Technical Guidance Note

Assessment of Death Registration Completeness:

An Overview of Data and Methods

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UNFPA

CENTRE OF EXCELLENCE for CRVS Systems

IDRC · CRDI
International Development Research Centre
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About the **Centre of Excellence**

The Centre of Excellence for Civil Registration and Vital Statistics (CoE-CRVS) is a global resource hub that actively supports national, regional and global efforts to develop, strengthen and scale up sustainable civil registration and vital statistics (CRVS) systems that work for all, especially women and girls. The CoE-CRVS facilitates technical assistance, global standards, tools, evidence, and good practice, with a strong commitment to gender equality, and strategic partnerships.

The CoE-CRVS was founded in 2015 at the International Development Research Centre (IDRC, Canada). In August 2021 the CoE-CRVS transitioned to UNFPA to expand the Centre's reach through UNFPA's global network with activities in over 150 countries. The CoE-CRVS is funded by Global Affairs Canada, IDRC and UNFPA.

UNFPA and the CoE-CRVS implement a life-course approach to CRVS support - from birth to death, including marriage and divorce - ensuring that a person's legal identity is progressively updated over the life-course. A life-course approach advances human rights principles and inclusive development strategies for official statistics and public accountability, as shown below. Civil registration and legal identity facilitate access to health care, primary and secondary education, and social support.

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1 Objectives

The purpose of this Technical Guidance is to provide:

- An overview of the different data sources and methods that can be used to assess death registration completeness;
- A comparative overview of the different input data, potential analytical outputs and accompanying assumptions associated with the different methods;
- A discussion of the relative strengths and weaknesses of these different method; and
- A synopsis of further resources, computational tools and technical readings on birth registration completeness assessment.

This Technical Guidance Note is designed to support demographers and statisticians in National Statistics Offices, UNFPA Country Offices, and partner institutions in their evaluative assessments of death registration data. It is designed to help analysts at NSOs identify the different methods that can be used given different data availability scenarios at the national and subnational levels.

2 Introduction

Civil Registration and Vital Statistics (CRVS) play a key role in facilitating progress towards the Sustainable Development Goals (SDGs)...

...and in providing important data to monitor progress in achieving the SDGs.[1] Complete and timely vital statistics provide policy makers with better data on which to base policies and SDG implementation plans. Indicator 17.19.2 of the SDG includes a provision to achieve 100% birth registration and 80% death registration by 2030. As such, reliably estimating completeness of vital events is critical to achieving various targets of the SDGs.

The importance of completeness assessment of death registration data is two-fold:

1) It guides evidence-based improvements of the death registration system and **2)** it helps identify the needed statistical adjustments when constructing representative mortality statistics.[2]

Thus, completeness assessment of death registration data provides a useful guide to efforts for improving the quality and completeness of mortality data in the CR system and helps to adjust incomplete and deficient death data when producing representative VS outputs.

This Technical Brief provides an overview of data sources and methods used to assess completeness of death registration data and presents worked examples and/or links to worked examples or UNFPA e-learning resources for some of the methods presented in this technical guide. In addition, references to computer programs and associated tools that may be used for these types of analyses are included in this Brief.


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1 Mills, Samuel, Carla Abouzahr, Jane Kim, Bahie M. Rassekh, and Deborah Sarpong. 2017. Civil Registration and Vital Statistics (CRVS) for Monitoring the Sustainable Development Goals (SDGs). Paper prepared for the eLearning course on Civil Registration & Vital Statistics Systems. https://openknowledge.worldbank.org/bitstream/handle/10986/27533/115150.pdf

2 United Nations. Principles and Recommendations for a Vital Statistics System 2014. https://unstats.un.org/unsd/demographic/standmeth/principles/M19Rev3en.pdf.

