United Nations | Department of Economic and Social Affairs

Population Division
Technical Paper No. 2020/01
September 2020

Data and methods for the production of national population estimates: An overview and analysis of available metadata*

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Abstract

Official population estimates can be produced using a variety of data sources and methods. These range from the direct extraction of information from continuously updated population registers to procedures for updating the status of a population enumerated previously in a periodic census. Additional sources and techniques involve the use of sample surveys or complementary sources of headcount statistics for specific age groups (e.g., immunization records, school enrollment statistics, electoral roll data). In all cases, the objective is to derive regular (typically annual) time series of the estimated size of a population classified by age and sex. Some methods and data sources are considered preferable, as they are more likely to produce internally consistent and reliable estimates. In all cases, the data and methods used to produce population estimates should be clearly documented and made readily available to data users. These metadata are essential for interpreting properly and for assessing the accuracy and reliability of population estimates and their suitability for informing policy formulation and implementation at the national level. Access to such metadata is especially important if population estimates are being used for comparative purposes at the global level.

This paper offers a concise review of the methods that are commonly used by national statistical offices to produce annual time series of population estimates by age and sex. These methods depend on the availability of two essential components: an initial population count and a method of time adjustment. Both components play a crucial role in determining the overall quality of a set of population estimates. The paper formulates specific recommendations concerning best practices for the production of official population estimates. Drawing on information from various sources used by the United Nations to produce its biennial edition of global population estimates, the *World Population Prospects*, the paper also provides (in the appendix) an overview of data availability and current practices in the production of official population estimates around the world.

Keywords: Official statistics, population estimates, data quality, data availability, metadata

Sustainable Development Goals: 16, 17

* The current version benefits from the inputs and feedback from Patrick Gerland, François Pelletier, Frank Swiaczny, and John Wilmoth. A special acknowledgment is made to the contribution of Minja Chen in recoding and analyzing the metadata information provided to the Statistics Division of UN DESA.

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CONTENTS

The Population Division of the Department of Economic and Social Affairs provides the international community with timely and accessible population data and analysis of population trends and development outcomes. The Division undertakes studies of population size and characteristics and of the three components of population change (fertility, mortality and migration).

The purpose of the **Technical Paper series** is to publish substantive and methodological research on population issues carried out by experts both within and outside the United Nations system. The series promotes scientific understanding of population issues among Governments, national and international organizations, research institutions and individuals engaged in social and economic planning, research and training.

Suggested citation: Spoorenberg, Thomas (2020). *Data and methods for the production of national population estimates: An overview and analysis of available metadata*. United Nations, Department of Economics and Social Affairs, Population Division, Technical Paper No. 1.

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1. INTRODUCTION

High-quality, transparent information is needed to support and inform public policy formulation and decision-making. Providing information in an objective, transparent and independent manner is therefore important to achieve and maintain public trust in official statistics.

Obtaining accurate and reliable information about a country's population is important not only to determine its size and understand other characteristics such as age, sex, residence, education, labor force status, occupation and other attributes, but is useful as well for policy formulation and evidence-based decision-making and to monitor progress towards achieving the universally recognized and internationally adopted Sustainable Development Goals (SDGs). While all these characteristics are important, determining accurately the size and structure of the total population is essential, because it affects the accuracy of many, if not all, of the other variables (Commission on Population and Development, 2016a, 2016b). Therefore, it is imperative that the estimation of the size and composition by age and sex of a country's population be conducted with standard/agreed upon procedures.

Global efforts have been pursued to guarantee that official information released by statistical organizations meet minimum quality standards (UNSD, 2019a). In the area of the production of official population estimates,[1] several guidelines are available since the 1950s (United Nations, 1952, 1955, 1956) with more specific principles and recommendations for censuses and vital registration that have been revised over time (UNSD, 2014, 2017, 2019b). The compliance to these best practices is recommended, especially if official data are to be used for international comparative purpose. It is therefore important that countries follow standards in producing official estimates and in providing sufficient metadata about those estimates.

At the international level, the United Nations Statistics Division (UNSD) is responsible for collecting, organizing and disseminating official population statistics. Official population estimates are collected by UNSD through annual questionnaires sent to national statistics offices. The collected data are published in the *Demographic Yearbook* collection on an annual basis.[2] In addition to numerical population figures, UNSD gathers also metadata documenting the methods used by countries in constructing their latest population estimate. Such data allow us to draw several conclusions about the global situation in terms of data availability, estimates by period, and the methods used to produce official population estimates. In addition, such information is very useful to assess the reliability of the estimates made available by national statistics offices. UNSD (2018a: 51) defines as reliable data estimates that "are based on a complete census (or a sample survey) and have been adjusted by a continuous population register or on the basis of the calculated balance of births, deaths and migration."

When producing its biennial collection of population estimates and projections for successive revisions of the *World Population Prospects*,[3] the Population Division of the United Nations Department of Economic and Social Affairs utilizes various types of data sources, such as population censuses, civil registration data, population registers and sample surveys, as well as official population estimates. In the

[1] "Official population estimates" will be used herein to refer to the official statistics pertaining to the size and structure by age and sex of the population that are produced by national governmental institutions (usually the national statistics office).
[2] https://unstats.un.org/unsd/demographic-social/products/dyb (last accessed 20 February 2020).
[3] https://population.un.org/wpp/ (last accessed 9 September 2020).

absence of a recent census or a population register, official population estimates often provide the most up-to-date information on the population of a country. It is therefore essential that the official estimates be produced using consistent methods and accompanied by sufficient information about sources and methods for the estimates to be considered for inclusion in the revision process.

This paper provides an overview of different practices and principles for producing official population estimates. After recalling some general principles regarding demographic accounting, two components that are required for the production of official population estimates are presented (i.e., an initial population count and a method of time adjustment). We then turn to the factors affecting the quality of the initial population count and of the time adjustment methods used to derive the most recent estimates, and how these two components influence the quality and reliability of the estimates. The different methods used to produce official population estimates are then reviewed, starting with the 'gold standard' method (i.e., a complete and continuously updated population register) and ending with the situation where no information is provided about the data or methods used to generate the official estimates. To conclude, the paper reiterates the importance of making available, in a transparent manner, the information and methods utilized to produce the official population estimates.

2. GENERAL PRINCIPLES

2.1 THE GENERAL BALANCING DEMOGRAPHIC EQUATION

According to the general balancing demographic equation, the size of a population at a given time is the sum of the 'entries' and 'exits' from the same population at a previous time. Changes in the number of births and deaths, as well as the arrivals of immigrants and departures of emigrants, modify the size of a population.

The size of a country's population at a given time (*Pt*) can be determined by the following equation (1):

$$P_t = P_i + (B - D) + (I - E) \quad (1)$$

With P_i, the initial population count;

B, the number of births since the date of the initial population count;

D, the number of deaths since the date of the initial population count;

I, the number of arrivals since the date of the initial population count;

E, the number of departures since the date of the initial population count.

The data required to determine the population at a given time can be available at the total/aggregated level only, but it is better to have those by age and sex in order to be able to estimate a population that is consistent along cohorts and to provide consistent population distribution by age and sex. A population is in a constant state of flux and it is incorrect to assume that the population distribution by age and sex remains unchanged through time. As demographic behaviors change over time, and differ by age and sex (e.g. people get older over time; women can have children over a specific age span; mortality risks are distinct between children, young adults, and older persons, as well as by sex; migration concerns mainly young adults and to a lesser degree young children or older persons, etc.), special care and effort should therefore be placed in estimating official population figures that are consistent by age and sex and cohorts. The cohort-component method shall be preferred as it ensures internal consistency by age and sex and over time by cohort, and between the three demographic components of change (fertility, mortality and net migration) and the population that is estimated for a specific date.

2.2 TWO COMPONENTS TO PRODUCE OFFICIAL POPULATION ESTIMATES

Producing an official population estimate requires two components:

a) an (accurate) initial population count (or base data) and;

b) a method of time adjustment by which the initial population count is brought up to date.

2.2.1. Initial population count

Several sources can be used to obtain an initial population count: [4]

a) a continuous population register;

b) a complete census enumeration;

c) a sample survey;

d) a partial census or registration of individuals;

e) any kind of alternative conjecture/count variable (non-censal count); or

f) a conjectural estimate derived by means other than counting.

Among the various sources, a continuous population register or a complete census enumeration are the recommended options to obtain an initial population count as reliable as possible.

The time elapsed since the last measurement of the initial population count can vary across countries. Some countries conduct population censuses[5] or update their population register at regular intervals, while in other countries population censuses have not been conducted for several decades or population registers are updated only seldomly. In any cases, it is imperative that the initial population count is brought up to date by a method that is accounting as accurately as possible for the changes that have occurred in the demographic components. In settings where censuses have not been conducted regularly or where population registers are not regularly updated, the method used to update the initial population count will determine the quality of the official population estimates. Before using the initial population count as source for the official population estimate, special care should be placed in the evaluation and proper adjustment, if needed, of the initial data (see section 3).

2.2.2 Method of time adjustment

Several methods can be used to adjust the initial population count to a given date. The initial population count can be adjusted by: [4]

a) a continuous population register;

b) the balance of births, deaths and migration;

c) an assumed rate of population change;

or in some cases:

d) not be adjusted at all (initial population count is kept constant); or

[4] This list is based on the metadata that countries are asked to provide annually to the United Nations Statistics Division in its questionnaire on population estimates. This information is used by the Statistics Division to produce the United Nations *Demographic Yearbook*. The questionnaire is available at: https://unstats.un.org/unsd/demographic-social/products/dyb/index.cshtml#questionnaires (last accessed, 20 February 2020).

