Mid-year admin-based population estimates for England and Wales QMI

Quality and Methodology Information for mid-year admin-based population estimates (ABPEs) for England and Wales, detailing the strengths and limitations of the data, methods used, and data uses and users.

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To be announced

Notice

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As part of the transformation of our website, this page has been superseded by our Mid-year admin-based population estimates for England and Wales quality and methods guide.

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1 . Output information

- Accredited official statistics: no
- Data collection: administrative data
- Frequency: bi-annual
- How compiled: administrative and census data with cohort component methodology and statistical modelling
- Geographic coverage: local authorities in England and Wales
- Related publications: Admin-based population estimates: local authorities in England and Wales

2 . About this quality and methodology information report

This quality and methodology information (QMI) report contains information on the quality characteristics of the data (including the European Statistical System's five dimensions of quality) as well as the methods used to create it.

The information in this report will help you to:

- understand the strengths and limitations of the data
- learn about existing uses and users of the data
- understand the methods used to create the data
- help you to decide suitable uses for the data
- reduce the risk of misusing data

3 . Important points

- Mid-year admin-based population estimates (ABPEs) for local authorities in England and Wales are official statistics in development while we refine our methods and the data sources used; they do not currently replace official mid-year population and international migration estimates and should not be used for policy or decision making.

- We are aiming for our ABPEs to become the official mid-year population estimates in 2025 and we are working to meet the standards expected of accredited official statistics.

- Our estimates refer to the mid-year reference point (30 June) and are consistent with the UN definition of usual residence outlined on page 40 in the Principles and Recommendations for Population and Housing Censuses publication (PDF, 2.36MB), which includes people who reside, or intend to reside, in the country for at least 12 months, whatever their nationality; visitors and short-term migrants, who enter or leave the UK for less than 12 months, are not included.

- Estimates of the population and components of population change are produced for local authorities in England and Wales by single year of age and sex; these are summed to give higher-level estimates, such as total population within a local authority, region or country.

- ABPEs are subject to uncertainty related to the measurement of population stocks at specific points in time and the components of population change over time; credible intervals, as explained in Section 8: Glossary, released alongside the estimates give the range of plausible values and illustrate the uncertainty around the estimates.

- We welcome your feedback on our first published version of this report to help guide future updates and ensure we best meet user needs.

4 . Quality summary

Overview

Our population and migration statistics are evolving in response to rapid changes in society and technology and to better meet user needs. To do this, we are making greater use of a wide range of administrative data that are acquired in line with the Office for National Statistics' (ONS's) data acquisition policy and our data ethics policy. More information on these developments can be found on our Future of population and migration statistics in England and Wales web page.

Our methods and the data sources used to produce the admin-based population estimates (ABPEs) are being continually developed and enhanced. The dynamic population model (DPM) captures the dynamics of population change and produces the ABPEs. The model builds on the cohort component method (as explained in our Population estimates methods guide), which has been used to produce our population estimates for many years.