3 Conceptual Overview of Death Registration Completeness Assessment

Assessing the completeness of death registration data entails comparison between the size, nature and attributes of registered deaths (i.e. deaths that have been officially registered with the civil registration authority) and total expected deaths. The term “expected deaths” refers to the number of deaths that are expected to occur in a geographic area during a specified time period given the prevailing population dynamics. The basic requirement of assessing completeness of death registration data is to derive the best estimate of the total expected deaths.

Mathematically, the completeness of death registration data in a given area a for a specified time period t, denoted as C(a,t), can be described as follows

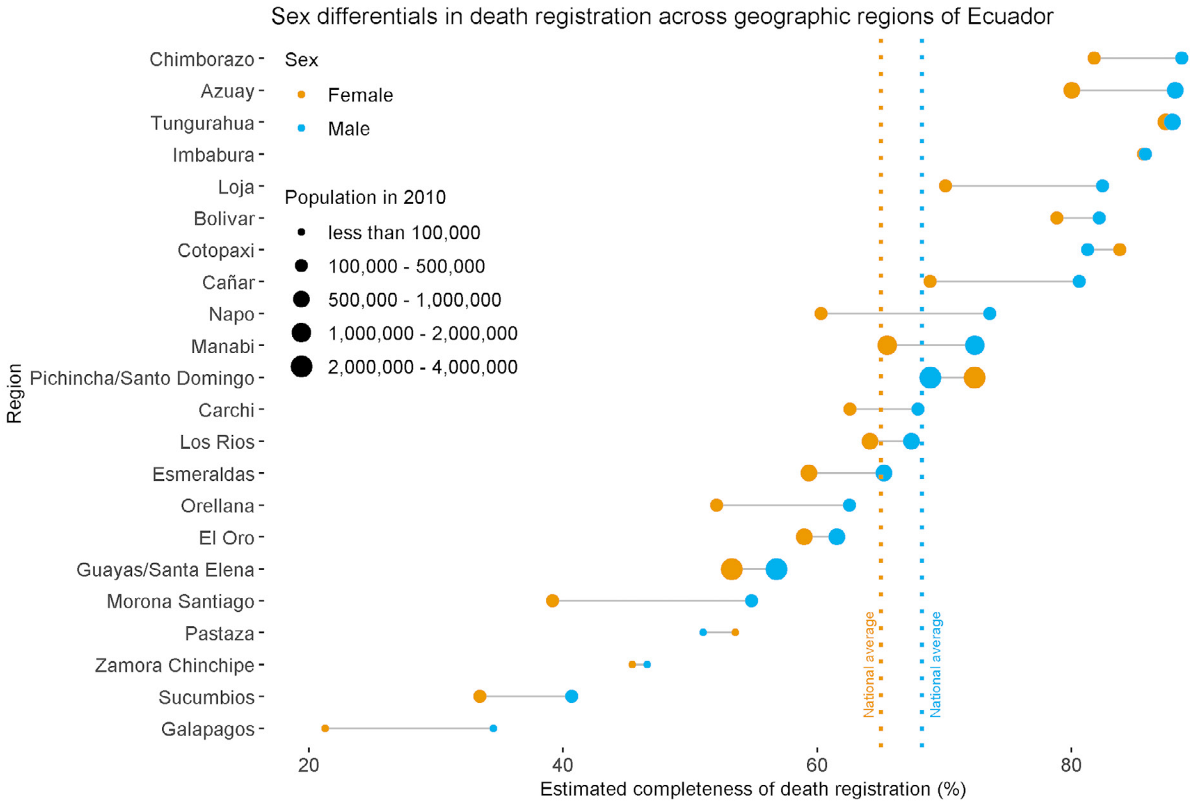
$$C(a,t) = \frac{R(a,t)}{E(a,t)}$$

where ***R(a,t)*** is the number of deaths recorded in the civil registration system that occurred in area ***a*** during time period ***t*** and ***E(a,t)*** is the number of total deaths that are expected to occur in area ***a*** during time period ***t*** given the prevailing population dynamics.

