



Centenarians in Scotland: Methodology Guide

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Contents

Introduction.....	3
1. Methodology.....	3
2. Quality Assurance.....	4
3. Contact Us.....	11

Introduction

The National Records of Scotland (NRS), produces annual estimates of the resident population of Scotland aged 90 and over as at 30 June each year.

This paper describes the current methodology used by National Records of Scotland to produce the annual mid-year population estimates for people aged 90 and over.

1. Methodology

The National Records of Scotland produces population estimates by single year of age from 0 to 89 using the 'cohort component' method. Starting with the census, each year the population of a given area is aged on by one year, births in the area are added to the population, deaths in the area are subtracted and estimates of migration are used to allow for people moving in and moving out. More information on the cohort component method can be found in the [mid-year population estimates methodology guide](#) on the National Records of Scotland website.

However this method is not currently reliable for single year of age populations for the very elderly because the census itself is less reliable for populations aged 90 and over (as it becomes harder to establish firmly someone's age the older they get). So, in the standard National Records of Scotland mid-year estimate of the Scottish population, people aged 90 and over are aggregated together into one group.

To produce single year of age estimates of the population aged 90 and over, National Records of Scotland uses the Kannisto-Thatcher¹ (KT) method. The KT method uses 'age at death' data to build up distribution profiles of the numbers of elderly people in Scotland in previous years. For example, if someone dies in 2006 aged 105, then this means that they were alive and aged 104 in 2005, 103 in 2004, and so on. By collating 'age at death' data for a series of years, it becomes possible to make an estimate of the number of people of a given age alive in any particular year and so create age distribution profiles, assuming that migration at these oldest ages is minimal.

To make estimates for 2015, it is not possible to use death data, as we are interested in the population who are currently or very recently alive. So the KT method uses an average of the last five years of age at death information to produce an estimate of the number of survivors for the most current year. Estimates are then made consistent with the National Records of Scotland mid-year estimates of people aged 90 and over.

One consequence of this method is that each year the estimates for earlier years become more accurate as more death data become available to inform the age profiles. For example, the current estimate of the number of people aged 90 in 2014 (9,330) is different from the estimate that was calculated in the 2014 publication (9,360).

Footnote

1) Thatcher, R, 1999, The demography of centenarians in England and Wales. Population Trends 96.

The increase in the number of centenarians reflects an increase in life expectancy. The ONS produces annual estimates of life expectancy for Scotland on behalf of National Records of Scotland². The latest figures (for the period 2013 to 2015 based on population estimates rolled forward from the 2011 Census) show a life expectancy at birth of 77.1 for males and 81.1 for females, which is an increase of 2.9 years for males and 1.9 years for females over the last 10 years (since the period 2003 to 2005). Life expectancy at age 65 has also increased over the last 10 years to 17.3 years for males and 19.7 years for females, an increase of 1.9 years for males and 1.3 years for females compared to 2005.

National Records of Scotland have also produced mid-year estimates at single year of age up to 99 and aggregated for 100+ for council areas. These cover the period 2005 - 2015 and have been published as 'data being developed' alongside the 2015 'Centenarians in Scotland' publication.

The KT method is considered sound at national level and has outperformed other methods in numerous studies, however, the KT method becomes less reliable at smaller area levels. The KT method also assumes negligible migration. While figures show that international and cross border migration can be considered negligible at ages 90+³, internal migration within Scotland is more common.

The method to produce the sub-national estimates uses the Community Health Index data for single year of ages 90+ as an initial proxy for the distribution of these ages within each council area.

Once this data was extracted, the totals for ages 100 and above were aggregated to a single 100+ age group. Iterative proportional fitting was applied to give estimates which were consistent with published aggregate estimates from both the mid-year estimates and the Centenarians in Scotland publications. The aggregation of ages 100 and above and the subsequent iterative proportional fitting mean that the estimates produced are non-disclosive even for small numbers.

This method is explained in more detail in the publication which is available on the [National Records of Scotland website](#).

2. Quality Assurance

Introduction

This report provides information about the quality of the centenarian population estimates for Scotland and their strengths, weaknesses, uses and limitations. A summary of this information is available in the [About this Publication](#) paper which goes with this release.

Footnotes

2) [Life expectancy at Scotland level](#) – available on the NRS website.

3) Further information can be found in the [Migration Statistics](#) section of the NRS website.

Population estimates of people aged 90 and over are published by sex and single year of age up to age 104 at Scotland level. Estimates for people aged 105+ are aggregated. National Records of Scotland have also published statistics with population estimates of people aged 90 and over by sex and single year of age at council area level as data being developed, to allow users to provide feedback on the method and results.

Scotland's population is ageing therefore estimates of the very old are important for policy development, particularly for health and welfare services. These estimates are also used to calculate mortality rates and are required in order to be able to use the revised European Standard Population.