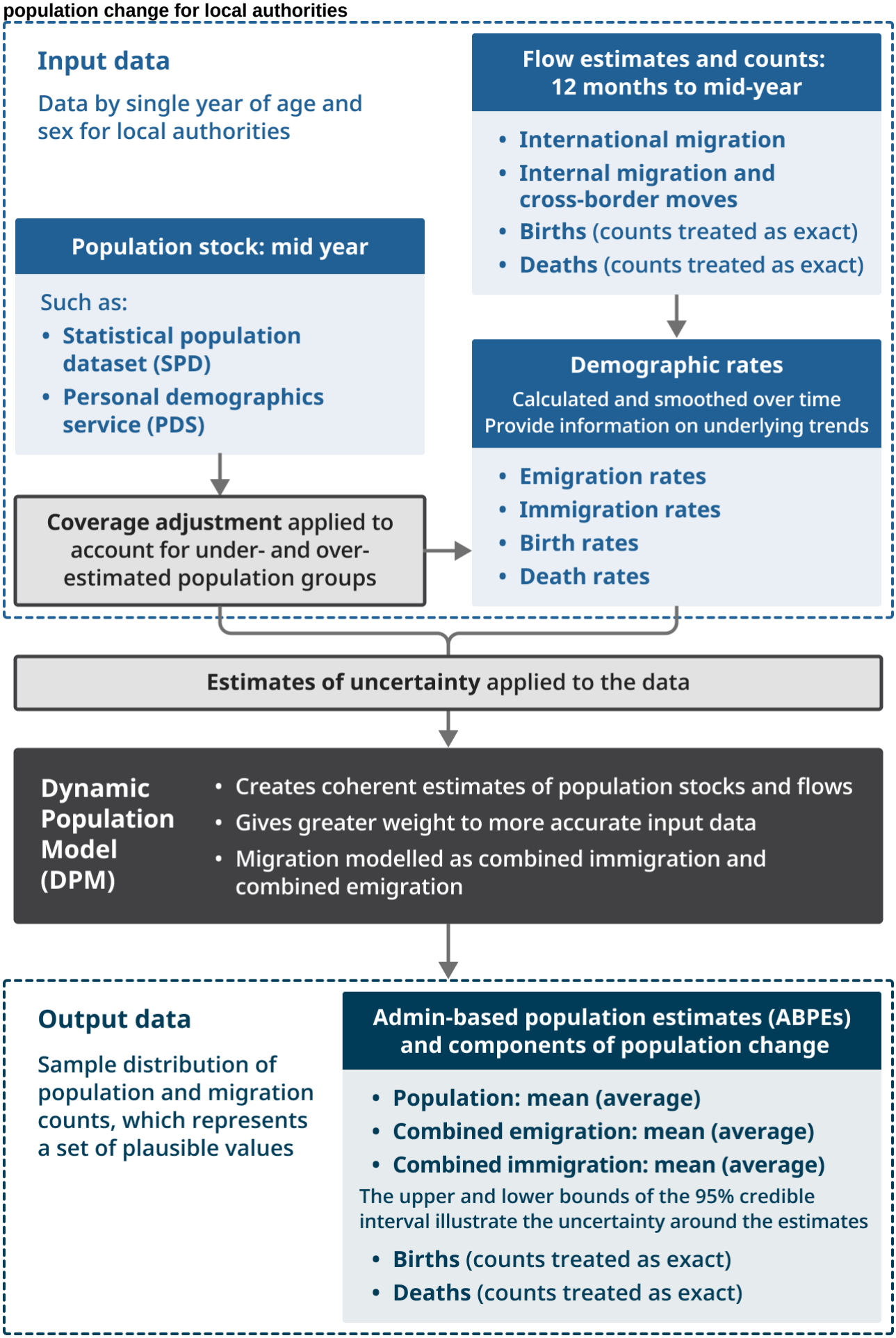
Timely provisional ABPEs are usually published around six months after the reference period. They are produced using incomplete data alongside some assumptions about migration. Improved updated estimates are usually provided around 12 months after the reference period. These use additional data that have become available.

The DPM is effectively an extension to our existing mid-year population estimate methods. It incorporates statistical modelling to take account of underlying demographic trends and allow for differing levels of coverage and uncertainty associated with input data. Modelling enables measures of uncertainty to be generated. The DPM supports the use of an increasing range of data sources, enabling our ambition to maximise and optimise the use of administrative data. It has been developed using open-source software. We plan to open source the code in the future as part of our commitment to continuous improvement and transparency.

The DPM can take account of quality limitations in the underlying data sources and draws strength across the wide range of data sources being used (detailed in Section 6 of this publication). In June 2023, updated ABPEs were published despite quality issues in some of the data used for the internal migration component. However, our release of official mid-year population estimates in 2023 was delayed because of these issues. This demonstrates how ABPEs can be more resilient to changes in data than the current official population estimates.

The DPM balances input data on population (stocks) at specific points in time with the components of population change (flows of births, deaths, and migrants) over time, generating a sample distribution of potential population and migration counts. This sample distribution represents a set of plausible values, given the uncertainty of the inputs. Our estimates are the average (mean) value from the distribution. Credible intervals illustrate the range of plausible values and give users an idea of the uncertainty around the estimates. The probability that the true value lies in the credible interval is 95%.

Figure 1: How the Dynamic Population Model (DPM) estimates the population and components of population change for local authorities



Source: Mid-year admin-based population estimates (ABPEs) from the Office for National Statistics

Our methodological work, published on the UK Statistics Authority website, has been presented to the independent Methodological Assurance Review Panel (MARP), chaired by Sir Bernard Silverman and consisting of a panel of recognised experts. All papers presented to the panel are available on the Papers section of the UK Statistics Authority website. An appendix in the most recent paper, published by The Authority in February 2023, provides technical information on the Design and Implementation of the Dynamic Population Model (PDF, 1,343 KB). A subgroup of MARP, consisting of Bayesian statisticians, is being set up to provide advice on the methods developed for and used in the DPM. The methods have also been presented and discussed at a cross-government Demographic Methods Expert Group.

The Office for National Statistics (ONS) has been supported in the production of ABPEs by the University of Southampton. Specifically, we would like to thank John Bryant, Peter Smith, Paul Smith, Jakub Bijak, Jason Hilton, Andrew Hind, Erengul Dodd and Joanne Ellison for their guidance and support.