The numerator, R(a,t), is usually directly observed from the civil registration system. Whereas, the denominator, E(a,t), is usually estimated either by a direct or indirect mortality estimation technique. There are a range of approaches used to derive the estimate of total expected deaths, each with its own data needs, statistical methods, assumptions, and limitations. In the following sections, the basic mechanics of estimating the total “expected deaths”, E(a,t), are described including the standard data sources that can be used, the various direct and indirect estimation methods and their associated strengths and weaknesses.

As an example, in figure 1 below, we present a data visualization of a detailed death registration completeness assessment from Ecuador using death distribution methods. Clearly, the figure shows a small sex differential in female and male death registration completeness at the national level - 65% and 68%, respectively. However, when these estimates are further disaggregated by region, we see that death registration completeness varies notably across regions - from approximately 30% in Galapagos to 85% in Chimborazo. Further, in almost all regions (except 4 provinces) male death registration is systematically higher than female death registration. For some regions, such as Morona Santiago, Galapagos, Napo and Loja, female death registration is 15% percentage points lower than that of males. This type of assessment is useful to identify differences in death registration completeness by sex and region. Such analysis can guide both the (i) efforts to improve the inclusiveness of death registration processes, and (ii) statistical adjustments when constructing vital statistics that account for incomplete and deficient registration data.

FIGURE 1 | Sex differentials in death registration completeness by region estimated using death distribution methods, Ecuador, 2001-2010



Source: Peralta et al. (2019); Ecuador National Institute of Statistics and Census (INEC)

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4 Description of Measurement Methods and Data Sources

This section briefly describes each of the methods that can potentially be used for estimating the total expected death and/or completeness assessment of death registration data. In Table 1 below, we provide a summary overview of data requirements and sources that can be used to implement the various methods, separating such methods for estimating child and adult mortality.

TABLE 1 | Overview of measurement methods, data requirements, and sources of data for estimating expected deaths

No.	Method	Data requirements	Data sources
		Infant and child mortality	
1	Direct estimation of child mortality	• Month and year of birth of each child • Child's survival status • If dead, information on age at death • Sex of the child (optional)	• Surveys (DHS, MICS)
2	Direct Questions on death registration or death certificate possession	• Number of reported deaths in the survey/ census (possibly by age and sex) • Number of deaths reported to have been registered in CR system	• Survey • Census
3	Indirect estimation of child mortality	• Number of women by five-year age group • Number of children ever born alive by relevant age group of women • Number of children born alive by women that have died before (or are alive at) the time of the survey	• Surveys; DHS, MICS • Censuses
		Adult mortality	
4	Direct assessment	• Number of expected deaths (by age and sex) • Number of registered deaths (by age and sex) • (in some cases, population distribution by age and sex)	• Census • Surveys • Sample registration system • Mortality models
5	Death Distribution Methods (DDMs)	• Two age distribution of the population from two censuses • Age distribution of intercensal deaths	• Census • Vital registration systems
6	Adair-Lopez method	• Under-five mortality rate • Proportion of the population age 65 and over	• Survey • Census

No.	Method	Data requirements	Data sources
		Adult mortality	
7	Orphanhood method	• Proportion of respondents whose father/ mother is alive by 5-year age group • Number of births in the year before survey by 5-year age group of the mother • (Married men-women difference in mean age at childbearing; for adult men mortality estimation)	• Surveys • Census
8	Sibling-survival method	• Proportion still alive of sisters/brothers who were alive at age 15 by 5-year age group of respondent	• Surveys • Census
9	Direct Questions on death registration or death certificate possession	• Direct question (to either head of household or woman of reproductive age), • Question usually added to related questions about household deaths in the last 12 (or 24) months prior to census/survey	• Census • Sample Survey
10	Capture-recapture method	• Unique identifying variables from two independent sets of data	• Civil registration • Census or large sample surveys

Here are the more detailed descriptions of each method:

4.1 Infant and Child Mortality

4.1.1 Direct estimation

a. Comparison between registered deaths and expected deaths (based on survey/census estimates or mortality projections)