Strengths and Weaknesses of the data

Deaths data is used to produce the Scotland level estimates. Strengths of the death data collected in Scotland include that death registration is compulsory and a death must be registered by a registrar within eight days of the date of death. Furthermore, death data is an administrative data source and so is not vulnerable to sampling error. A weakness of the data is that as the date of birth on death certificates are not validated it is possible that there may be some inaccuracies in this data source. More information about the [quality of deaths data](#) is available on the National Records of Scotland website.

Estimates at Scotland and sub-Scotland level are constrained to the mid-year population estimates. The mid-year population estimates are produced by rolling forward the census population estimates allowing for ageing, births, deaths and migration. Strengths of census data are their coverage and validation using multiple data sources. Weaknesses in constraining to the mid-year population estimates are that any error in the 90 and over census estimate is thereby carried forward to the inter-censal mid-year population estimates and will be reflected in the SYOA 90+ estimates. More information about the quality assurance undertaken for the [mid-year population estimates](#) and the other administrative sources used in their calculation and also for the [2011 Census](#) are available on the National Records of Scotland website.

Relevance

The degree to which the statistical product meets user needs for both coverage and content.

The European Standard Population is an artificial population structure which is used in the weighting of mortality of incidence data to produce age-standardised rates. It was introduced in 1976. Because the age-structures of European countries' populations have changed significantly since then, Eurostat, the statistical institute of the European Union, has brought the European Standard Population up to date introducing a revised version in 2013. The 2013 European Standard Population more closely reflects the age-structure of the current population and gives much greater weight to the older age-groups than the 1976 European Standard Population.

The highest age group in the 1976 European Standard Population was 85+. As National Records of Scotland produces mid-year estimates at single year of age up to age 89 it was possible for National Records of Scotland to supply the required age standardized rates to Eurostat. In the 2013 European Standard Population, the 85+ group has been split into three groups: 85-89, 90-94 and 95+. The production of estimates for people aged 90 and over at Scotland and council area level at single year of age allows supply of the new age standardized rates, separated for ages 90-94 and 95+.

Other developed countries, such as Australia and the United States of America, now publish estimates up to age 100+ by single year of age. The Office for National Statistics publish up to age 105+ for England and Wales, while the Northern Ireland Statistics and Research Agency produce to 105+ for Northern Ireland. As part of the UK, it is important that equivalent data is produced for Scotland in order that data can be aggregated to provide UK level estimates, and the production of these estimates mean that this is the case.

As the population of those at the oldest old ages increases, interest in population estimates at these ages further increases and it becomes increasingly important to have high quality statistics on this population, for policy development and for planning and providing public services.

The estimates can be used for:

- finance allocation
- informing pensions policy
- housing planning
- health care planning
- looking at the implications of an ageing population
- making national and international comparisons

In addition to the above, population estimates of the very old are used by ONS in the production of national life tables and national population projections.

Finally they are used for research by demographers, actuaries, medical researchers and others interested in longevity, and are of interest to members of the media and the public.

Accuracy

The closeness between an estimated result and the (unknown) true value.

To produce single year of age estimates of the population aged 90 and over at Scotland level, NRS uses the Kannisto-Thatcher (KT) method. This method has also been adopted by the Office for National Statistics to produce estimates for the elderly in England and Wales and by the Northern Ireland Statistics and Research Agency to produce equivalent estimates for Northern Ireland. The KT method is considered robust at national level. It is used by the World Health Organisation to compute

population estimates for ages 85+, it is the method used to construct the Human Mortality Database and it has outperformed other methods in numerous studies⁴⁵⁶.

Estimates of the very old in Scotland are constrained to the National Records of Scotland mid-year population estimates of those aged 90 and over by sex. In effect this means that, while the KT method determines the estimated distribution of the population aged 90 and over, the accuracy of the overall KT estimates is dependent on the accuracy of the 90 and over total in the official mid-year estimates.

Survivor ratio methods such as the KT method provide age-specific estimates of the population for those aged 90 and over using data from death registrations. Statistics on deaths registered in Scotland are collected through administrative sources, maintained by National Records of Scotland. These data are considered very reliable for two reasons. Firstly, there is a legal requirement to register a death within eight days and the certificate issued upon registration is needed and used by the recipient. Secondly, administrative data do not suffer from sampling error in the way that survey data do. Comparisons of National Records of Scotland data with National Health Service data found National Records of Scotland data on deaths to be highly accurate. More information on how death data are collected and further information about the quality of death data is available on the [National Records of Scotland website](#).

The KT method assumes negligible migration. Published migration data for people in Scotland aged 85 and over, based on information obtained from the International Passenger Survey and the Scottish National Health Service Central Register, show that the average annual net international and cross border migration between 2001 and 2015 accounts for fewer than one hundred people. As such, net international migration at ages 90+⁷ is assumed negligible for purposes of population estimation.