We welcome your feedback on our first published version of this report, which is designed to provide a suitable level of detail for a broad range of users. Links to further information are provided for those who require more detail. Please email your feedback to us at pop.info@ons.gov.uk. Feedback is also being invited through our wider user engagement program and will help ensure future iterations of this report best meet user needs

Uses and users

The ONS ran a consultation from 29 June 2023 to 26 October 2023 on the Future of Population and Migration Statistics (FPMS) for England and Wales. The consultation provided us with information on how people use our population and migration statistics. More information on the consultation is available in Section 5 of this publication, under the subheading "Relevance".

ABPEs are official statistics in development that demonstrate our ability to produce provisional population estimates six months earlier than would be possible using current methods. They currently do not replace official mid-year population and international migration estimates and should not be used for decision making. Consequently, current users of our ABPEs include expert analysts and inquiring citizens who primarily wish to compare these against our official mid-year population estimates.

We are working towards our ABPEs becoming accredited official statistics. Once accredited, the number and types of users are likely to grow to include all current users of official mid-year population estimates including:

Central and local government and the health sector

For planning and monitoring service delivery, resource allocation and managing the economy.

International organisations

Used by organisations such as the United Nations to contribute to international measures of the population.

ONS teams

Population estimates are used:

- directly as a base for other population statistics, such as our population projections and our population estimates for the very old
- to produce population estimates for lower geographical levels and alternative geographies
- for weighting survey estimates such as those from the Labour Force Survey (LFS) and other social surveys to ensure they are representative of the total population (adjusted to remove persons living in communal establishments where necessary)
- for denominators for rates and ratios relating to population, health, crime, and the economy

Private sector including commercial companies

For market research.

Researchers

Including academics, demographers, and special interest groups to explore trends and for research purposes.

Information on the methods we use to engage with our users and stakeholders is available in Section 5, under the subheading "Relevance".

Strengths and limitations

Strengths:

Overall, for 2021, our ABPE for England and Wales is 0.2% lower than the official census based mid-2021 population estimate; differences vary by local authority, for 96% of areas there was a difference of 0.8% or less.

Timely provisional ABPEs are usually published around six months after the reference period. They are produced using incomplete data alongside some assumptions about migration. Improved updated estimates are usually provided around 12 months after the reference period. These use additional data that have become available.

ABPEs are subject to uncertainty related to the measurement of population stocks at specific points in time and the components of population change over time. Calculated from the model-based estimation approach, credible intervals, as explained in Section 8: Glossary, give the range of plausible values and illustrate the uncertainty around the estimates. The probability that the true value lies in the credible interval is 95%.

ABPEs are produced using independent population stocks for each year, which reduces the increase in uncertainty as we move further away from a census. This is a known limitation of the current mid-year population estimate methodology which simply "rolls forward" our census-based population estimates.

Limitations:

ABPEs are official statistics in development while we refine our methods and the data sources used. They should not be used for policy or decision making.

ABPEs represent the usually resident population and so do not include daytime populations, such as day-trip visitors or short-term visitors.

Our current proxy coverage adjustment method for population stocks uses census data. We are currently exploring methods using administrative data sources for coverage adjustment. Work to date has focused on applying dual system estimation (DSE) to available administrative sources as a possible approach. DSE is a well-recognised and established approach typically used to ensure that estimates resulting from a census have maximum coverage. It uses a coverage survey following the census to estimate how many people responded. We are currently considering if a similar method could be applied with different sources of administrative data. Further work could cover approaches such as multiple system estimation, use of additional administrative sources and potentially the use of surveys. In the meantime, we will continue to use Census 2021 results to apply coverage adjustment to the ABPEs and will continue consulting with methodological experts as we develop our methods.

The estimation process models migration as combined in-flows and combined out-flows for each local authority in England and Wales. These combined flows then need to be disaggregated to provide estimates of international, internal, and cross-border flows. Disaggregated migration flows data will be published in the future once we have had more time to develop and quality assure our methods and the resultant estimates.

Our ABPE methodology is not designed to produce estimates for geographical breakdowns below local authority level; Small Area Population Estimates in the transformed population estimation system: methods development explores possible alternative approaches.

Research into credible intervals showing the uncertainty around aggregate estimates combined across local authorities, age and sex is ongoing. In July 2024, our published dataset provided estimates of uncertainty at the local authority level for 2011 to 2023.

Recent improvements

Improvements in methods or data sources are documented in our Dynamic population model, improvements to data sources and methodology Articles.