[5] It is recommended to carry population census once per decade (UNSD, 2017); some countries carry them every five years, while some others have not conducted a census for more than 10 years.

e) no information is provided on the method of time adjustment.

For all types of method of time adjustment, the quality of the time adjustment depends on the proper accounting of the population balance. In the case the method of time adjustment is drawn from a continuous population register (2.2.2.a) or the balance of births, deaths and migration (2.2.2.b), the quality of that adjustment varies if the population balance: a) is adequately accounted for, b) is not adequately determined, but is assumed to be adequate, and c) is not adequately accounted for.

Similarly, the quality of the time adjustment based on an assumed rate of population increase (2.2.2.c) would depend on the availability and use of a) two or more censuses taken at decennial intervals or less, b) two or more censuses taken, but the interval between the latest two censuses exceeds a decade, and c) only one or no census.

Before reviewing some of these different categories, it is important to keep in mind that another series of factors can affect the quality of official population estimates.

3. FACTORS AFFECTING THE QUALITY OF THE INITIAL POPULATION COUNT AND TIME ADJUSTMENT

A series of factors can affect the quality of both the initial population count and the time adjustment method and consequently determine the quality and reliability of the official population that is estimated (United Nations, 1955).

3.1 QUALITY OF THE INITIAL POPULATION COUNT

3.1.1 Definition of the population

Before using a population estimate as initial population count, one should make sure that the definition of the population included in the initial population count is clear and consistent. As defined by the United Nations Statistics Division (2017: 186),

> "*In the broadest sense, the total [population] may comprise either all usual residents of the country or all persons present in the country at the time of the census. The total of all usual residents is generally referred to as the de jure population and the total of all persons present as the de facto population.*"

In practice, depending on national circumstances, it is oftentimes difficult to comply fully to either type of count.[6] Definitional changes (e.g. between de facto and de jure) can be difficult to adjust for unless the country collects and publishes enough data to compute both for the same date. It is important, therefore, to have a clear description of what groups of the population are included or excluded in the total count. A list of groups to be considered can be found in UNSD (2017: 187, section 4.87).

3.1.2 Geographic coverage

Change in the geographic coverage can give rise to inconsistencies between the initial population count and later official population estimates. In case a change in geographic coverage occurs between the time the initial population was counted and the time adjustment was made, the initial population count needs to be adjusted accordingly in order to account for the inclusion or exclusion of geographic areas in the official population estimates.

As accounted below in section 4.4, the population enumeration (register, census, etc.) can sometimes not include the whole area of a country. In the case some areas are not included in the initial population count, there is need to account by some means of the population living in these areas.[7] Any available administrative counts, survey data, prospective demographic reconstruction, satellite imagery, and the combination of any of these data sources can be used to estimate the population of these areas. Failure to account appropriately for the changes in geographic coverage contribute to patterns of over- or under-enumeration of the population and bias in official population estimates which should be fully documented as caveats.

[6] In most countries, differences between the population under each concept are greater at the subnational level due to internal migration.

[7] For example, the 2014 census of Georgia covered only 82 per cent of the whole area of the country. The census could not be carried out in the Autonomous Republic of Abkhazia and South Ossetia (GEOSTAT 2016).

3.1.3 Over-enumeration or under-enumeration

The completeness of the initial population count, including differentials by age and sex, as well a geographic coverage, can constitute a problem in many countries. Patterns of over- or under-enumeration by age and sex can distort significantly the initial population count and affect the quality of the series of official population estimates that are based on this initial count.

In the case when a census is used as the initial population count, it is recommended to conduct a post-enumeration survey (PES) shortly after the census (UNSD, 2010; 2017: 120-122). A post-enumeration survey is an independent survey that covers a sample of the population and tries to match the respondents to the respondents in the census. The purposes of the PES are to estimate the coverage of the census (what proportion of the population was enumerated in the census), by age and sex, if possible, and to study the differences in the characteristics of the respondents in the two data collection operations. The results from the PES are used to adjust the census data for statistical purposes, if needed.

The completeness of the enumeration can also be estimated by demographic analysis and/or by comparisons of the census data to various administrative data (e.g., electoral rolls, education statistics, immunization records, etc.). Various demographic techniques exist and can be applied, ranging from graphical evaluation of census data to more elaborated comparative analysis using two or more census age distributions (United Nations, 1955; U.S. Bureau of the Census, 1985).

3.2 QUALITY OF THE TIME ADJUSTMENT

In order to bring up to date the initial population count, it is required to update the initial population count for the changes that have occurred in each demographic component. Births and arrivals of immigrants that have taken place since the date of the initial population count should be added to the initial population, while deaths and departures of emigrants need to be subtracted from it. As much as possible, it is recommended to adjust the population by age and sex, and not only the total population, using the cohort component method, because mortality, fertility and migration vary across the ages and by sex. A population is in a constant state of flux that needs to be accounted for as best as possible in official population estimates. Updating only the total population, without accounting for the changes along cohort (i.e. not updating the age and sex structure of the population), or using simple cross-sectional age interpolations, produce population structures that are inconsistent and provide misleading information for public policy formulation and decisions, and especially for health and education services delivery to infants and children when the respective sizes of the birth cohorts change over time (as the average number of children per woman also decreases).

The quality of the time adjustment—i.e. the proper accounting of the population balance by age and sex between the initial population count and the date for which the official population is to be estimated—depends on the availability and quality of information or the formulation of assumptions consistent with the demographic changes since the date of the initial population count. Accounting for the changes in mortality, fertility and migration levels and age patterns through time should be conducted with special care and effort as it determines the quality of the population estimates by age and sex, and along cohorts.

The time between the initial population count and the date for which the official population estimate refers to influences also the quality of the time adjustment. In general, the shorter the time between when the population was counted and the date for which the official population is produced, the better the quality of the official population estimate. In the absence of sufficient information on demographic changes, longer

time intervals between the date of the initial population count and the date of the official population estimate can increase the chances of producing official population figures that are not accounting properly for the ongoing changes in mortality, fertility and/or migration.

While both the availability and quality of information and the time elapsed since the initial population count are important to determine the quality of the time adjustment, the method used to update the initial population contributes also to determine the quality of the official population estimates.

4. METHODS OF ESTIMATION

This section reviews different methods that are available to produce official population estimates.

Depending on the development of their statistical systems, countries present different amount and types of demographic information that could serve to produce official population estimates. This information differs also in its degree of accuracy and completeness.

4.1 OFFICIAL POPULATION ESTIMATES BASED ON CONTINUOUS POPULATION REGISTER

In countries with advanced statistical systems, a continuous population register, oftentimes coupled with migration records or estimates, allows for providing the size of the population with relatively high accuracy and completeness at any point in time (Poulain and Herm, 2013). In such bookkeeping system, each person has an individual record in the population; each birth adding a new record; and each death removing a record. As detailed by the United Nations (1952: 42),

"The individual records of a continuous population register thus follow each person from birth, through the major events in his/her life, such as marriage, divorce, and the birth of children, or changes of residence, until death. Addition of the number of live records, at convenient time intervals, results in a population count almost equivalent to a census; and if the register is well kept the population figures which it yields may be superior in quality to those obtained from the average census."

Continuous population registers should be distinguished from vital registration system "where records of births, deaths, marriages and divorces are kept at the locality of their occurrence (or at the residence of the persons concerned), these records, once made, being final." (United Nations, 1952: 42). However, in the current context of the increasing expansion of national identity systems, the continuous population register and the vital registration system are being progressively more integrated (UNSD, 2018b).

Population registers may also have some errors or omissions, and it is therefore recommended that they are checked and corrected by censuses at regular interval, or by comparison with tax returns, voters' list, school enrollment, immunization records, or any other independent system from which information on population count can be drawn. Such checks should be run to assure that the population given by the register is not under- or over-estimated and provide accurate information to estimate demographic indicators (e.g. Statistical Office of the United Nations, 1969; Monti and others, 2019).

4.2 OFFICIAL POPULATION ESTIMATES BASED ON POPULATION CENSUS

The official population estimate of a country is often estimated based on an adjusted/unadjusted population census that is adjusted to account for the changes in the number of births, deaths and net number of migrants (i.e., arrivals of immigrants and departures of emigrants) that have occurred since the date of the census.

The population enumerated during the census can be used as-is and not be adjusted, but it is recommended that the population enumerated be adjusted to account for coverage error (if any), and patterns of under- and over-enumeration that have been estimated by a post-enumeration survey (PES), demographic analysis (based on the availability of information on births, deaths and migration since the

census, or, in the absence of direct information on these components, on assumptions on the changes in these components since the census) or other techniques (UNSD, 2017).

Official estimates based on population census can be conducted at the level of the total population or in more details by estimating the population by age and sex.

4.2.1 Population census and vital registration system

In countries where the number of births, deaths and/or migration are available from a complete civil registration system, the official population estimates can be derived from updating the population enumerated at the census with the number of births, deaths and net migration. In doing so, proper care should be placed in the evaluation for completeness of the recording of vital events in the registration system.

In the case that information on migration is not available from the civil registration system, estimates of migration could be derived from other administrative sources (i.e. migration stocks, labor permits or visas, refugee statistics, etc.) or based on realistic assumptions. As the role of migration in population dynamics is becoming more important in an increasing number of countries, special care should be placed on the estimation of this component, otherwise information gaps on migration will affect the reliability of the population estimates.