One consequence of the KT method is that each year the estimates for earlier years become more accurate as more death data become available to inform age profiles. As such each year the data referenced in the archive is superseded by the data in the latest publication. Once a cohort becomes fully extinct death data can be reliably used to retrospectively trace the survival patterns of all members of that cohort, however, assuming a maximum age of 115 years, it could be 25 years after the cohort reaches age 90 before all members are extinct. Changes to previous estimates following the inclusion of new data on deaths have required only very small adjustments indicating that the original estimates were already of a high level of accuracy.

Population estimates at advanced ages are very sensitive to the quality of statistics. The same absolute error leads to much higher effect in older ages due to a small

Footnotes

4) Terblanche, Wilma and Wilson, Tom (2015) An evaluation of nearly-extinct cohort methods for estimating the very elderly populations of Australia and New Zealand. *PLoS One*, 10 4.

5) Jdanov DA, Jasilionis D, Soroko EL, Rau R, Vaupel JW (2008) Beyond the Kannisto-Thatcher Database on Old Age Mortality: An Assessment of Data Quality at Advanced Ages'. MPIDR Working Paper WP 2008–013, March 2008.

6) Thatcher, R, 1999, The demography of centenarians in England and Wales. *Population Trends* 96.

7) More information is available in the [migration between Scotland and overseas section](#) of the NRS website.

number of survivors. Consequently, this effect also tends to be more marked for men than for women.

There are few data sources available which allow quality assurance of the estimates produced however several steps are taken to ensure that the estimates are consistent with those obtainable.

Firstly, age distributions are examined for any large variations that cannot be explained. The estimates are analysed to ensure that they reflect past trends and events. For example, the number of 90 year olds between 2004-2009 should reflect the lower birth rates within the war years while from 2010 onward, evidence of the large 1920 post war cohort is expected.

Analysis shows that estimates produced using the KT method are highly correlated with Census data from 2001 and 2011, with the correlation coefficient for both males and females above 0.99. The correlation coefficient measures the strength of the relationship between two variables so a coefficient of 0.99 indicates a very strong relationship between the estimates and the census data, with a close to perfect fit. In the Scotland's Census Quality Assurance process the Pension Age Client Group data from Department of Work and Pensions is used to assess the number of people aged 90 and over by single year of age (up to 100 years old) and the age group 'over 100' at Scotland level. The Super Old Persons Database contains information which has been derived from a variety of different data streams, such as TV Licensing, Winter Fuel Allowance, as well as Pension and Disability Allowances. More information about quality assurance of 2011 Census data at old ages is available on the [Scotland's Census website](#).

Comparisons are carried out by National Records of Scotland between the previous year's estimates and Pension Age Client Group data for the previous year, obtained from the Department for Work and Pensions. This comparison work is completed retrospectively due to data availability but a high correlation between the estimates and the equivalent Department for Work and Pensions data increases confidence in the method used. Scotland level estimates for 2013 for ages 90 to 100+ were found to have a correlation coefficient of greater than 0.99 for both males and females.

Finally, the age frequencies and sex ratios of those aged 90 and over given by the estimates are compared to those reflected in the Scottish National Health Service Central Register and the Community Health Index. Both age frequencies and sex ratios produced by the estimates have been found to be very similar to those seen in the National Health Service Central Register and the Community Health Index at Scotland and council area level. More information about the quality of these data sources can be found in the research papers on the [National Records of Scotland website](#) and in the papers of the [Population and Migration Statistics Committee](#).

Timeliness and Punctuality

Timeliness refers to the lapse of time between publication and the period to which the data refer. Punctuality refers to the time lag between the actual and planned dates of publication.

Population estimates of the oldest-old for Scotland have previously been published annually in the autumn. For a particular mid-year (30 June) they tend to become available around 15 months after the reference date. This time lag reflects the availability of the data sources which measure the components of population change over the year preceding the estimate, and the time required to process the data and calculate the estimates. The time lag to publication of these estimates also reflects their priority in relation to other statistics.

The publication data for population estimates at single year of age for people 90 and over is determined by the availability of the mid-year population estimates as well as registration data for deaths for the relevant time period. All forthcoming releases are pre-announced through the future publications page on our website, the Scottish Government forthcoming releases spreadsheet and on the [Gov.uk Release calendar](#). In the unlikely event of a change to the release schedule public attention will be drawn to any change in the pre-announced release date through the [Gov.uk Release calendar](#), on the [National Records of Scotland website](#) and on the [Scottish Government website](#), and a reason for the change will be explained, as set out in the Code of Practice for Official Statistics.