5 . Quality characteristics of the admin-based population estimates for England and Wales data

This section provides information about the quality and characteristics of the data and identifies potential issues.

Relevance

The degree to which the statistical outputs meet users' needs.

The Office for National Statistics (ONS) compiles and publishes population estimates for England and Wales, and all of the UK. Population estimates for the UK are compiled using estimates for England and Wales produced by the ONS, estimates for Scotland produced by National Records of Scotland (NRS), and estimates for Northern Ireland produced by the Northern Ireland Statistics and Research Agency (NISRA).

Methods for producing UK estimates in the future are being considered in collaboration with NRS, and NISRA.

How users perceive and use our estimates is measured by:

- sharing our progress and seeking feedback through groups, including the Central Local Information Partnership (CLIP), the UK Population Theme Advisory Board (chaired by ONS and including representatives from academia, the Welsh Government, NRS and NISRA), the British Society of Population Studies (BSPS), Administrative Data Research UK (ADR UK), and the Royal Statistical Society (RSS).
- engaging with users and stakeholders through conferences and webinars
- engaging with local authorities to assess the quality and impact of our ABPEs, as well as asking for local insights and data sources to help us improve our methods
- asking for feedback through consultations, and in all our publications, and having queries sent to pop.info@ons.gov.uk, provides us with a good understanding of user needs

Our consultation on the Future of Population and Migration Statistics (FPMS) for England and Wales from 29 June 2023 to 26 October 2023 has captured user feedback on our proposals for the development of our population and migration statistics. Our consultation update (PDF, 163KB) details the number of consultation responses by sector, and outlines how we engaged with users both before and during the consultation. It also explains how we have carried out our analysis of the responses. Our formal response will be published later in 2024.

This valuable feedback, received through a range of engagement activities, continues to guide our work. We continue to explore and include further opportunities for user feedback to understand how to best meet their needs.

We are working towards our admin-based population estimates (ABPEs) for local authorities in England and Wales becoming accredited official statistics. Methods to create ABPEs for geographical areas smaller than that of the local authority level continue to be explored.

ABPEs provide timely provisional estimates of the usual resident population for England and Wales around six months after the reference period. Improved updated ABPEs are usually provided around 12 months after the reference period, when more data are available.

Our Published Admin-based population estimates for local authorities in England and Wales datasets are designed to be easy to use and in a machine-readable format. The datasets allow users to look at populations split by components of population change, by age and sex for any local authority. As we continue to develop our ABPEs, we will explore dissemination approaches to enable users to create bespoke datasets covering the specific age groups, sexes, areas, and time periods they require. We will engage with users to ensure our outputs best meet their needs.

ABPEs cover the usually resident population, and so do not include daytime populations such as day-trip visitors or short-term visitors. Our Population and migration estimates - exploring alternative definitions: May 2023 article considers new ways of estimating the population to enhance our existing statistics.

Accuracy and reliability

Accuracy is the degree of closeness between an estimate and the true value. Reliability is the closeness of the initial element value to the subsequent estimated measure.

The dynamic population model (DPM), which produces the admin-based population estimates (ABPEs) uses a well-established demographic approach called the cohort component method, explained in our Population estimates methods guide. A wide range of data sources feed into the estimation process, which incorporates statistical modelling to take account of underlying demographic trends and allow for differing levels of coverage and uncertainty associated with the input data.

The DPM acts to balance the available information on the usual resident population at specific points in time (population stocks) with information about changes in population over time (population flows) to produce a coherent set of estimates. If a substantial change in one component is not reflected in other components, for example if a change in migration is not reflected in the population stock, then the model will consider the relative strength of each component and take this into account.

Population stocks provided to the DPM are produced independently for each year, which reduces the increase in uncertainty as we move further away from a census. This is a known limitation of the current mid-year population estimate methodology.

The DPM produces a sample distribution of potential population and migration counts, representing a set of plausible values, given the uncertainty of the inputs. The numbers of births and deaths come from administrative registers and are considered reliable, so are treated as exact counts throughout the whole estimation process. Our best estimates for population, combined emigration and combined immigration are the average (mean) value from the distribution of population and migration counts produced by the DPM.

Credible intervals provide the range in which the true value of each population and migration estimate is likely to be contained. The lower and upper bounds of the credible interval are taken to be the 2.5th and 97.5th percentiles respectively, from the distribution of counts produced by the estimation process. Using the credible intervals, we can say that the probability that the true value lies in the credible interval is 95%. Credible intervals are not provided for births and deaths as these are treated as exact counts.