4.2.2 Population census and demographic components derived from sample surveys

In the absence of a functioning and complete civil registration system, the population enumerated by the census can be updated using information on births and deaths collected by sample surveys.

Since the late 1970s, several large nationally representative household sample survey programs have been conducted to collect information on demography and health.[8] Coupled to other national survey initiatives, the corpus of these data allows to derive estimates of mortality and fertility rates for different time periods (UNSD, 2004). The reconstructed changes in these two components can be employed to update the census population count by applying the mortality and fertility rates to the initial population count.

Any new data becoming available should be assessed for quality and consistency and eventually be used to revise the changes in the number of births and/or deaths since the last census. These revised estimates of should serve to update the official postcensal population estimate.

Generally, the large survey programs do not provide any information regarding the estimation of net migration. Therefore, information on migration should be obtained from other sources (specific sample surveys, statistics on refugees, etc.) or based on assumptions informed by previous intercensal trend(s) in order to bring in a consistent way the initial population up to date.

4.2.3 Population census and demographic components derived from assumptions made on the changes in fertility, mortality and migration

In some cases, in the absence of civil registration system and/or sample surveys, the official population estimates can be derived from assumptions on the changes in fertility, mortality and migration that are used

[8] These international survey programs include the World Fertility Surveys (WFS), the Demographic and Health Surveys (DHS), and the Multiple Indicator Cluster Surveys (MICS).

to update the population derived from the census. These assumptions can rely on partial or no empirical basis and be based on changes observed in neighbouring countries or countries presenting similar demographic patterns.

One should make sure that the assumptions made are somewhat accounting for and consistent with the changes occurring in the country since the last census. Failure to account for important changes in the assumptions of demographic components can lead to erroneous population estimates that can affect development policy formulation and planning.[9]

4.2.4 Population census and assumptions made on the growth rate of the population

Some countries draw their official population estimates by updating the total population enumerated during the most recent census using only an assumption on the growth rate of the total population. Sometimes, the assumption is made that the population growth rate observed between the two most recent censuses, i.e. during the preceding intercensal period, remains constant and is applied to the most recent census population count to derive postcensal official population estimates. If the application of such method could provide realistic results in settings where mortality and fertility have remained stable for some time, the assumption of stable population growth rate leads clearly to an over-estimation of the population when, for instance, fertility has started to decline, as it is the case in most countries of the world.

If the population is available by age and sex from the two most recent censuses, growth rates could also be computed for each age group and sex, and a distribution of the population by age and sex could be obtained by applying these age- and sex-specific growth rates to the population enumerated in the last census. Such procedure is to be applied with extreme caution, however, because the age-specific population growth rates could present implausible trends that would produce inconsistent population structure.

In some cases, the distribution of the population by age and sex of the official estimate for a given year is obtained by applying the relative distribution of the last census to the adjusted total figure of the official population estimate. In doing so, the assumption is made that no change has occurred in the population's age structure since the last census. Deriving official population estimates by age and sex by assuming that the age structure of the census population remains unchanged in the years following the census is problematic; such practices are likely to return inconsistent age structure that can be misleading for policy formulation and decision-making. This problem may be even more acute when the period since the last census exceeds a few years, and the recent fertility has been changing rapidly leading to recent birth cohorts of different sizes than the previous ones.

In the case when three or more censuses are available, the trend in the population growth rate between censuses could be extrapolated and be applied to the most recent census population count to derive an official series of total population estimates for the years following the most recent census. The application of a similar procedure to obtain the distribution of the population by age and sex is to be used only with extreme caution, however, due to possible implausible trends in age-specific growth rates that would produce inconsistent population structure.

[9] A recent example is the case of Myanmar where, in the absence of a population census since 1983, official estimates put the population of the country to 62 million in 2012. This figure is about 10 million lower than the population enumerated in the 2014 population census. The official population estimates were based on outdated population projections that did not account properly for the changes in fertility and international migration (Spoorenberg, 2013).

In such situation, it is recommended to use the cohort-component method of population projection in order to derive more robust official estimates of population by age and sex rather than updating only the total population (United Nations, 1956).

4.3 Official population estimates based on sample surveys

In some cases, because the conduct of a traditional population census is not feasible due to various reasons (e.g. security issues, budget constraints, etc.), countries have relied on the use of sample surveys to estimate an initial population count. One of such sample surveys is the "rolling census"—an operation consisting of a continuous cumulative survey that covers the whole area of a country over an extended period of time (i.e. several years) (Kish, 1990; Durr, 2005). Rolling censuses can take various forms, however, and in some cases provide more detailed and up to date information only for some parts of a country or area.[10]

Some countries collect basic information for the whole population through a short census questionnaire and more detailed information through a long questionnaire administered only to a sample of the population enumerated (e.g., USA, China, Ethiopia). Alternatively, some countries have used population registers to obtain count data and draw population characteristics from sample surveys or other specific administrative sources.

As for the other methods, the quality of the official population estimate based on sample surveys would also depend on the method of time adjustment used to bring the population up to date. Similar methods of time adjustment (as discussed above) can be applied to the initial population count based on sample surveys.

4.4 Official population estimates based on a partial census or registration of individuals

A census can sometimes not be carried out in some areas of a country or a register system could also not cover some areas of a country. A partial census or incomplete population register can still be useful to derive an official population estimate if the population for the areas that could not be enumerated is estimated using another type of method.

The cartographic work and household listing conducted during the preparation phase of a census, or an address register in the case of an area not included in a population register, can serve for the purpose, for example by assuming an average household size.

Depending the size of the population living in areas not enumerated in a census or not included in a population register, and in the case the population in these areas present distinct demographic behaviours (e.g. higher/lower levels of infant and child mortality, higher/lower average number of live births per woman, etc.), these specificities need to be accounted for appropriately in the time adjustment of the initial population count.

[10] For example, given the difficulty to conduct a traditional census in the country, Afghanistan conducted a rolling census, the Socio-Demographic and Economic Survey (SDES) between 2011 and 2015, in one or more provinces at the time, that consisted in a full household enumeration and a detailed data collection for 50 per cent of the households.

Box 1. Revision of intercensal population estimates

When population figures from a new census are made available, it is common to observe a difference between the existing official population estimate for the census date and the population figure provided by the new census. The difference between the two population estimates is called the error of closure and is due to measurement errors in one or more of the demographic components over the intercensal period (i.e. non-accounting properly of changes in the levels, trends, and/or age patterns of mortality, fertility and/or migration), as well as census coverage error in the previous and/or new censuses.

In order to assure that previous postcensal official population estimates are consistent with the new census count, it is therefore recommended to revise the intercensal estimates (i.e. the population estimates for reference dates between two censuses). For this procedure to be as robust as possible, the new census data needs first to be adjusted for net under coverage.

The methods of time adjustment to update the initial population count based on partial census or registration of individuals are similar to those previously discussed.

Further information on the methods to revise intercensal population estimates can be found in European Commission (2003), Statistics Canada (2012), and U.S. Bureau of the Census (2012).

4.5 Official population estimates based on any kind of alternative conjecture/count variable

In the absence of population register or census, an official initial population figure can be estimated based on the use of alternative conjecture or count variable. A total population estimate can be derived from the application of an average household size to a count of households or buildings or be estimated by consolidating information drawn from immunization records, school statistics, election listings, government ID issuance counts, etc.

Alternatively, in some countries, official population estimates have been derived, either entirely or partly, by summing up local population reports that are centrally collected and consolidated. Oftentimes, it is not clear how the local population reports were established, and what their quality is, rendering difficult to evaluate the consistency of official population estimates derived from such approach.

The principle of estimating the national population from local figures (bottom-up approach) has gained renewed momentum recently with the increasing availability of fine-scaled satellite imagery, the collection of geo-referenced information in sample surveys, and the development in statistical methods and computational capabilities. The combination of these recent advances allows to derive detailed population estimates for areas or the entire country where population census and/or population register are not available (Wardrop and others, 2018). Despite its advantages, such hybrid methodology cannot replace the breadth of information a traditional population census can generate (UNFPA, 2017).

As for the two previous methods of estimation of official population figures, a method of time adjustment would need to be applied in order to determine the official population estimate for years after the initial population count.

4.6 CONJECTURAL ESTIMATE DERIVED BY MEANS OTHER THAN COUNTING

In some cases, the initial population count can be derived by means other than counting. Such conjectural estimate can be made based on pure or informed speculation, political dictate, etc. In general, under such cases, the information on which data or conjecture the initial population count is based is rarely made available.

Similarly, it is also generally not clear what method of time adjustment is used to update the initial population count.

5. TRANSPARENCY AND AVAILABILITY OF INFORMATION

Regardless of the nature of the initial population count and the method of time adjustment used to estimate an official population figure, it is important that national statistical institutions in charge of estimating such figures be as transparent as possible. Information on the type of the initial population count, on the kind of adjustment made to the initial data, as well as the method of time adjustment selected, used to determine the size and structure by age and sex of the official population estimate should be made easily available, and include as much as possible the associated metadata or relevant technical documentation. If no adjustments were made to an initial population count, the reasons guiding this choice (e.g. political reason, no funding to conduct a PES, no agreement on the correction factor, or if the initial population count is deemed complete) should also be made available.

The availability of such information is important if national official population estimates are to be considered and used in processes at the global level.

6. RECOMMENDATIONS

Several methods are available to produce official population estimates. Among those, some methods provide more reliable population figures than others. For example, official population estimates by age and sex that are based on a complete, well maintained and regularly updated population register (section 4.1) provide certainly more consistent population figures than an official number based only on an initial population count drawn from a partial census and updated using an assumption on the growth rate of the population (section 4.4).