This method uses data from full birth histories (FBH) or truncated birth histories (TBH) from standard surveys (e.g., DHS or MICS) to estimate the probability of dying at young ages. FBH or TBH require that for each birth reported the date of birth, survival status, and age at death are recorded. Probabilities of dying can be estimated for age-cohorts or age-period. For example, the cohort infant mortality rate (IMR) for births in the 12 to 23 months before the survey is simply the number of such births that died before the age of 1 divided by the number of births. Similarly, the cohort U5MR for births 5 to 9 years before the survey is the number of such births reported to have died before exact age 5 divided by the number of such births. Age-period measures require careful estimation of exposure to risk and then the calculation of mortality rates, which are converted into probabilities of dying. Wherever possible, it is recommended that a computer routine is used to implement these calculations. Detailed information and worked examples can be found here.

b. Self-reported information via surveys or censuses

This approach involves adding specific self-disclosure questions to existing mortality modules in household surveys or censuses to enquire whether deaths reported in the survey or census have been registered with the local CR unit. The measure of completeness is taken as the proportion of self-reported deaths registered with the local CR authority to the total reported deaths captured in the survey. All data for this method is usually internal to the survey or census itself, without reference to any external data source. However, where feasible, respondents may also be asked to produce registration documents as proof in order to validate the completeness estimate.

c. Capture-recapture estimation

The capture-recapture method is a record-linkage analysis of completeness of death registration where two deaths reported from two different independent sources (one being events from the CRVS system) for the same population are linked using specific matching criteria. For those who are familiar, this method is similar to the post-enumeration survey (PES) that is conducted to estimate under-enumeration of events in a recently conducted census or large survey. Upon linking all events of interest from the the two data sources, completeness of death registration is estimated as follows:

$$C(reg) = \frac{N(reg)}{N(total)}$$

where ***C(reg)*** is the completeness of death registration, ***N(reg)*** is the number of deaths registered with the civil registration system, and ***N(total)*** is the total number of deaths from the two sources of data, i.e. civil registration and a second data source plus deaths that are estimated to have been missed by the two sources (obtained by multiplying deaths recorded in source 1 but not in source 2 and those recorded in source 2 but not in source 1 divided by deaths recorded in both sources).

4.1.2 Indirect estimation

d. Comparison between registered deaths and expected deaths (based on survey/census estimates or mortality projections)

One of the approaches to estimating completeness of infant and child mortality is by way of comparing the probability of dying before ages 1 and 5. The numerator is estimated from births and deaths registered in the CR system for those aged under-5 years. The denominator (the expected level of infant and child mortality) can be estimated from summary birth history (SBH) data collected from traditional sources such as censuses or surveys. Thus, information on aggregate numbers of children ever born and children still alive (or dead) reported by women classified by age group are used to estimate expected infant and child mortality.

Through models of fertility and child mortality, the proportions dead are converted into probabilities of dying by exact ages of childhood, nq0. The older the women, the greater the value of n. A ‘time location’ method is used to estimate how many years previously each proportion dead approximates period probabilities of dying. For detailed information on this method, refer to indirect estimation of child mortality in Tools for Demographic Estimation (TDE).

4.2 Adult Mortality

4.2.1 Direct Assessment

a. Comparison between registered deaths and expected deaths (based on survey/census estimates or mortality projections)

For the direct assessment, the number of expected deaths is obtained from direct mortality questions from the census or survey, especially from the survival status of members of the household. Data can be segragated by age and sex.

b. Self-reported information via surveys, censuses

See, self-reported information assessment under infant and child mortality

4.2.2 Indirect Demographic Methods

a. Death Distribution Methods (DDMs)

DDMs are a family of methods that attempt to estimate the completeness of death registration of adults. The methods are effectively based on a comparison of the age distribution of registered deaths with the age distribution of the population in which the deaths occurred. The age distributions of the population are typically extracted from two successive population censuses, while the age pattern of registered deaths during the intercensal period can be extracted from CR data.

