.1 Input data

Population and death data are required to calculate life expectancy figures. To calculate life expectancy at administrative areas within Scotland, the [Mid-year Population Estimates](#) (published by NRS) given by council and NHS Board area by sex and single year of age are used. More information about the methods used to produce them can be found within the [Mid-Year Population Estimates for Scotland: Methodology Guide](#) on the NRS website.

Death data for calendar year by date of registration and by age at death in the same format as the population data are also used and obtained from the Vital Events branch in NRS.

For life expectancy in special areas published by NRS, [Small Area Population Estimates](#) (SAPE) (population estimates at data zone level) are required by sex and single year of age, as well as death data by the same distribution obtained from the Vital Events branch in NRS. These population and deaths figures are then assigned a lookup and aggregated to the required geography level. The match of data zones to Community Health Partnerships and Scottish Parliamentary Constituency is best fit.

There are sometimes deaths in the zero age group for which the sex is unclassified. For the purpose of calculating special area life expectancy data these deaths are always treated as male.

The majority of life expectancy figures published by NRS are a three year average. They are produced by aggregating deaths and population data for the relevant three year period (usually for the three years before publication). Three years of data are needed to provide large enough numbers to ensure that the figures published are sufficiently robust. Similarly, ONS uses three years of aggregated data for life expectancy data including for the calculation of Scotland's definitive life expectancy figures.

Life expectancy figures for council area split by deprivation are a five year average to ensure a higher level of statistical robustness due to the small size of some of the geography areas. The useful effects of increasing the size of the number of years used (n) needs to be weighed against the fact that the resultant life expectancy is an average of five years and assumes that the underlying life expectancy has not changed over the n years under investigation. For example, if n is equal to ten, then the implicit assumption is that life expectancy has not changed over those ten years. As n increases, the confidence interval decreases, but the validity of the assumption decreases too.

#### 3.2 Calculating life expectancy statistics

NRS use the Chiang II method<sup>1</sup> when calculating life expectancy figures. ONS and ISD also use this method for calculating life expectancy. The methodology of calculating life expectancy is published by ONS in the following report, Government Statistical Service Methodology (GSSM) series – number 33 [Life expectancy at birth: methodological options for small populations](#) which can be found within the GSSM series section of their website. The Chiang II method is also used to estimate the variance for all of the age groups up to and including 85 to 89 years. As Chiang II cannot be used to calculate the

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<sup>1</sup> Chiang CL (1979) Life table and mortality analysis. World Health Organisation

variance of the final age group of 90 years and over, the Silcocks method<sup>2</sup> is used to enable confidence intervals to be calculated for the final age group.

In previous publications, life expectancy was calculated for those under one year, aged one to four, five to nine and at five year age intervals up to 80 to 84. The final age group was those aged 85 and older. Working with other producers of life expectancy and healthy life expectancy statistics across the UK<sup>3</sup>, we have investigated the impact of increasing the final age group to those aged 90 years and over. We presented the findings about the impact of the change for Scotland to our user group, the [Population And Migration Statistics \(PAMS\) Committee for Scotland](#). More information on this can be found in the paper (PAMS (16) 11) from the meeting on 16 November 2016. As a result, we used the new 90 years and over upper age group for the publication of life expectancy estimates for 2013-2015 on 29 November 2016.

ONS also used the 90 years and over age group in their publication on 29 November 2016 on '[Health state life expectancies in the UK](#)'. This publication included life expectancy, healthy life expectancy and disability-free life expectancy for lower geographies<sup>4</sup> in the UK, and is available via the [ONS website](#). The estimates presented for Scottish council areas are the same as published by NRS. The aim of the ONS publication is to allow comparisons at lower geographies between the UK constituent countries.

### 3.3 Treatment of deaths

Deaths of Scottish residents occurring in Scotland are assigned to place of normal residence. NRS include deaths of non-residents but allocate them to place of death and ignore deaths of Scottish residents occurring out with Scotland.

Currently ONS, NRS and ISD all differ in the approach taken to deal with non-residents deaths for sub-national life expectancy figures as well as resident deaths that occur outwith each UK constituency country.