A series of general recommendations to produce of consistent official population estimates can be formulated.

First, regardless of the methods used, it is essential that sufficiently detailed information documenting national practices is made available alongside the estimates of official population figures. This detailed knowledge is important for interpreting properly and for assessing the accuracy and reliability of the underlying data and methods used to derive these estimates. Beside the information on the data sources and methods used, the definition of the population included in the initial population count should be clear and consistent. National practices that consist in releasing official estimates without information detailing the initial population count, the type of adjustment made, and the method of time adjustment used to produce these figures should be absolutely avoided (sections 5 and A1.1).

A second recommendation is that countries should strive as much as possible to produce population estimates that are consistent by age and sex and along cohorts (section 3.2). Producing official estimates for the total population only should therefore be avoided as much as possible (section 4.2.4). In the case the required information to update the initial population count by age and sex is not available, assumptions should be used to produce population estimates by age and sex (section 4.2.3).

Third, it is important that the initial population count by age and sex is assessed and properly adjusted if needed (sections 3.1 and A1.4). Key results (for the total population and, if possible, by age and sex) of the post-enumeration surveys (percentage of under/over-enumeration and net error), or adjustments made based on analytical methods shall be publicly available. While providing details on the type of adjustments made is important, countries should also provide some arguments as to why adjustments were not made to an initial population count (e.g. political reason, no funding to conduct a PES, no agreement on the correction factor, or if the initial population count is deemed complete). Such information would also be useful to assess the accuracy and reliability of the official population estimates.

Fourth, the initial population count by age and sex needs to be brought up to date in a correct manner in order to produce consistent population estimates (sections 3.2). The cohort component method is the gold standard method to produce estimates of population by age and sex that account properly for the age- and sex-specific changes in mortality, fertility and migration. An initial population count by age and sex that is brought up to date by the cohort component method will generate official population estimates that are consistent by age and sex, and through time and along cohort lines. Among the diverse national practices to produce an official population estimate by age and sex, the one consisting in bringing up to date the total population only and distributing this total population across the ages and sex using the structure from the initial population count should be strongly discouraged. Such practice assumes that no change is happening

across the age and sex and produces population structures that are inconsistent and misleading for policy formulation and implementation.

In order to obtain the data that are required to properly update an initial population count by age and sex, it is recommended to strengthen, and develop and use further data from vital registration, and population registers upon availability or a recent population census (sections 4.2.1, A1.2 and A1.3). It is also important that the initial population count used to produce the official estimates is as recent as possible (sections 3.2 and A1.2). It is therefore important to continue investing and strengthening census activities to ensure that censuses are of high quality, follow international principles and recommendations, and produce data that can be widely disseminated and used.

If complete vital statistics on births and deaths are available along a recent population census, national official population estimates should be produced by the application of the cohort component method in order to bring up to date the initial population count in a consistent way by age and sex and along cohort lines. Such practice is hopefully generally followed by countries, especially among those with complete birth and death registration, but some exceptions remain (section A1.6).

The application of this set of recommendations and the systematic reporting to the United Nations of the official population estimates and their accompanying metadata on the initial population count and method of time adjustment used to produce official estimates would contribute to improve the consistency of population estimates at the national level, as well as their use at the global level.

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APPENDIX

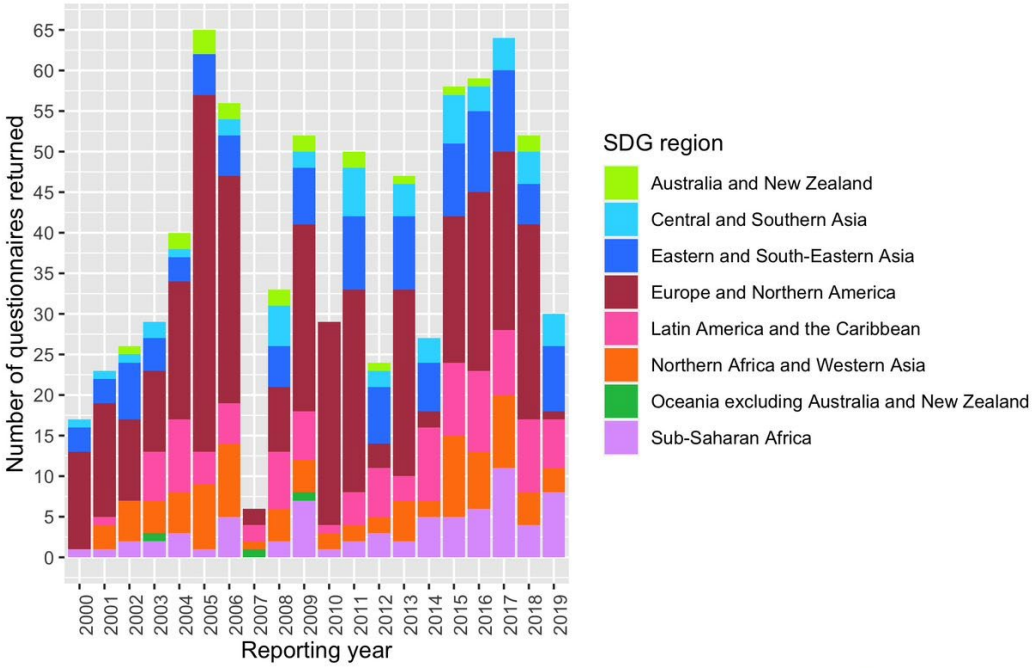
A1. Overview of the global situation

Every year, the Statistics Division of UN DESA sends a questionnaire[11] to Governments to collect relevant metadata about the official population estimates submitted to the United Nations for inclusion in the UN *Demographic Yearbook*. Such metadata pertain to the initial population count and to the method of time adjustment used to transform the initial count into annual time series of population estimates. However, the questionnaire is not typically returned in every year by all countries, whose responses vary also in the completeness of the information provided. Therefore, the availability and content of these metadata vary widely by country. The graphs and text below summarize the metadata on official population estimates that were transmitted to the United Nations between 2000 and mid-2019.[12]

A1.1 Availability of information

Figure A1 shows the number of questionnaires returned annually to the United Nations between 2000 and mid-2019. The response rate differs both by region and by year.

Figure A1. Annual numbers of questionnaires on official population estimates returned to the United Nations between 2000 and mid-2019



The number of questionnaires returned varies by region. Figure A2 shows the average number of questionnaires received from each region between 2000 and mid-2019. With ten questionnaires returned in

[11] See https://unstats.un.org/unsd/demographic-social/products/dyb/index.cshtml#questionnaires (last accessed, 20 February 2020).
[12] In the analysis that follows, one annual questionnaire returned by a Government counts as one observation.

total, Australia/New Zealand had the highest average response rate (questionnaires returned per country), while Oceania (excluding Australia and New Zealand) had the lowest.

Besides the population estimates themselves, information about the methods used to produce the estimates was gathered as well. As discussed in this note, various types of data for the initial population count and various techniques of time adjustment can be used to produce official population estimates. Such information is important to assess data quality. However, this information is not consistently communicated by countries to the United Nations, and the information provided is not always complete.

Between 2000 and mid-2019, out of 201 countries or areas, 50 did not return any information regarding the initial population count or the method of time adjustment used to produce their official population estimates. For the others, the completeness of the available information on these aspects varied significantly, as shown in figure A3.

Figure A2. Average number of questionnaires on official population estimates submitted by countries in a region between 2000 and mid-2019

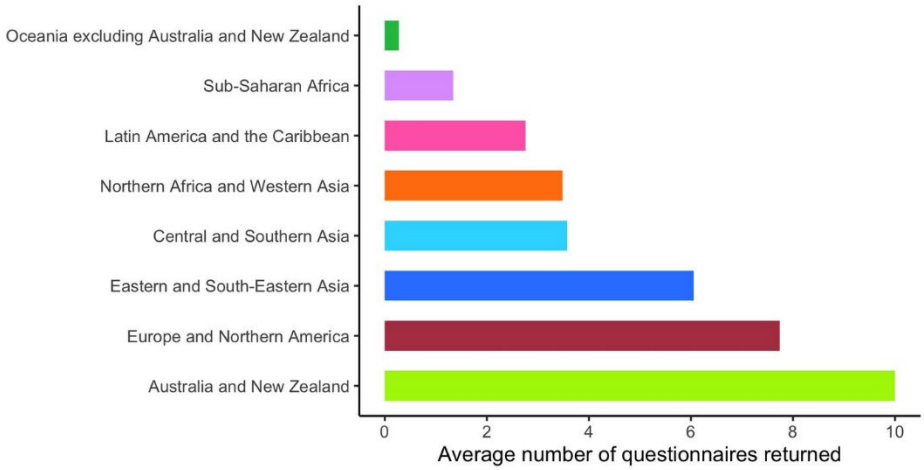
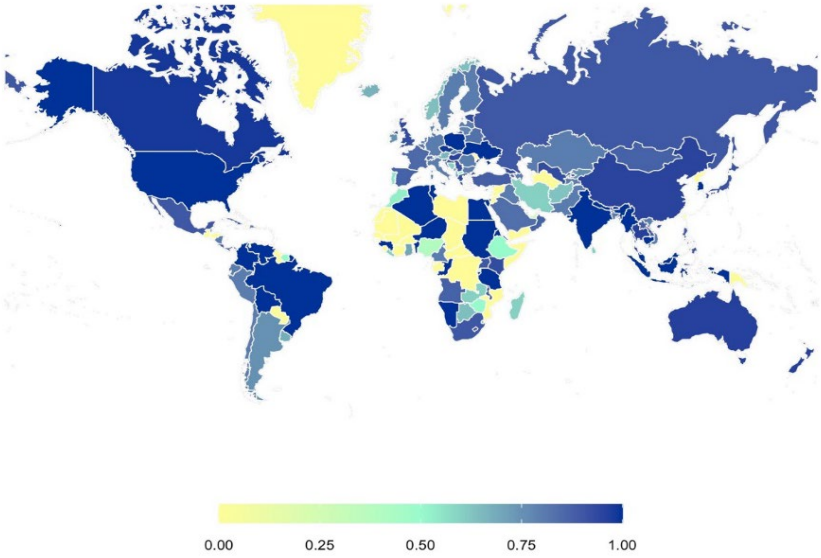