The three commonly used DDMs for assessing the completeness of death registration are the generalized growth balance (GGB), synthetic extinct generations (SEG), and a hybrid of the two approaches (GGB-SEG). These methods are based on finding the best-fitting linear relationship between two modeled parameters; partial birth rate (b(x+)) minus partial rate of growth (r(x+)) against partial death rates (d(x+)) in the case of GGB. As such, care must be taken when deciding on the age range to use when estimating completeness. To this effect, diagnostic plots need to be carefully examined so as to identify the age range over which the line is to be fitted - those points that

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fall in a straight line on the X-Y axis plot (see TDE for detailed information).

b. Adair-Lopez Method: Regression-based Models

The DDMs presented above are complex and rely on stringent assumptions about the population and the age distribution of the population. The Adair-Lopez method simplifies the estimation procedure by modeling the key drivers of mortality in a population through a regression technique based on mortality data from the Global Burden of Disease database.

The method has two regression models that predict completeness based on the relationship between registered crude death rate, the true level of mortality and population age structure. The true level of mortality is estimated using U5MR (5q0). Model 1 includes an additional variable, the completeness of under-five death registration, calculated as the 5q0 from death registration data divided by the estimated actual level of 5q0. Adair and Lopez note that in case death registration data consists largely from deaths occurring in health facilities, this variable may not be as suitable since deaths of young children are more likely to occur in health facilities than deaths at older ages. Completeness of under-five death registration would therefore be relatively high compared to completeness of deaths at all ages, and subsequently the resulting death registration completeness estimates might also be too high. To avoid this problem, a second model (Model 2) that excludes this additional predictor variable, can be estimated.

A notable limitation of this method is that the model-based estimates are derived using GBD mortality data, hence the model parameters assume the GBD mortality is accurate. Further, the Adair-Lopez model is calibrated so that completeness estimates cannot exceed 100%.

c. Orphanhood method

Other methods that can be used to estimate the expected number of deaths include the Orphanhood and Sibling survival (below) methods that rely on reports of the survivorship of respondent's parents and siblings, respectively. The orphanhood method estimates the mortality of adult men and women from data on survival status of respondents' fathers and mothers respectively. Mortality estimates can be produced without requiring respondents to recall the dates when deaths occured or age at death of the deceased.

d. Sibling survival method

The sibling survival method estimates adult mortality based on information on the survivorship of the respondents' adult brothers or sisters. This method also does not require respondents to recall the dates when deaths occured or age at death of the deceased. Mortality can be estimated for men (based on survival of brothers) or women (based on survival of sisters) only or both sexes combined. The method estimates adult mortality on the premise that respondents' siblings are approximately of the same age, on average, as the respondents. It estimates the conditional probability of surviving from age 15 to the current age of respondents.

NOTE: The orphanhood and sibling survival estimation methods significantly underestimates adult mortality in a population.

e. Capture-recapture method

Please see description under 4.1.1 (c) above.

5 Overview of Required Input Data and Expected Estimates for Respective Estimation Techniques

Direct estimation of expected infant and child deaths from survey data

Using the standard birth recode datafile of the DHS survey, the following variables are required to compute child mortality indicators: v005, v008, v021, v022, b3, b7. See table below.

v005	v008	v021	v022	b3	b7
1767724	1328	399	2	1316	
1767724	1328	399	2	1280	
1767724	1328	399	2	1255	
1767724	1328	399	2	1238	
1767724	1328	399	2	1219	
1767724	1328	399	2	1182	
1767724	1328	399	2	1132	
1767724	1328	399	2	1105	
1767724	1328	399	2	1081	120
1767724	1328	399	2	1324	
1767724	1328	399	2	1292	
1767724	1328	399	2	1258	
1767724	1328	399	2	1224	6
1767724	1328	399	2	1201	6

where **v005** is the sample weight, **v008** is the date of interview in century-month code (CMC), **v021** is the primary sampling unit, **v022** is the Strata, **b3** is the date of birth of the child in CMC, and **b7** is the age at death of the child in months.