Credible intervals are provided for each age and sex within each local authority. They cannot be aggregated to provide credible intervals across combined groups. We are developing methods that enable estimates of uncertainty at all levels of aggregation. Our accompanying July 2024 dataset includes estimates of uncertainty at the local authority level for 2011 to 2023. For mid-2023, credible intervals were less than 5% of the ABPE in 72% of local authorities, and less than 7% of the ABPE in 97% of local authorities.

Our Transforming population statistics, comparing 2021 population estimates in England and Wales article , published in February 2023, evaluated the quality of our admin-based estimates. At the England and Wales level, our "future" admin-based estimates for 2021 were within 0.6% of the Census 2021-based mid-year population estimates. Unlike our published ABPEs, the "future" estimates do not use census-based mid-year estimates for the population stock in 2021. These "future" estimates give an indication of the level of quality users can expect from our ABPEs. However, census data was used in our proxy coverage adjustment approach while we develop our future method.

Stakeholder feedback is valuable in informing how we improve the accuracy of our admin-based estimates. Our Local population statistics insight feedback framework enables users of population statistics to provide feedback at local authority level and suggest data sources for us to better understand the quality of our estimates.

Coherence and comparability

Coherence is the degree to which data derived from different sources or methods, but referring to the same topic, are similar. Comparability is the degree to which data can be compared over time and domain, for example, geographic level.

Users may compare admin-based population estimates (ABPEs) for individual local authorities with other data sources, for example, administrative records or anecdotal evidence. Comparisons between data sources should be treated with caution, as there are often definitional differences in the data collected. For example, whether the data differentiate between long-term or short-term migration, or whether they account for individuals who have left the country or local authority. Also, other data sources may cover only a subset of the population or measure daytime populations rather than the usual resident population.

The different methods used to produce the ABPEs and the official mid-year population estimates mean that we do not expect these two sets of estimates to be the same. Differences are expected to increase as we move further from a census, as the reliability of the mid-year population estimates reduces over the decade between censuses.

Our methodology article published in June 2023 showed that between 2011 and 2021, the level of uncertainty increased at a much slower rate for ABPEs, compared with mid-year population estimates. For mid-year population estimates, uncertainty accumulates over time as you roll forward from a census. However, for the ABPEs, we include an independent population stock estimate each year. This allows the uncertainty of the ABPEs to be more stable over time.

ABPEs for the UK are not yet available, but methods for producing these in the future are being considered. We are working with the devolved administrations, to ensure population and migration estimates remain coherent across the UK.

Official statistics in development of international migration estimates are included in the dynamic population model (DPM). The model balances input data on population stocks and flows to produce a coherent set of estimates of the population and the components of population change. The estimation process takes account of differing levels of coverage and uncertainty associated with the input data and underlying demographic trends. As a result, estimates of international migration provided as part of the ABPE components of change will differ from the official estimates feeding into the DPM.

Estimates of births and deaths used to calculate the ABPEs are based on live births and deaths that occur during the year to the mid-year reference point, irrespective of the date when they were registered. These can differ slightly to those used in other Office for National Statistics (ONS) births and deaths statistics if the reporting periods differ (calendar year rather than mid-year). Estimates can also differ if the figures represent the number of events registered rather than the number that occurred.

The way in which England and Wales is subdivided into local areas is subject to change. Each ABPE release uses the latest geography boundaries available at the time of production. For this reason, ABPEs produced at different points in time may not have comparable geographical boundaries. The geographical boundaries used in each release will be clearly stated within the published datasets.

A fully comparable time series of ABPEs for 2011 to 2023 was published in July 2024 and takes account of methodological improvements and new and updated data sources. These include new estimates for migration; this supersedes and is not comparable with previous series.

Our methods make the best use of available data to produce the best possible statistics at a point in time. Provisional estimates are released with the expectation that they will be revised and updated as further and more complete data become available. Our population and migration revisions policy (May 2022) provides more information on why we make revisions. We will review the policy to provide clarity and transparency for users as we transition to providing ABPEs. We welcome feedback on this policy.

Official mid-year population estimates are currently used across the UK. They are used as a base for other publications, for weighting surveys, and as a denominator for various rates and ratios relating to population, health, crime and the economy. We will ensure coherence across the population statistics system as we work towards our ABPEs becoming our future official population estimates.

Accessibility and clarity

Accessibility is the ease with which users can access the data, also reflecting the format in which the data are available and the availability of supporting information. Clarity refers to the quality and sufficiency of the release details, illustrations and accompanying advice.

The articles in our Admin-based population estimates series consist of a combination of narrative, charts, and graphs and can also be downloaded in PDF format. Data are provided in usable formats such as CSV and Excel. We are considering the best way to meet user needs for customisable data and analysis for when we transition to making ABPEs our official population estimates.