Figure A3. Completeness of the information reported between 2000 and mid-2019 about type of initial population count and method of time adjustment used to derive official population estimates



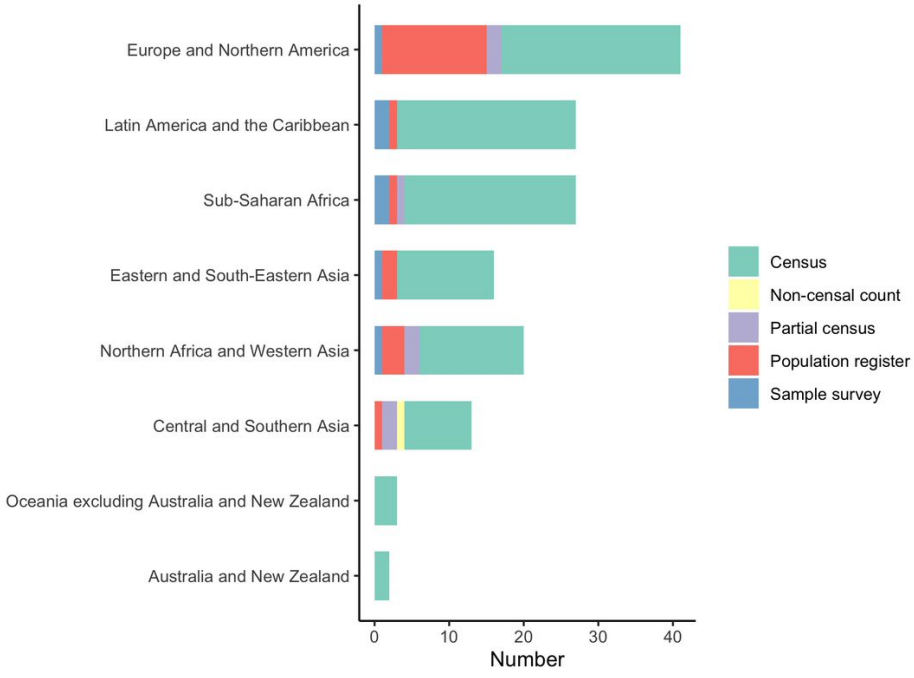
Note: An index of completeness was computed based on information provided by countries concerning four questions (a. type of base data/initial population count; b. method of time adjustment; c. adjustment in base data by age and sex; and d. type of adjustment method to the base data by age and sex). For countries that submitted information for one or more years, data from all available years were taken into account to compute an average completeness score. Countries that returned no questionnaires were assigned a completeness of 0.

Disclaimer: The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

A1.2 INITIAL POPULATION COUNT

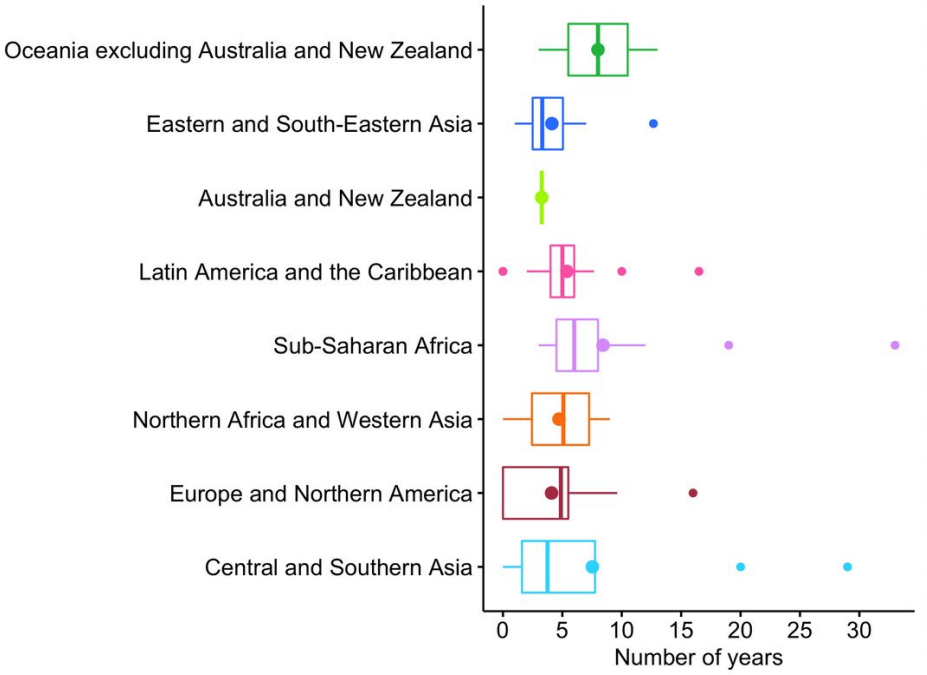
Across the world, a population census remains the primary data type used as the initial population count when deriving time series of official population estimates (Figure A4). Population registers are used for this purpose in some regions, especially in Europe and Northern America, but also in Northern Africa and Western Asia, and in Eastern and South-Eastern Asia. Given recent investments being made in population registers across the world, it is expected that registry data will increasingly serve as the source of the initial population count in the future. Other types of initial population counts, including non-census counts, partial censuses and sample surveys, are rarely used.

Figure A4. Numbers of initial population counts by type and region



A time lag is usually observed between the year of the initial population count and the year in which the information is reported to the United Nations. Such a lag is to be expected, because population censuses are not conducted every year. Even when a population register provides the initial population count, a time is needed to review, collate, and transmit this information to the United Nations. Figure A5 shows the distribution of these time lags by region, according to the questionnaires submitted by countries between 2000 and mid-2019. For example, if a population count from a census in 2010 were used as the initial population count to derive population estimates through 2016, the time lag would be six years. In most regions, the time lag rarely exceeds ten years. However, longer time lags (up to around 30 years) have been observed for a small number of countries.

Figure A5. Time lags (in number of years) between the initial population count and the year in which official population estimates were reported to the United Nations, by region

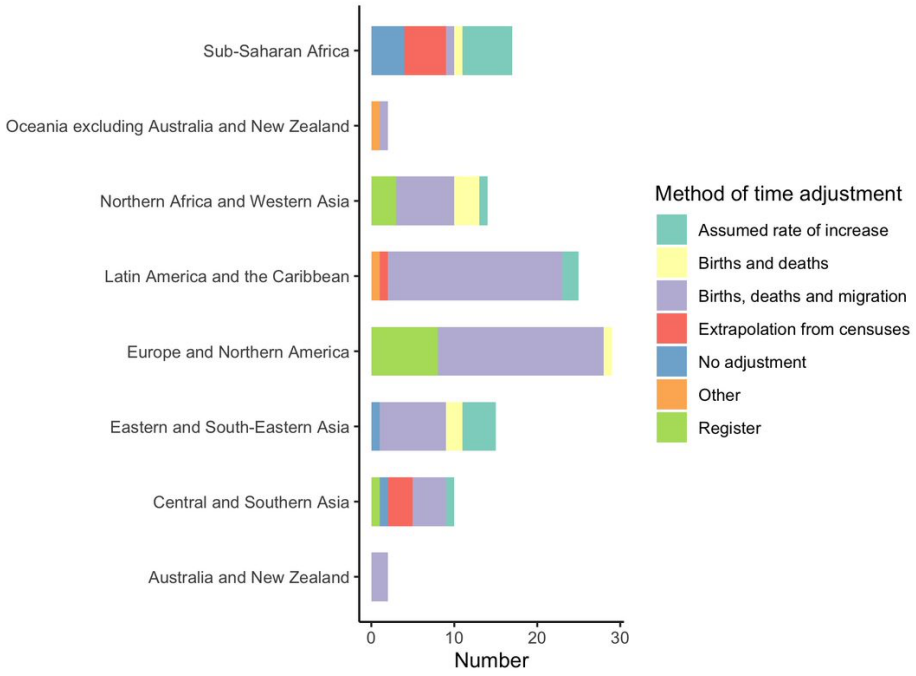


A1.3 METHOD OF TIME ADJUSTMENT

In order to produce official population estimates, the initial population count needs to be brought up to date. As described earlier, several methods can be used for this purpose. The gold standard is to account for changes in population size in terms of the deaths, births and migrations that have occurred over the intervening period and to update the initial population count by age and sex by tracking individual cohorts as they add or subtract members over time. However, since the data required for such calculations are not always available, it has been necessary to develop alternative approaches that may include stronger assumptions or utilize less elaborate methods.

The methods of time adjustment used by countries to bring their initial population counts up to date are presented in Figure A6. Although these methods vary by region, most countries try to account for changes in numbers of births and deaths, and, if possible, migration. In very few countries, the initial population count is used as an estimate of population size in subsequent years, without accounting explicitly for demographic changes that have occurred since the year of the initial population count. Such practices should be avoided.