With these data inputs, the following indicators can be obtained: NMR, PNMR, IMR, CMR, and U5MR as shown below (for example).

Indicator	Value
nmr	0.02822
pmr	0.03639
imr (1q0)	0.06462
cmr (4q1)	0.06635
u5mr (5q0)	0.12668

Indirect estimation of child mortality

Two data inputs are required to estimate indicators of child mortality: Average parity of women in each age group and proportion of children surviving for each age group of women. Pi is the total number of CEB to women in age-group i divided by the total number of women in that age group.

Below is an example of child mortality indicator estimation using data from the 2014 Moroccan census, with life table parameters coming from the Chilean pattern of UN life tables.

age of mother	mean children ever born	mean children surviving	proportion dea	x	q(x)	alpha	time location	mortality per 1000 q(1)	mortality per 1000 q(5)
15-19	0.0749	0.0713	0.049	1	0.0564	-0.2599	2013.43	56.4	69.0
20-24	0.5122	0.4952	0.0333	2	0.0359	-0.5512	2012.31	32.3	39.8
25-29	1.1602	1.1187	0.0357	3	0.0372	-0.5594	2010.67	31.8	39.1
30-34	1.8077	1.7349	0.0403	5	0.0419	-0.5234	2008.57	34.1	41.9
35-39	2.4201	2.3011	0.0492	10	0.0516	-0.4414	2006.12	39.9	49.1
40-44	2.8989	2.7152	0.0634	15	0.0659	-0.3316	2003.29	49.2	60.4
45-49	3.3721	3.1122	0.0771	20	0.0803	-0.2586	1999.83	56.5	69.2

q(x) is the probability of dying by exact age **x**, alpha is a life table parameter, time location is the time reference for each child mortality indicator **q1** and **q5**, the probability of dying before exact age 1 and 5, respectively. For example, around 2010, infant mortality rate was estimated at 31 deaths per 1000 live births, while under-5 mortality rate was 39 deaths per 1000 live births in Morocco.

Death Distribution Methods (DDMs) for adult mortality

To implement DDMs, the data need to be in the following format, especially when using the R packages listed in section 7 below. As shown below, the input data include population counts from two adjacent censuses (“pop1” and “pop2”) by 5-year age group and sex, the number of deaths registered in the intercensal period (“deaths”) by 5-year age group and sex, and the dates of each of the censuses (“date1” and “date2”). In addition, these data may also be disaggregated by province/region for subnational estimates.

DATA FOR ECUADOR | 2001 and 2010 census.

province	sex	age group	pop1	pop2	deaths	date1	date2
Azuay	m	0	34101	34886	772	2001	2010
Azuay	m	5	34996	36406	232	2001	2010
Azuay	m	10	34946	38125	223	2001	2010
Azuay	m	15	32387	37611	416	2001	2010
Azuay	m	20	25634	33665	480	2001	2010
Azuay	m	25	18606	28376	475	2001	2010

Upon implementation of these methods, some or all of the following output can be obtained depending on the tool and data used to produce these estimates.

province	sex	GGB-SEG	GGB	SEG	lower-age	upper-age
Azuway	f	0.868	0.987	0.822	15	50
Azuway	m	0.943	1.070	0.968	15	50
Bolivar	f	0.713	0.988	0.720	20	60
Bolivar	m	0.743	0.955	0.796	25	60
Canar	f	0.619	0.998	0.575	20	55
Canar	m	0.709	0.953	0.792	15	50

For each province, sex-specific estimates are produced for each of the three DDMs. The lower and upper ages are the cut-off points that produce the best linear-relationship that can be observed in the respective diagnostic plots.