Our Transforming the way we produce statistics video on YouTube provides a high-level overview of the Dynamic Population Model (DPM) and is also available as a Welsh language video and a British sign language video.

Any additional enquiries regarding the ABPEs can be made by email at pop.info@ons.gov.uk or by telephone on +44 1329 444661.

For information regarding conditions of access to data, please refer to the following web pages:

- our terms and conditions web page (for data on the website)
- our accessibility statement web page
- the UK government's copyright and reuse of published data information
- our freedom of information web page
- our requesting statistics web page

Timeliness and punctuality

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

To maintain the timeliness of our admin-based population estimates (ABPEs), the data sources used are the best available at the time of production. Timely provisional ABPEs are usually published around six months after the reference period. They are produced using incomplete data alongside some assumptions about migration. Improved updated estimates are usually provided around 12 months after the reference period. These use additional data that have become available. Typically, our current official mid-year population estimates have a 12-month lag between the reference period and their publication.

The time lags for provisional and updated ABPEs reflect the availability of the data sources that measure the components of population change over the year preceding the estimate and the time required to process the data, and calculate, quality assure and analyse the estimates.

For more details on related releases, the UK government's research and statistics release calendar provides 12 months' advance notice of release dates. In the unlikely event of a change to the pre-announced release schedule, public attention will be drawn to the change, and the reasons for the change will be explained fully at the same time, as set out in the Code of Practice for Statistics, published on the UK Statistics Authority website.

Concepts and definitions (including a list of changes to definitions)

Concepts and definitions describe the legislation governing the output, and a description of the classifications used in the output.

Although the population estimates are not explicitly required by law, their production is consistent with our duty under Section 5 of the Census Act 1920 (as explained on our web page) to collect and publish "any available statistical information" with respect to the number and condition of the population between censuses.

Our admin-based population estimates (ABPEs) are consistent with the standard UN definition for population estimates, which is based upon the concept of usual residence and includes people who reside, or intend to reside, in the country for at least 12 months, whatever their nationality. Visitors and short-term migrants (who enter or leave the UK for less than 12 months) are not included. Students are taken to be resident at their term-time address.

Members of His Majesty's Armed Forces stationed in England and Wales are included at their place of residence but those stationed outside England and Wales are excluded. Members of the US armed forces and their dependants stationed in England and Wales are included.

The usually resident population does not always coincide with the number of persons to be found in an area at a particular time of day or year. The daytime populations of cities and the summertime populations of holiday resorts, for example, will normally be larger than their usually resident populations.

Geography (including list of changes to boundaries)

Our admin-based population estimates (ABPEs) for England and Wales are published on the latest available local authority boundaries in place at the time of production. The geographical boundaries used in each release are clearly stated. When changes occur to local authority boundaries between releases, a list of the areas affected is included in the relevant published datasets.

The ONS Open geography portal provides information on local authority boundaries over time.

Why you can trust our data

The Office for National Statistics (ONS) is the UK's national statistical institute and the largest producer of official statistics in the UK. It is the executive office of the UK Statistics Authority and is independent of ministers, reporting through the Authority to the UK Parliament and the devolved legislatures.

ONS statistics are crucial for effective debate and decision-making in government, industry, academia or by private individuals. In line with the Statistics and Registration Service Act 2007 and the supporting Code of Practice for Statistics, the statistics we produce are designed to meet the wider public good as well as the needs of government.

Our admin-based population estimates (ABPEs) are produced using the best data sources available and methods that are rigorously scrutinised by experts, both within and outside of the ONS. More detail is available in Section 6 , under the subheading, "How we review and maintain the data processes". Methods and data sources are regularly reviewed, and improvements are made where possible.

Comprehensive processing checks are applied by both suppliers and the ONS. Data suppliers are contacted when unusual patterns are found in data, which feeds into the ABPEs. Our Data source overviews provide summary information on the data sources, which feed into the Dynamic Population Model (DPM), and provide links to more detailed quality information.

The DPM has been developed using a free software environment for statistical computing, known as "R". Pre-processing of all input data also uses R coding. This ensures that consistent processes are followed during each production cycle, unless changes are purposefully introduced.

Staff are encouraged to apply "curiosity" while conducting pre-processing and processing checks, and quality assurance on the resultant estimates. Large changes, anomalies and outliers are scrutinised. This ensures both inputs and outputs are rigorously checked by multiple people and that changes over time are plausible. Work is also conducted throughout the year to look at wider changes in local authority characteristics to understand how this might affect the estimates over time. An example of this is examining changes in the number of communal establishments and houses.