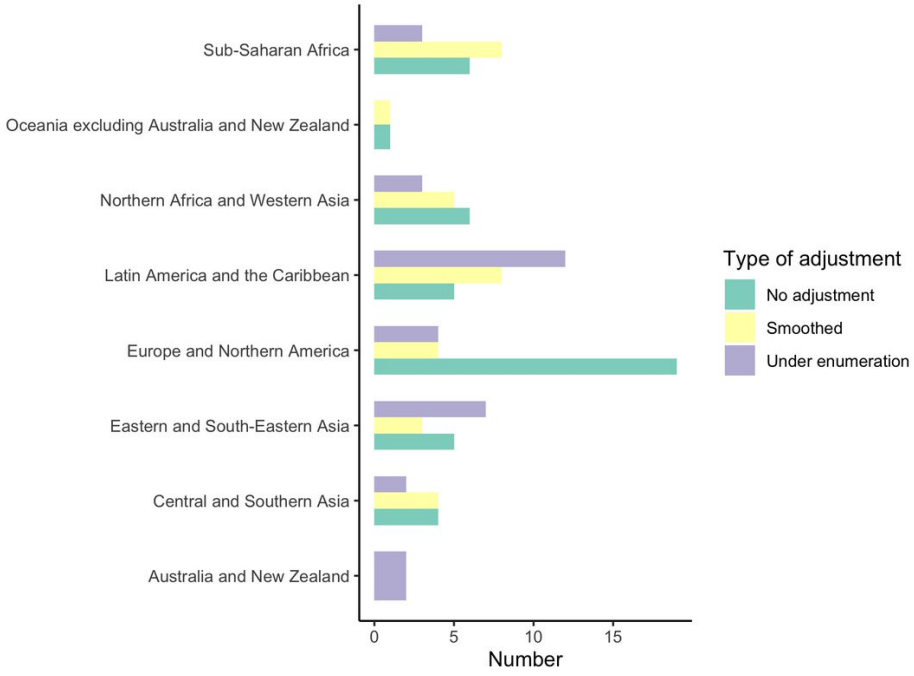
Figure A6. Frequency of methods of time adjustment used to update an initial population count, by region



A.1.4 ADJUSTMENT OF INITIAL POPULATION COUNTS

Before bringing the initial population count up to date, the count needs sometimes to be adjusted to address deficiencies in the data. Census data often suffer from under-enumeration, especially at young and adult ages, and may also display "heaping" on (or attraction for) ages ending in '0' or '5'. If such deficiencies are not identified and corrected in the initial population count, they will affect the quality of the official population estimates. Figure A7 indicates whether any adjustments were applied and, if so, the type of adjustment.

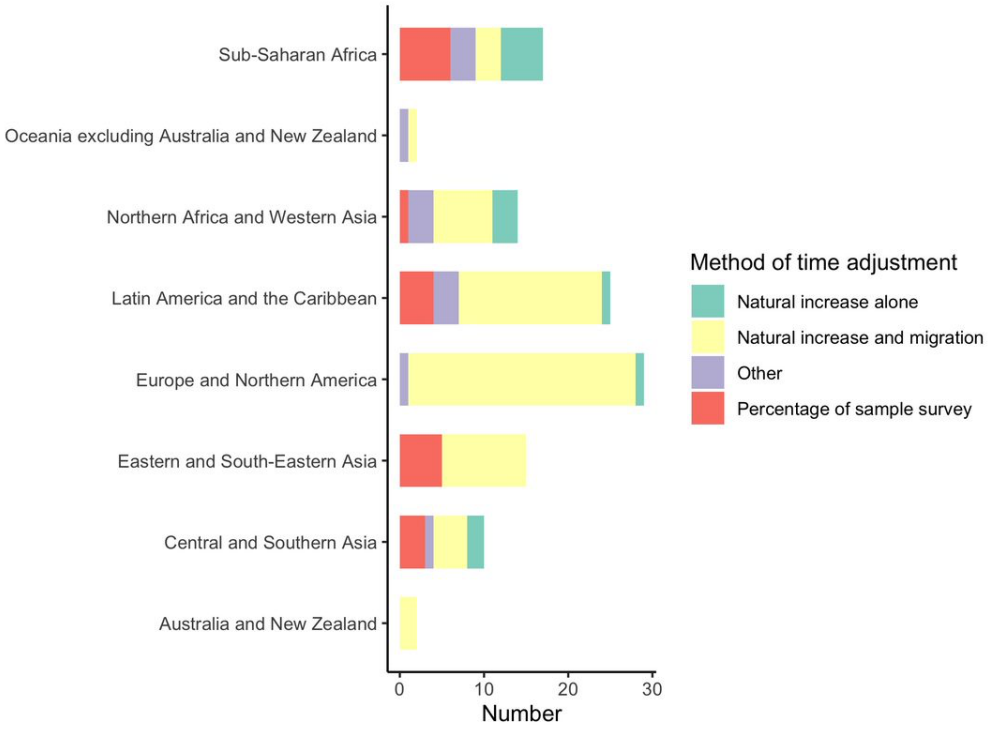
Figure A7. Numbers of adjustments applied to correct deficiencies in initial population counts, by type and region



A.1.5 METHOD OF TIME ADJUSTMENT BY AGE AND SEX

The recommended method to update the initial population count is to track changes over time in population size attributable to deaths, births and migrations classified by age and sex. Such a procedure ensures that the estimates of population size are fully consistent with observed demographic changes by age and sex and within the lives of cohorts. The methods used by countries to update the initial population count are presented in Figure A8. Among countries that update the initial population count by age and sex, most account for changes in deaths and births only or in deaths, births and migrations.

Figure A8. Frequency of methods of time adjustment affecting the internal consistency of estimates by age and sex used in updating an initial population count, by region



A.1.6 METHOD OF TIME ADJUSTMENT USED BY TYPE OF INITIAL POPULATION COUNT

In most countries and areas, the official population figure is estimated using the cohort component method as method of time adjustment. All the countries that use a population register as initial population count account for the changes in the natural increase (the balance between births and deaths) and migration when bringing up to date their initial population count (Table A1). Out of the 88 countries that rely on a population census as initial population count, less than two thirds use a method of time adjustment that accounts for changes in the balance between births and deaths and between immigration and emigration.

TABLE A1. DISTRIBUTION OF SELECTED COUNTRIES* BY TYPE OF INITIAL POPULATION COUNT AND METHOD OF TIME ADJUSTMENT APPLIED TO THE TOTAL POPULATION

Initial population count	Method of time adjustment for the total population							
	Register	Births, Deaths and net migration	Births and Deaths only	Extrapolation from censuses	Assumed rate of increase	No adjustment	Other	Total
Register	11	3	0	0	0	0	0	14
Census	1	53	6	7	13	6	2	88
Sample survey	0	4	1	2	0	0	0	7
Partial census	0	3	0	0	1	0	0	4
Non-censal count	0	1	0	0	0	0	0	1
Total	12	64	7	9	14	6	2	114

Note: (*) Data refer only to countries with a population of at least 90,000 persons in 2020 that submitted metadata to the United Nations concerning their production of population estimates.

An important footnote is that in 31 countries, out of 114 countries that submitted metadata to the United Nations concerning their production of population estimates, the official estimates are not updated using a method of time adjustment that allows for a full accounting of, at a minimum, the impact of trends in births and deaths.

Table A2 give similar information but for the time adjustment of the population by age and sex.

TABLE A2. DISTRIBUTION OF SELECTED COUNTRIES* BY TYPE OF INITIAL POPULATION COUNT AND METHOD OF TIME ADJUSTMENT APPLIED TO THE POPULATION CLASSIFIED BY AGE AND SEX

Initial population count	Method of time adjustment by age and sex				
	Births, Deaths and net migration	Births and Deaths only	Percentage of sample survey	Other	Total
Register	12	0	0	2	14
Census	51	12	15	10	88
Sample survey	3	0	4	0	7
Partial census	4	0	0	0	4
Non-censal count	1	0	0	0	1
Total	71	12	19	12	114

Note: (*) Data refer only to countries with a population of at least 90,000 in 2020 that submitted metadata to the United Nations concerning their production of population estimates.

Finally, Table A3 indicates the method of time adjustment used in countries with complete birth and death registration. In 9 of these countries, the method of time adjustment used to update the initial population count does not allow to account for trends in the balance of births and deaths and of immigration and emigration. In this situation, official population estimates for a given country may not be internally consistent by age and sex and within cohorts.

TABLE A3. METHOD OF TIME ADJUSTMENT USED BY SELECTED COUNTRIES* WITH "COMPLETE" REGISTRATION OF BIRTHS AND DEATHS

	Total	Percentage
Countries with "complete" birth and death registration	69	100%
Method of time adjustment:		
Register	11	16%
Births, deaths and migration	49	71%
Births, deaths	4	6%
Extrapolation from censuses	1	1%
Assumed rate of increase	2	3%
Other	2	3%

Note: (*) Birth and death registration systems were considered "complete" if 90 per cent of births and deaths were being registered (see Table A.2.1 below); data refer only to countries with a population of at least 90,000 persons in 2020 that submitted metadata to the United Nations concerning their production of population estimates.