ONS includes deaths of non-residents for figures that feed into UK total figures, as well as the UK, Great Britain (GB) and England and Wales National Life Tables. For constituent UK country National Life Tables, non-resident deaths in England and Wales are allocated to England and non-resident deaths in Scotland are allocated to Scotland. All life expectancy figures calculated by ONS for Northern Ireland include the deaths of non-residents. Otherwise ONS does not include deaths of non-residents nor do they include deaths of English or Welsh residents dying outwith England and Wales.

ISD include deaths of non-residents but impute a pseudo place of residence and ignore deaths of Scottish residents dying outwith Scotland.

Work is planned to bring the methods of the three organisations more in line. NRS, alongside ISD, is currently investigating obtaining the records of Scottish residents dying outside of Scotland.

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<sup>2</sup> Silcocks PB, Jenner DA, Reza R (2001) Life expectancy as a summary of mortality in a population: statistical considerations and suitability for use by health authorities. *J Epidemiol Community Health* **55**:38-43

<sup>3</sup> National Records of Scotland (NRS), Office for National Statistics (ONS), Information Services Division (ISD), Scottish Government, Northern Ireland Statistics and Research Agency (NISRA), Public Health England (PHE), NHS Wales and the Welsh Government

<sup>4</sup> The lower geographies are council areas in Scotland, local authorities in England and Wales, and local government districts for Northern Ireland.

### 3.4 Accuracy of results

Life expectancy, like most statistics, is an estimate which is subject to a margin of error. The accuracy of the results can be indicated by calculating a confidence interval (included in the Chiang II method) which provides a range of values within which the true underlying life expectancy would lie (with 95% probability). Life expectancy for an area can be said to be significantly different from, for example, the Scottish level, if the 95% confidence intervals do not overlap.

There is no simple 'rule of thumb' for the size of confidence intervals. But they largely depend on the size of the population, so confidence intervals for areas with smaller populations tend to be wider. It is also worth noting that life expectancy results in these areas can be affected by the random variation in the number of annual deaths. This means that the results can vary from year to year.

Life expectancy is subject to random fluctuations in the number of deaths and the age at death.

NRS have published research papers assessing the quality of the administrative data sources that are used in the production of mid-year population estimates. Mid-year population estimates are an important input in calculating life expectancy estimates. For more information go to the [Research for the 2021 Census](#) section of the NRS website. Information on the quality assurance arrangements for administrative data used in population estimates is also available on the [NRS website](#).

The quality of deaths data which are part of the inputs in computing life expectancy estimates is available on the [Vital Events section](#) of the NRS website.

### 3.5 Abridged life tables

In the reports for life expectancy in administrative areas and life expectancy in special areas abridged life tables are included. These tables give expectation of life at an 'exact age'. This is the average number of years that those at this age would survive thereafter, if they experienced the particular area's age specific mortality rates for the time period throughout the remainder of their life.

In the extracts from period life tables the column headed  $l_x$  shows the numbers who would survive to exact age of  $x$ , out of 100,000 persons who, from birth, were subject to the mortality probabilities indicated by the deaths for the corresponding time period. The column headed  $e_x^0$  shows the expectation of life – that is, the average number of years of life left to persons aged exactly  $x$  who are subject to the corresponding years mortality probabilities from age  $x$  onwards.

## 4. Methodology for producing healthy life expectancy statistics

### 4.1 Input data

Healthy life expectancy (HLE) uses the same population and death inputs as life expectancy. In addition, it requires survey data from which to estimate prevalence of good health. These data come from the general health question in the Annual Population survey (APS), which asks:

How is your health in general; would you say it was...

Very good?  
Good?  
Fair?  
Bad?  
Very bad?

Healthy life expectancy is defined as the number of years that someone could expect to spend in 'good' or 'very good' health.

Input data from the 2011 census is also used as a term in the HLE model and to impute good health prevalence for people under 16 (which the APS does not survey) and those over 85 (where the APS has a very small sample size).

## **4.2 Calculating healthy life expectancy**

An imputation method is first applied to the under 16 and over 85 age groups. Then a prevalence rate for each age group is estimated using a least squares regression which includes a census health term drawn from the 2011 census. The modelling approach acts to smooth the data and rein in more volatile values, especially at older ages and in small geographies. From the good health prevalence rate, deaths and population data, the average number of remaining years in good health can be calculated for each age group and geography.

This is a new method developed by the ONS and adopted following a consultation in December 2017. NRS responded to the consultation jointly with the Scottish Government and ISD. The [consultation](#) and [response](#) from stakeholders can be viewed on the ONS website.