The ONS has a proven track record of protecting sensitive data. This has been built over many decades of delivering the census in England and Wales and the UK's biggest regular household surveys. For more information, see our Data strategy web page.

We protect administrative data to the same high standards as census data. It is a legal duty to maintain confidentiality under the Statistics and Registration Service Act 2007 and the Data Protection Act 2018. Strong sanctions are in place to stop anyone from disclosing or seeking to disclose personal data.

Access to person identifiers, such as name and detailed address, are restricted to a small number of ONS employees. Once data are linked, person identifiers are removed from the data used for wider statistical analysis.

All our procedures, systems and staff protect both the data and confidentiality by law, so no one can be identified from the statistics we publish.

6 . Methods used to produce the admin-based population estimates for England and Wales data

How we collect the data, main data sources and accuracy

Data used to create the admin-based population estimates (ABPEs) are obtained from a variety of organisations. The quality of data acquired from external sources are assured through memoranda of understanding. Any concerns relating to data quality are raised and investigated using the appropriate governance forum.

The data sources used to produce the ABPEs can vary based on availability. The specific data sources used to create each individual set of ABPEs are detailed within our published accompanying datasets.

More generally, the Statistical Population Datasets (SPDs), which provide the population stock for each year are created by combining a variety of data sources including:

- tax and benefits datasets
- health datasets
- education datasets covering schools, further education and higher education
- prisoner's data
- birth and death registrations

Our research paper Statistical Population Dataset version 4: Research to Date and Future Developments (PDF, 474KB), published in May 2023, provides more detail on the SPDs.

Our methods to produce the ABPEs are not reliant on census data. However, census data do currently feed into the estimation process. Census-based, mid-year population estimates for 2011 and 2021 are used as population stocks as they represent the best available stock for these years. Census data for 2011 and 2021 are also used in our proxy coverage adjustment method for the population stocks while we explore methods for coverage adjustment using administrative data sources.

Data estimating population flows also feed into the estimation process and include:

- counts of live births and death registrations recorded by the General Register Office
- estimates of internal migration and cross-border flows: these are primarily based on Personal Demographics Service (PDS) data which flags when people change their address with their doctor. The methods and all the data sources used are described in our Population estimates methods guide.
- estimates of long-term international migration: these are based on different data sources and methods for each nationality grouping. Methods and data sources are described in our Methods to produce provisional long-term international migration estimates.

Our Data source overviews provide more information on the administrative data sources used to estimate the population stocks and flows. They cover why the data sources are important, their coverage of the population, and their data quality.

The data sources used are not designed to be tools for creating population statistics. To show how we ensure they remain fit for purpose, quality assurance of administrative data (QAAD) reports are published detailing how the data are collected, their quality, strengths, and limitations. Additional QAADs are being developed to ensure all data sources which are used to produce the ABPEs are covered.

How we process the data

The dynamic population model (DPM) has been developed in a free software environment for statistical computing, known as "R".

Pre-processing of input data is also conducted using R and data are quality assured before the estimation process is run. These tasks broadly involve:

- formatting input data
- calculating and smoothing population flow rates
- providing estimated coverage levels for population stocks
- providing measures of uncertainty relating to the input data

The dynamic population model (DPM), which produces the ABPEs uses a Bayesian demographic accounts framework, which creates consistent demographic estimates from multiple imperfect datasets.

Within the Bayesian demographic accounting framework, data models attempt to capture biases, coverage errors, lags and other imperfections in the measurement processes related to a dataset. Allowing for one or more unreliable datasets gives us much more flexibility than requiring a single perfect dataset.

Statistical models take account of underlying demographic trends present in the population flow rates (system models). Published in February 2023, the Design and Implementation of the Dynamic Population Model (PDF, 1,343KB) technical paper provides more technical detail on:

- the Bayesian demographic accounting framework
- how system models summarise underlying demographic trends
- how data models summarise the quality of the data sources
- how we estimate the hyper-parameters for the system models for births, deaths, in-migration, and out-migration
- the data models used for population stocks

The Laplace approximation method is used to derive the distribution of migrant counts, which is then used to generate a sample of potential population and migration counts, reflecting the many possible ways to balance the input data.

We are working towards implementing reproducible analytical pipelines (RAPs) and unit testing in our statistical processing. These automated statistical and analytical processes ensure that estimates are reproducible, auditable, delivered efficiently and are high quality.

We plan to publish a methods guide in summer 2025, which will provide a detailed explanation of how our ABPEs are produced.

Our Articles outlining improvements to data sources and methodology used to produce our most recent ABPEs are available on our website. There is also a June 2023 article and a February 2023 article available.