A. 2. Detailed information by country

Table A2.1 presents a quick overview of the information available by location based on the United Nations Statistics Division database and the United Nations Population Division internal database (DemoData). The table includes information on the latest year for which a population by age and sex is available from a population census and/or an official population estimate, as well as information on whether a metadata questionnaire was returned to the United Nations Statistics Division since 2000; the last year the births by age of the mother are available from a census and/or a register; An estimate of the completeness of the birth registration, if available; the last year the deaths by age and sex are available from a census and/or a register; the last year for which life table statistics are available; and an estimate of the completeness of the death registration, if available. The completeness of vital registration varies between 0 and 1 as the proportion of all annual vital events get registered in each location. See metadata for Indicator 17.19.2(b)[13] for further details about definitions and measurement by location.

Table A2.1. Latest information about available data on population size and numbers of deaths by age and sex, and on numbers of births by age of mother and sex of child, for countries and areas with 90,000 inhabitants or more in 2020, as provided by national statistical authorities to the United Nations.

Location	Population by age and sex			Births by age of mother		Birth registration completeness**	Deaths by age and sex		Life table statistics		Death registration completeness**
	Census	Estimate	Metadata questionnaire available	Census	Register*		Census	Register*	Census	Register	
Afghanistan	1979	2019	Yes	1979			1979		1979	2004	
Albania	2011	2018	Yes	2011	2017	0.82	2011	2017	2011	2017	0.82
Algeria	2008	2017	Yes		1986	0.95		2016		2017	0.45
Angola	2014	2019	Yes			0.25		1973		2019	
Antigua and Barbuda	2011	2019		2011	2018	0.95		2016		2017	0.95
Argentina	2010	2019	Yes		2017	0.95		2017		2015	0.95
Armenia	2011	2018	Yes		2017	0.99		2017		2017	0.97
Aruba	2010	2018	Yes		2017	0.95		2017		2011	1.00
Australia	2016	2018	Yes		2017	1.00		2017		2017	1.00
Austria	2011	2018	Yes		2017	0.95		2017		2017	0.95
Azerbaijan	2009	2018	Yes		2017	0.94		2017		2017	0.95
Bahamas	2010	2018	Yes	2010	2012	0.82		2012		2001	0.95
Bahrain	2010	2018	Yes		2017	0.95		2017		2015	0.95

[13] https://unstats.un.org/sdgs/metadata/files/Metadata-17-19-02b.pdf (last accessed 5 July 2020).

Location	Population by age and sex			Births by age of mother		Birth registration completeness**	Deaths by age and sex		Life table statistics		Death registration completeness**
	Census	Estimate	Metadata questionnaire available	Census	Register*		Census	Register*	Census	Register	
Bangladesh	2011	2017	Yes			0.37		1986		2017	0.38
Barbados	2010	1988			2007	0.99		2007		1980	1.00
Belarus	2009	2018	Yes		2017	0.95		2017		2017	0.95
Belgium	2011	2018	Yes		2017	0.95		2017		2018	0.95
Belize	2010	2019	Yes		2016	0.96		2018		1991	1.00
Benin	2013	2018	Yes			0.85					
Bhutan	2005	2016	Yes	2005		1.00	2005		2005		
Bolivia (Plurinational State of)	2012	2019	Yes	2012	1977	0.95	2012	1991	2012	2017	0.45
Bosnia and Herzegovina	2013	2010	Yes		2010	0.95		2010		2003	0.95
Botswana	2011	2018	Yes	2011	2017	0.75	2011	2017	2001	2016	0.75
Brazil	2010	2018	Yes	2010	2017	0.95	2010	2017	2010	2015	0.95
Brunei Darussalam	2011	2018	Yes		2017	1.00		2017		2017	1.00
Bulgaria	2011	2018	Yes		2017	0.95		2017		2017	0.95
Burkina Faso	2006	2017	Yes			0.77					
Burundi	2008	2019	Yes			0.75				2017	
Cabo Verde	2010	2019			1990	0.95		1991		2018	0.88
Cambodia	2008	2015	Yes			0.73				1959	
Cameroon	2005	2019	Yes			0.66				2016	
Canada	2016	2018	Yes		2017	0.95		2017		2016	0.95
Central African Republic	2003	1985				0.61	1988		1988		
Chad	2009	2019				0.12					
Channel Islands	1996	1995	Yes			0.95					0.95
Chile	2002	2019	Yes		2017	0.95		2016		2019	0.95
China	2010	2011	Yes	2010	1989	0.95	2010	1999	2010	2010	0.04

Location	Population by age and sex			Births by age of mother		Birth registration completeness**	Deaths by age and sex		Life table statistics		Death registration completeness**
	Census	Estimate	Metadata questionnaire available	Census	Register*		Census	Register*	Census	Register	
China, Hong Kong SAR	2016	2018	Yes		2018	0.95		2018		2018	0.95
China, Macao SAR	2011	2015	Yes	2016	2017	0.95	2016	2017		2018	0.95
Colombia	2005	2019	Yes		2017	0.68		2017		2015	0.73
Comoros	2003	1973				0.87					
Congo	2007	2009	Yes		2014	0.96		2014		2007	0.38
Costa Rica	2011	2018	Yes		2018	0.98		2018		2019	0.97
Côte d'Ivoire	2014	2017		2014		0.65				2016	
Croatia	2011	2018	Yes	2011	2017	0.95	2011	2017	2011	2017	0.95
Cuba	2012	2018	Yes		2017	1.00		2017		2013	1.00
Curaçao	2011	2017	Yes		2018	0.95		2018		2017	0.95
Cyprus	2011	2018	Yes		2017	0.95		2017		2017	0.95
Czechia	2011	2018	Yes		2017	0.95		2017		2017	0.95
Dem. People's Rep. of Korea	2008			2008	1993	1.00	2008	2008	2008	2008	
Dem. Rep. of the Congo	1984	1985				0.25					
Denmark	2011	2018	Yes		2017	0.95		2017		2017	0.95
Djibouti	2009	1956				0.92					0.45
Dominican Republic	2010	2019	Yes		2017	0.62		2017		2015	0.62
Ecuador	2010	2019	Yes		2017	0.85		2017		2018	0.75
Egypt	2017	2018	Yes		2012	0.98		2017		2019	0.96
El Salvador	2007	2017			2015	0.95	2007	2014	2007	2005	0.85
Equatorial Guinea	2015	1990				0.53		1959		2001	
Eritrea	1984	2018	Yes							1984	
Estonia	2011	2018	Yes	2011	2017	0.95	2011	2017	2012	2017	0.95
Eswatini	2017	2018	Yes	2007		0.54	2007	1997		2018	0.38
Ethiopia	2007	2017	Yes			0.07				1994	

Location	Population by age and sex			Births by age of mother		Birth registration completeness**	Deaths by age and sex		Life table statistics		Death registration completeness**
	Census	Estimate	Metadata questionnaire available	Census	Register*		Census	Register*	Census	Register	
Fiji	2017	2008	Yes		2008	0.95		2008		2013	1.00
Finland	2010	2018	Yes		2017	0.95		2017		2017	0.95
France	2015	2019	Yes		2018	0.95		2014		2016	0.95
French Guiana	2015	2018	Yes		2017	0.95		2017		2015	0.95
French Polynesia	2017	2015			2014	0.95		1968		2017	0.88
Gabon	2013	2005		1960		0.90	1960				
Gambia	2013	1980				0.53					
Georgia	2014	2018	Yes		2017	0.95		2017		2016	0.95
Germany	2011	2018	Yes		2017	0.95		2017		2017	0.95
Ghana	2010	2015	Yes	2010		0.65	2010	1971	2010	2010	0.25
Greece	2011	2018	Yes		2018	0.95		2018		2017	0.95
Grenada	2011	2017			2014	0.95		2014		1961	1.00
Guadeloupe	2015	2018	Yes		2017	0.95		2017		2015	0.95
Guam	2010	2019	Yes		2018	0.95		2018		2017	0.95
Guatemala	2002	2018			2016	0.97		2017		2015	0.90
Guinea	2014	2019	Yes	2014	1955	0.35	2014	1955	2014	2017	
Guinea-Bissau	2009	2019				0.24		1970		2014	
Guyana	2012	2010		2012	1972	0.89		2003		1961	0.73
Haiti	2003	2018	Yes			0.80		2003		1950	
Honduras	2013	2019			2012	0.99		1983			0.84
Hungary	2011	2018	Yes	2011	2017	0.95		2017		2017	0.95
Iceland	2011	2018	Yes		2017	0.95		2017		2017	0.95
India	2011	2011	Yes			0.84		1964		2016	0.67
Indonesia	2010	2019	Yes	2010	1964	0.67	2010	1964		2019	
Iran (Islamic Republic of)	2016	2019	Yes	2016	2017	0.97		2017		2016	0.92
Iraq	1997	2015	Yes		2000	0.68		1989		1997	0.34
Ireland	2016	2018	Yes	2011	2017	0.95	2011	2017	2011	2017	0.95