Orphanhood method

The important input information to estimate adult mortality using the orphanhood method is the proportion alive of respondents' parents. However, this information is usually calculated from the numbers of respondents and fathers/mothers alive by 5-year age group of the respondent, as shown below:

Age of respondent	Total respondent	Father/mother alive	Proportion father/motheralive
5-9	1,442,900	1,388,100	0.9620
10-14	1,219,280	1,097,060	0.8998
15-19	1,104,880	924,330	0.8366
20-24	913,400	712,530	0.7801
25-29	817,290	563,710	0.6897
30-34	616,970	355,580	0.5763
35-39	368,600	176,100	0.4778
40-44	402,630	135,460	0.3364

Upon implementing this approach, especially using the tools from TDE, the following output is obtained.

where **30q30** is the probability of dying before age 60 having survived to age 30 and Date is the reference date for the mortality estimates. The method can also produce probabilities of dying before age 60 from age 15 (**45q15**).

Probability of dying 30q30	Date
0.176	1992.7
0.249	1990.6
0.260	1988.7
0.253	1987.0
0.261	1985.4
0.250	1984.5

Sibling survival method

Similarly, the proportion of siblings still alive by age group of respondents, having survived to age 15, can be calculated from the number of siblings that were alive by age 15 and those that are still alive at the time of the inquiry. See below.

Age group of respondent	Siblings alive at 15	Siblings still alive	Siblings dead after age 15	Proportion still alive
15-19	370.9	349.3	21.6	0.9418
20-24	387.1	363.4	23.7	0.9387
25-29	447.9	412.8	35.1	0.9216
30-34	378.8	349.2	29.6	0.9218
35-39	323.9	285.6	38.4	0.8816
40-44	266.3	238.0	28.3	0.8937
45-49	218.3	164.6	53.7	0.7540

From the proportions still alive, probabilities of dying before age 40, 50, or 60 can be estimated using life table methods as shown below.

Probability of dying 45q15	Ref Date
0.438	2000.0
0.419	1997.7
0.333	1995.6
0.361	1993.5
0.262	1991.8
0.422	1989.5

6 Strengths and Limitations of Data and Methods

The above measurement methods have their strengths and weaknesses. The advantages of these methods lies in that input data are readily available from traditional sources of data such as censuses and demographic and health surveys. While some of the methods can be easily implemented, others require a tedious procedure to implement.

In addition, because most of the methods rely on indirect estimation measures, they require stringent assumptions on population dynamics, especially relating to mortality and migration. For instance, the DDMs for estimating completeness of adult death registration requires that the population be closed to migration. For self assessment methods, self-disclosure mortality questions are not commonly asked in large surveys or censuses. Therefore, deliberate efforts need to be made to include such questions in routinely conducted surveys. Table 2 presents a summary of strengths and weaknesses of the methods discussed above.

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TABLE 2 | Advantages and limitations of methods used to assess completeness of death registration data

Method	Strengths ▲	Weaknesses ▼
	Infant and child mortality	
Direct estimation of child mortality	• Input data are readily available from traditional surveys and census	• Data limitations may prevent detailed understanding of overall completeness • (some) Relies on fertility and mortality models
Internal/self-assessment (Direct Questions on death registration or death certificate possession)	• Easy to compute and interpret • Input data can be collected in conjunction with existing and on-going survey programs • Method can collect and inform about contextual factors affecting completeness	• Relies on self-reported events which are subject to recall bias • Data limitations may prevent detailed understanding of overall completeness • No external validity • Usually small sample sizes
Indirect estimation of child mortality		• Assumption of uniform child mortality by five year age group of women may be problematic • Relies on model life tables for estimating child mortality
	Adult mortality	
Direct assessment	• Input data are readily available from traditional surveys and census • Easy to compute and interpret	• Data limitations may prevent detailed understanding of overall completeness
DDMs	• Can estimate completeness of enumeration between the two censuses in addition to completeness of death registration	• Provides only a single completeness estimate for the entire intercensal period • Relies on stronger assumptions on net migration, age-reporting errors • Not suitable to apply to subnational populations due to high volume of migration • Cannot be used to produce recent estimates if recent census is not available • Complex data input needs • High uncertainty in estimated results

