Centenarians in Scotland: Methodology Guide

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1. Introduction

National Records of Scotland (NRS), produces annual centenarians estimates, which includes:

- Estimates of people aged 90 to 104 by single year of age
- Aggregated estimates of people aged 105+

This paper describes the current methodology used by NRS to produce these estimates.

NRS previously produced mid-year estimates at single year of age up to 99 and aggregated for 100+ for council areas. These covered the periods 2004 to 2014 and 2005 to 2015. These were developmental statistics that were published alongside the 2014 and 2015 'Centenarians in Scotland' publications. These estimates are available on the NRS website, but are no longer being updated. The latest annual Mid-Year Population Estimates publication provides an aggregate figure for those aged 90 and over by council area.

1.1 How are these estimates used?

Information on numbers of the very old is important for policy development, particularly for health and welfare services. These estimates are also used to calculate mortality rates and the European Standard Population.

The Office for National Statistics (ONS) uses centenarians estimates to produce estimates of the very old in the UK. They are also used to calculate life expectancy for Scotland and National Population Projections on behalf of NRS.

Further information on the relevance of these statistics can be found in Section 3.

2. Methodology

2.1 Cohort Component Method

NRS produces population estimates by single year of age from 0 to 89 using the 'cohort component' method. Starting with the census, each year:

1. The population of a given area is aged on by one year
2. Births in the area are added to the population
3. Deaths in the area are subtracted
4. Estimates of migration are applied 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 NRS website.

The 'cohort component' method is not currently reliable for single year of age populations for the very old because the census itself is less reliable for populations aged 90 and over as age is self-reported. As a result, the number of people aged 90 and over are aggregated together into one age group in the Mid-Year Population Estimates.

2.2 Kannisto-Thatcher Method

To produce single year of age estimates of the population aged 90 and over, NRS uses the 'Kannisto-Thatcher[1]' (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 2019 aged 105, then this means that they were alive and aged 104 in 2018, 103 in 2017, 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. This method assumes that migration at these oldest ages is negligible.

To make estimates of the population who are currently or very recently alive, it is not possible to use death data. 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 NRS mid-year population estimates of people aged 90 and over.

2.3 Differences with previously published estimates

One consequence of this method is that each year the estimates for earlier years become more accurate as more death data becomes available. For example, the current estimate of people aged 102 in 2019 (120) is different from the initial estimate that was published in the 2019 publication (130).

[1] Thatcher, R, 1999, The demography of centenarians in England and Wales. Population Trends 96: 5-12.

2.4 Revisions to Mid-Year Estimates

The data in this report uses the revised mid-year population estimates for 2002 to 2010 which take into account the 2011 Census results. These were originally published on 17 December 2013, and a corrected version which mainly affected the estimates of 90+ year olds was published on 25 September 2018. Further details on this correction can be found in the report provided on the NRS website.

The estimates for 2012 to 2014 are based on corrected population estimates published on 28 April 2016. More details are available in the papers of the Population and Migration Statistics Committee (PAMS) available on the NRS website.

2.5 Rounding

At the end of the process, the number of people within each age group is rounded to the nearest 10.

3. Quality assurance

Quality assurance takes place throughout the production of the centenarians publication, with checks in place to ensure consistency and completeness. More information on the quality assurance arrangements for administrative data used in population estimates is available on the NRS website, along with information on the suitability of each data source used in the production of the population estimates.

3.1 Relevance

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 NRS produces mid-year estimates at single year of age up to age 89 it was possible for NRS to supply the required age standardised 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 single year of age allows supply of the new age standardised rates, separated for ages 90-94 and 95+.

Many other countries publish centenarian estimates; ONS publish centenarian estimates for England and Wales, while the Northern Ireland Statistics and Research Agency (NISRA) produces estimates 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 by NRS allows this.

As the population of the very old rises, interest in these estimates increases. High quality statistics on this population is important for policy development, 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

Population estimates of the very old are also used by ONS in the production of The Life Expectancy in Scotland, 2018-2020 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.

3.2 Accuracy

Data Sources

To produce single year of age estimates of the population aged 90 and over at Scotland level, NRS uses the KT method. This method has also been adopted by the ONS to produce estimates for the elderly in England and Wales and by the NISRA to produce equivalent estimates for Northern Ireland. The KT method is considered robust at national level and has outperformed other methods in numerous studies[2] [3] & [4].

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 NRS. 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 NRS data with NHS data found NRS 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.

Assumptions

The KT method assumes negligible migration. Published migration data[5] for people in Scotland aged 85 and over, show that the average annual net international and cross border migration between 2001 and 2020 accounts for fewer than one hundred people. As such, net migration at ages 90+ is assumed negligible for the purposes of these estimates.

Kannisto-Thatcher Method

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.