Location	Population by age and sex			Births by age of mother		Birth registration completeness**	Deaths by age and sex		Life table statistics		Death registration completeness**
	Census	Estimate	Metadata questionnaire available	Census	Register*		Census	Register*	Census	Register	
Israel	2008	2017	Yes		2017	0.95		2018		2017	1.00
Italy	2011	2018	Yes		2017	0.95		2017		2017	0.95
Jamaica	2011	2017	Yes	2011	2006	0.95	2011	2005	2011	2011	0.82
Japan	2015	2018	Yes		2017	0.95		2017		2017	0.95
Jordan	2015	2018			1979	0.98		1980		2017	0.65
Kazakhstan	2009	2018	Yes		2018	1.00		2018		2018	0.95
Kenya	2009	2017	Yes		2018	0.58		2018		2009	0.46
Kiribati	2015	1973			1996	0.94		2011		2005	0.76
Kuwait	2011	2018	Yes		2017	0.95		2017		2017	0.95
Kyrgyzstan	2009	2019	Yes		2017	0.95		2017		2018	0.95
Lao People's Dem. Republic	2015	2019	Yes	2015		0.75	2015			2018	
Latvia	2011	2018	Yes		2017	0.95		2018		2017	0.95
Lebanon			Yes								
Lesotho	2016	2016			2017	0.45		2017		2016	0.38
Liberia	2008	1977	Yes	2008		0.25				1971	
Libya	2006	2015	Yes		2009	0.95		2002			0.45
Lithuania	2011	2018	Yes	2011	2017	0.95	2011	2017	2011	2017	0.95
Luxembourg	2011	2018	Yes		2017	0.95		2017		2017	0.95
Madagascar	1993	2019	Yes	1993	1972	0.80	1993	1972	1993	2018	0.25
Malawi	2018	2016	Yes	2018	1971	0.25	2018	1998	2008	2008	0.25
Malaysia	2010	2018	Yes		2017	0.95		2017		2018	0.95
Maldives	2014	2019	Yes	2014	2017	1.00		2017		2016	1.00
Mali	2009	2016		2009		0.87	2009	1987		1987	
Malta	2011	2018	Yes	2011	2017	0.95		2018		2017	0.95
Martinique	2015	2018	Yes		2017	0.95		2017		2015	0.95
Mauritania	2013	2016		2013		0.59				2013	
Mauritius	2011	2018	Yes		2018	0.95		2018		2018	0.95

Location	Population by age and sex			Births by age of mother		Birth registration completeness**	Deaths by age and sex		Life table statistics		Death registration completeness**
	Census	Estimate	Metadata questionnaire available	Census	Register*		Census	Register*	Census	Register	
Mayotte	2012	2018			2017	1.00		2017		2017	
Mexico	2010	2019	Yes	2010	2016	0.95		2017		2018	0.95
Micronesia (Fed. States of)	2010	2019			2006			2003		2000	
Mongolia	2010	2018	Yes		2018	0.95		2018		2018	0.95
Montenegro	2011	2018	Yes		2018	0.95		2018			0.95
Morocco	2014	2018	Yes		2001	0.86		2007		2013	0.62
Mozambique	2017	2017				0.48	1997	1997		2016	
Myanmar	2014	2019	Yes	2014	2016	0.81		2016		2016	0.57
Namibia	2011	2019	Yes	2011		0.75	2011	2001	2001	2011	0.70
Nepal	2011	2016	Yes	2011		0.70	2001	2001	2001	2011	0.70
Netherlands	2011	2018	Yes		2017	0.95		2017		2017	0.95
New Caledonia	2014	2017	Yes		2015	0.95		2015		2017	0.88
New Zealand	2013	2018	Yes	2006	2018	0.95	2006	2018	2006	2018	0.95
Nicaragua	2005	2017	Yes		2010	0.84		2010		2010	0.70
Niger	2012	2016	Yes			0.28					0.04
Nigeria	2006	2016	Yes		2007	0.30				1989	
North Macedonia	2002	2018	Yes		2018	0.95		2018		2016	0.95
Norway	2011	2018	Yes		2017	0.95		2017		2018	0.95
Oman	2010	2018	Yes		2018	0.98		2018		2018	0.98
Pakistan	2017	2007	Yes			0.34					
Panama	2010	2019	Yes		2017	1.00		2017		2017	0.94
Papua New Guinea	2011	2016				0.62				2000	0.62
Paraguay	2002	2016			2016	0.44		2018		2018	0.65
Peru	2017	2018	Yes	2017	2017	0.82		2017		2015	0.62
Philippines	2015	2017	Yes		2017	0.95		2016		2010	0.88
Poland	2011	2018	Yes	2011	2017	0.95	2011	2017	2011	2018	0.95
Portugal	2011	2018	Yes	2011	2017	0.95	2011	2017	2011	2018	0.95

Location	Population by age and sex			Births by age of mother		Birth registration completeness**	Deaths by age and sex		Life table statistics		Death registration completeness**
	Census	Estimate	Metadata questionnaire available	Census	Register*		Census	Register*	Census	Register	
Puerto Rico	2010	2017	Yes	2010	2018	0.95	2010	2018	2010	2018	0.95
Qatar	2015	2018	Yes		2017	1.00		2017		2017	1.00
Republic of Korea	2015	2018	Yes		2017	1.00		2017		2017	1.00
Republic of Moldova	2014	2018			2018	0.95		2018		2017	0.95
Réunion	2015	2018	Yes		2017	0.95		2017		2017	0.95
Romania	2011	2018	Yes	2011	2017	0.95		2017		2017	0.95
Russian Federation	2010	2012	Yes		2011	0.95		2011		2012	0.95
Rwanda	2012	2018	Yes		1978	0.63				2017	0.38
Saint Lucia	2010	2018	Yes		2014	0.92		2005		2012	0.92
Saint Vincent and the Grenadines	2012	2019			2017	1.00		2016		2016	0.95
Samoa	2016	1977		2016	1980	0.59	2016	1980	2011	2006	0.51
Sao Tome and Principe	2012	2017			1979	0.95	2012	1979	2012	2017	0.88
Saudi Arabia	2010	2018	Yes	2010	2005	0.95	2010	2005	2010	2018	0.95
Senegal	2013	2016		2002		0.73				2019	
Serbia	2011	2018	Yes		2017	0.95		2017		2017	0.95
Seychelles	2010	2017	Yes	2010	2018	0.95		2018		2018	0.95
Sierra Leone	2015	2010				0.77	2004	2013	2004	2015	0.38
Singapore	2010	2018	Yes		2018	0.95		2018		2018	0.95
Slovakia	2011	2018	Yes		2017	0.95		2017		2018	0.95
Slovenia	2015	2018	Yes		2017	0.95		2017		2018	0.95
Solomon Islands	2009	2018			1969	0.80				2009	
Somalia	1987										
South Africa	2011	2018	Yes		2017	0.98	2011	2016		2014	0.82
South Sudan	2008	2018				0.35	2008		2008	2010	
Spain	2011	2018	Yes		2017	0.95		2017		2017	0.95
Sri Lanka	2012	2018	Yes		2015	0.95		2014		2002	0.95

Location	Population by age and sex			Births by age of mother		Birth registration completeness**	Deaths by age and sex		Life table statistics		Death registration completeness**
	Census	Estimate	Metadata questionnaire available	Census	Register*		Census	Register*	Census	Register	
State of Palestine	2017	2018	Yes		2007	0.95		2017		2017	0.75
Sudan	2008	2016	Yes			0.67				2008	
Suriname	2012	2017	Yes		2017	0.95		2017		2015	0.95
Sweden	2011	2018	Yes		2017	0.95		2017		2017	0.95
Switzerland	2011	2018	Yes		2017	0.95		2017		2018	0.95
Syrian Arab Republic	2004	2011				0.98		1984		1981	0.75
Tajikistan	2010	2017	Yes		2017	0.95		2017		2017	0.82
Thailand	2010	2017	Yes		2017	1.00		2017		2019	0.85
Timor-Leste	2015	2018		2004	1954	0.55				2018	
Togo	2010	2019				0.78		1961		1961	
Tonga	2016	2008			2003	0.93	2006	2006	2006	2010	0.70
Trinidad and Tobago	2011	2018	Yes		2009	0.97		2011		2011	0.86
Tunisia	2014	2016	Yes		2016	0.95		1998		2016	0.64
Turkey	2011	2017	Yes		2017	0.95		2017		2017	0.95
Turkmenistan	1995	2003			1989	1.00				1989	
Uganda	2014	2019	Yes			0.30				2014	
Ukraine	2001	2018	Yes		2017	0.95		2017		2017	0.95
United Arab Emirates	2005	2008	Yes		2017	0.95		2017		2006	0.95
United Kingdom	2011	2018	Yes		2017	0.95		2017		2017	0.95
United Republic of Tanzania	2012	2018	Yes			0.13				2010	0.38
United States of America	2010	2018	Yes		2015	1.00		2015		2015	1.00
United States Virgin Islands	2010	2008			2007	0.95		2007			0.95
Uruguay	2011	2019	Yes		2016	0.95		2016		2016	0.95
Uzbekistan	1989	2017	Yes		2017	0.95		2017		2017	0.95
Vanuatu	2016	2004				0.43		2014		2009	

Location	Population by age and sex			Births by age of mother		Birth registration completeness**	Deaths by age and sex		Life table statistics		Death registration completeness**
	Census	Estimate	Metadata questionnaire available	Census	Register*		Census	Register*	Census	Register	
Venezuela (Bolivarian Republic of)	2011	2019	Yes		2017	0.82		2017		2018	0.95
Viet Nam	2019	2018	Yes			0.95				2019	
Western Sahara	1970										
Yemen	2004	2017				0.39				2004	0.12
Zambia	2010	2019	Yes	2010		0.10	2010		2010	1980	
Zimbabwe	2012	2018	Yes	1992	1978	0.32	2002	2002	2002	2012	

Source: United Nations Statistics Division's Demographic Yearbook Database and United Nations Population Division's internal database (DemoData).

Notes: * including Sample Registration System (SRS);
** computed as the average of the low and high values of completeness available in the United Nations Statistics Division's Demographic Yearbook Database.