Accessibility and Clarity

Accessibility is the ease with which users are able to access the data, also reflecting the format(s) in which the data are available and the availability of supporting information. Clarity refers to the quality and sufficiency of the metadata, illustrations and accompanying advice.

Population estimates of people ages 90 and over by single year of age and sex are available online from 1981 onwards. Aggregated estimates for people ages 85 and over are available online from 1911 onwards and for ages 90 and over from 1971 onwards. Estimates for earlier years are available on request by contacting us using our [Contact Form](#) or via e-mail at: statisticscustomerservices@nrscotland.gov.uk.

Links from the National Statistics Publication Hub Homepage, the Scottish Government website and our website make the release date and location of each new set of estimates clear. The estimates can be downloaded free of charge in Microsoft Excel format and are available on the National Records of Scotland website.

The statistics are provided in Excel, PDF and CSV format.

It is the policy of National Records of Scotland to make its website and products accessible according to published guidelines. More information is available within the [Accessibility](#) section of the National Records of Scotland website.

Comparability

The degree to which data can be compared over time and domain.

The population estimates for people aged 90 and over in Scotland are consistent from mid-1981. Each annual set of estimates for people aged 90 and over in Scotland is derived using the same methodological approach and the best data sources available.

National Records of Scotland publish population estimates for people aged 90 and over in Scotland. The Northern Ireland Statistics and Research Agency produce equivalent population estimates for Northern Ireland using the same approach. The Office for National Statistics publish equivalent estimates for England and Wales using the same methodology and by aggregating data from each of the separate countries, publish comparable estimates for the UK as a whole.

Time-series comparisons from 1981 to 2015 for Scotland are appropriate.

The method used to produce the sub-national estimates is broadly comparable with the approach taken by the Office for National Statistics to produce population estimates for the 90-94 and the 95-plus age groups, by sex, for Lower Layer Super Output Areas in England and Wales in their [2013 research paper](#). The estimates produced by the Office for National Statistics are also currently data under review.

Coherence

The degree to which data that are derived from different sources or methods, but which refer to the same phenomenon, are similar.

The population estimates of people aged 90 and over are constrained to the mid-year population estimates and are therefore consistent. Mid-year population estimates are used both within and outside Government as the definitive set of population figures for the UK, constituent countries and sub-national geographies to local authority level. They are used for calculating other official population statistics, such as population projections, small area population estimates and household population estimates. Population estimates of people aged 90 and over are consistent with all these outputs at Scotland level.

The estimates produced for single year of age at ages 90 and over using the KT method are compared with the single year of age mid-year estimates for ages 85 to 89 to examine for any potential discontinuity. Any unexpected results are investigated to ensure these can be explained, for example by the post-war baby boom cohort. [Investigative work](#) completed by National Records of Scotland for the Population and Migration Statistics Committee found that estimates produced starting the KT method at ages 85 or 88 were very close to those produced starting at age 90 indicating that there is minimal discontinuity introduced by the change in estimation methods at age 90.

Any improvements made to the mid-year population estimates as a result of current work by the Office for National Statistics and National Records of Scotland to improve population and migration statistics using alternative sources of data will also be applied to the population estimates of people aged 90 and over in due course.

3. Contact Us

This methodology guide is designed to provide the users of statistics with an introduction to the methods employed by National Records of Scotland in the production of mid-year population estimates of those aged 90 and over. National Records of Scotland have also tried to provide background information on the data sources utilised.

The Scottish Population

For more information on the population of Scotland please visit the following websites:

[Population Statistics](#) (National Records of Scotland website);
[Census in Scotland](#) (Scotland's Census website).

Please contact our Statistics Customer Services if you need any further information.
E-mail: statisticscustomerservices@nrscotland.gov.uk.

The Northern Ireland Population

Further information on Northern Ireland's population can be found within the population of Northern Ireland and Census in Northern Ireland sections of the Northern Ireland Statistics and Research Agency website (www.nisra.gov.uk):

[Population of Northern Ireland](#) publications section; and
[Census in Northern Ireland](#).

or contact them by telephone (028) 9034 8160

or email census.nisra@dfpni.gov.uk

The England & Wales Population

For more information on the Office for National Statistics and the population of England & Wales please visit the following pages on the Office for National Statistics website (www.ons.gov.uk):

[Population Projections](#); and
[Census of England & Wales](#).

or contact them by telephone:

General enquiries 0845 601 3034
Census enquiries in England & Wales 01329 444972

or email:

General enquiries info@ons.gsi.gov.uk

Census enquiries in England & Wales census.customerservices@ons.gsi.gov.uk

The UK Population

Statistics regarding the UK population are compiled by the Office for National Statistics using the statistics produced by National Records of Scotland and Northern Ireland Statistics and Research Agency in conjunction with their own data on England & Wales.

For information on the population of the UK please use the details provided above with regards to England & Wales.