[2] 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.

[3] 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.

[4] 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.

[5] Based on information obtained from the International Passenger Survey and the Scottish NHS Central Register (NHSCR).

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

Several steps are taken to ensure the quality of the centenarians estimates. Firstly, age distributions are examined for any large variations that cannot be explained. They are also 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 around the war years 1914-1919.

Comparisons are made between the centenarians estimates and other estimates of people aged 90 and over. Analysis has shown that the centenarians estimates are highly correlated with Census data from 2001 and 2011 (correlation coefficient > 0.99 for males and females). Comparisons have also been carried out between centenarians and Pension Age Client Group obtained for the Department for Work and Pensions. This comparison was carried out retrospectively due to data availability, but showed a high correlation (>0.99) with centenarian estimates. The Pension Age Client Group is also used in the quality assurance of the census. More information can be found on the Scotland's Census website.

Finally, the age frequencies and sex ratios of those aged 90 and over have been compared to those reflected in the Scottish NHSCR 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 NHSCR and the Community Health Index. 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.

Mid-Year Estimates

While the KT method determines the estimated distribution of the 90 and over population, they are constrained to the mid-year population estimates. As a result, the overall accuracy depends on the accuracy of the mid-year estimates. The mid-year estimates are produced by rolling forward the census population estimates allowing for ageing, births, deaths and migration. Census data has wide coverage and validation using multiple data sources. However, any error in the 90 and over census estimate is carried forward to mid-year estimates produced between censuses and will be reflected in the single year of age 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 NRS website.

3.3 Timeliness and Punctuality

Centenarian population estimates are 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 and the time required to process the data and calculate the estimates.

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 the NRS website and the Scottish Government forthcoming releases spreadsheet.

3.4 Accessibility and Clarity

Population estimates of people aged 90 and over by single year of age and sex are available online from 1981 onwards. Aggregated estimates for people aged 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 via e-mail at: statisticscustomerservices@nrscotland.gov.uk.

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

It is the policy of NRS to make its website and products accessible according to published guidelines. More information is available within the Accessibility section of the NRS website.

3.5 Comparability

The population estimates for people aged 90 and over in Scotland are consistent from mid-1981. Similar estimates are also produced for Northern Ireland by NISRA and for England and Wales by ONS. ONS also aggregates data from each of the constituent countries, publishing comparable estimates for the UK as a whole.

3.6 Coherence

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 NRS 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 ONS and NRS 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.

4. Notes on statistical publications

4.1 National Statistics

The United Kingdom Statistics Authority (UKSA) has designated these statistics as National Statistics, in line with the Statistics and Registration Service Act 2007 and signifying compliance with the Code of Practice for Official Statistics (available on the UKSA website).

National Statistics status means that official statistics meet the highest standards of trustworthiness, quality and public value.

All official statistics should comply with all aspects of the Code of Practice for Official Statistics. They are awarded National Statistics status following an assessment by the Authority's regulatory arm. The Authority considers whether the statistics meet the highest standard of Code compliance, including the value they add to public decisions and debate.

It is National Records of Scotland's responsibility to maintain compliance with the standards expected of National Statistics. If we become concerned about whether these statistics are still meeting the appropriate standards, we will discuss any concerns with the Authority promptly. National Statistics status can be removed at any point when the highest standards are not maintained, and reinstated when standards are restored.

4.2 Information on background and source data

Further details on data source(s), timeframe of data and timeliness, continuity of data, accuracy…etc. can be found in the 'About this Publication' document that is published alongside this publication on the NRS website.

4.3 National Records of Scotland

We, the National Records of Scotland, are a non-ministerial department of the devolved Scottish Administration. Our aim is to provide relevant and reliable information, analysis and advice that meets the needs of government, business and the people of Scotland. We do this as follows:

Preserving the past – We look after Scotland's national archines so that they are available for current and future generations, and we make available important information for family history.

Recording the present – At our network of local offices, we register births, marriages, civil partnerships, deaths, divorces and adoptions in Scotland.

Informing the future – We are responsible for the Census of Population in Scotland which we use, with other sources of information, to produce statistics on the population and households. The next Census in Scotland will be held on 20 March, 2022.

You can get other detailed statistics that we have produced from the Statistics section of our website. Scottish Census statistics are available on the Scotland's Census website.

We also provide information about future publications on our website. If you would like us to tell you about future statistical publications, you can register your interest on the Scottish Government ScotStat website.

You can also follow us on twitter @NatRecordsScot.

4.4 Enquiries and suggestions

Please get in touch if you need any further information, or have any suggestions for improvement.

For media enquiries, please contact communications@nrscotland.gov.uk

For all other enquiries, please contact statisticscustomerservices@nrscotland.gov.uk

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