How we analyse and interpret the data

ABPEs and the associated components of change output from the DPM are entered into a Power BI dashboard. This dashboard is used to quality assure and analyse the estimates and components of change. Visualisations at national, regional, and local authority level enable changes over time and between population subgroups to be explored. The estimates are also compared with alternative data sources, currently the mid-year population estimates. Data are analysed extensively as part of the quality assurance process and to provide users with meaningful commentary, which includes how the population is changing and the main trends affecting population change.

How we quality assure and validate the data

ABPEs are rigorously quality assured at all stages of production. Specific procedures include:

- communicating with data suppliers to improve and confirm our understanding of the data, their quality assurance checks and the reliability of the data
- processing the input data to check that any values that seem abnormal are valid
- building regular quality assurance checks into the processing and estimation process to ensure it is working as it should
- scrutinising trends in other data sources that can be considered signal data
- once the data are compiled, looking at how changes in components relate to one another, and the overall population change
- comparing estimates with alternative sources to check plausibility and detect outliers
- checking output datasets to ensure there are no errors or inaccuracies in published data
- consulting demographic experts who scrutinise the estimates and further explore estimates where necessary
- further analyses as other data sources and feedback from users become available throughout the year

Each round of ABPEs is reviewed before publication. This is carried out by demographic experts within the Office for National Statistics, who review our analysis from a different perspective to consider plausibility of changes over time and any outliers.

Throughout the year, we also look at wider changes in local authority characteristics, for example changes in the number of communal establishments and houses, to understand how this might affect the estimates over time.

How we disseminate the data

ABPEs are published free of charge on the Office for National Statistics (ONS) website under the terms of the Open Government Licence.

Publication dates are planned in advance and pre-announced on our release calendar at least four weeks before the agreed date.

Stakeholders are alerted to new releases through various media channels. Each release includes an article that provides commentary to help users understand patterns, changes over time and compare with official mid-year population estimates. Data are published in our accompanying dataset.

We are considering the best way to meet user needs for customisable data and analysis for when our ABPEs become our official population estimates.

7 . Other information

Useful links relating to admin-based population estimates (ABPEs), the dynamic population model (DPM) and transforming population statistics are available.

- Our Understanding mid-year admin-based population estimates for local authorities in England and Wales
- Our Admin-based population estimates articles
- Our Dynamic population model, improvements to data sources and methodology articles
- Our Dynamic population model for England and Wales: July 2022
- Our How our population and migrations statistics are evolving article
- Our Consultation on the future of population and migration statistics in England and Wales
- Our Transforming population statistics, comparing 2021 population estimates in England and Wales

Other information relating to population statistics is available.

- Our Mid-year population estimates for the UK and its constituent countries: releases
- Our Mid-year population estimates QMI
- Our Population estimates for England and Wales, mid-2022: methods guide
- Our Admin-based long-term international migration estimates QMI
- Our Births in England and Wales QMI
- Our Mortality statistics in England and Wales QMI
- Our Overview of the UK population
- Our Census 2021 web page
- Our 2011 Census web page
- ONS Geoportal
- The National Records of Scotland's Mid-year population estimates for Scotland
- The Northern Ireland Statistics and Research Agency's Mid-year population estimates for Northern Ireland

8 . Glossary

Administrative data

Collections of data maintained for administrative reasons, for example, registrations, transactions, or record keeping. They are used for operational purposes and their statistical use is secondary. These sources are typically managed by other government bodies.

Accredited official statistics

Official statistics that have been independently reviewed by Office for Statistics Regulation (OSR) and confirmed to comply with the standards of trustworthiness, quality and value in the UK Statistics Authority's Code of Practice for Statistics. OSR introduced the term "accredited official statistics" to describe National Statistics in September 2023.

Coverage errors

A coverage error occurs when a member of the population is not counted (undercoverage), is counted more than once (overcoverage) or is counted in the wrong location.

Credible intervals

The range in which the true value of the quantity being estimated is likely to be contained. In Bayesian statistics, credible intervals (GitHub) are an important concept. We use 95% credible intervals in this article by taking 2.5th and 97.5th percentiles from the distributions of counts produced by our estimation process as the lower and upper bounds of our intervals, respectively. In this case, we can say that the probability that the true value lies in the credible interval is 95%.

Dynamic population model (DPM)

A statistical modelling approach that uses a range of data to measure the population and population changes in a fully coherent way.

Official statistics in development

Official statistics that are in the testing phase and not yet fully developed. The Office for Statistics Regulation provides a more detailed explanation of official statistics in development on their website.

9 . Cite this QMI

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