Method	Strengths ▲	Weaknesses ▼
Adair-Lopez method	• Easy to implement • Requires few data inputs, relatively easy to get • Unlike DDMs, can produce completeness estimates can be calculated for the most recent years the data are available	• The use under-five mortality to represent overall level of mortality may be problematic in some contexts • Can lead to erroneous results where under-five mortality is not correctly estimated • Does not derive age-specific measures of completeness that could be used to refine mortality rates • Cannot be applied in settings with heavy mortality from say HIV/AIDS
Orphanhood method	• Requires data from one census only unlike the DDMs. • Does not rely on the assumption that the population is closed to migration. • Can be estimated using data from small surveys • Information can be obtained from two questions only from the household roster	• Underestimates mortality • Suffers from selection bias; survival status of parents reported only by surviving children • Overrepresentation of parents with more than one survival children • Relies on standard mortality life table parameters
Siblings method	• Requires data from one census only unlike the DDMs. • Does not rely on the assumption that the population is closed to migration. • Can be estimated using data from small surveys	• Underestimates mortality • Biases due to multiple reporting of siblings • Relies on standard mortality life table parameters
Capture-recapture estimation methods	• Computation procedure is straight forward • Completeness assessment can easily be applied to subnational level or disagregated by age and sex	• Data quality issues from either of the sources can affect the accuracy of the linking process
Internal/Direct Questions on death registration or death certificate possession	• Easy to compute and interpret • Input data can be collected in conjunction with existing and on-going survey programs • Method can collect and inform about contextual factors affecting completeness	• Relies on self-reported events which are subject to recall bias • Data limitations may prevent detailed understanding of overall completeness • No external validity • Usually small sample sizes

7 Computation Tools for the Estimation of Expected Deaths and/or Completeness Assessment of Death Registration

Table 3 presents some of the computer programs or tools that have been developed for use when estimating child and adult mortality. It is important that the user understands how the method works before using any particular tool. For the Excel workbooks, PAS, XXX represents XXX tool from the PAS suite of tools developed by the US Census Bureau. Similarly, Mortpark, XXX represents a tool from the Mortpak set of tools developed by the United Nations and TDE are tools from the online version of Tools for Demographic Estimation (TDE) guide.

TABLE 3 | Computational tools from different sources

Method	Excel Workbook	Stata	R
	Infant and child mortality		
Direct estimation of child mortality	PAS, BTHSRV	syncmrates	DHS.rates::chmort
Indirect estimation of child mortality	TDE, CM_Indirect Mortpak, QFIVE or CEBCS		u5mr
	Adult mortality		
Direct assessment			DHS.rates::admort
DDMs	TDE, AM_GGB or SEG_ Mortpak, BENHR (estimates the Bennet-Horiuchi method)		SubnationalCRVS::EstimateDDM DDM::ddm
Adair-Lopez method			
Orphanhood method	TDE, Orphanhood one census Mortpak, ORPHAN		
Sibling survival method	TDE, AM_Siblings_Indirect		
Capture-Recapture Methods			OpenRecLink

The SubnationalCRVS package also comes with a function PlotDDM() that plots the results from the EstimateDDM function to offer a clear visualization of the completeness assessment.

8 Conclusions


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This technical brief provides a general overview of the methods used for completeness assessment of death registration data. It showcases the different methods that can be used to assess completeness of death registration. We provide an overview of the array of methods that are available, the input data required for the respective methods, and the analytical outputs that can be produced with the respective methods.

In this brief, we have emphasized the value and importance of assessing the completeness of death registration, where possible, using multiple assessment methods and multiple data sources. The use of multiple data sources and methods is important to ensure the robustness of the assessment and identify data inconsistencies and/or limitations of the assessment methods.

This technical guidance note is designed to support and guide demographers and statisticians in National Statistics Offices, UNFPA Country Offices, and from partner institutions. Data availability shapes the type of methods that can be used to assess death registration completeness. So this note is designed to assist analysts, given available data and country context, to identify the possible methods they can use to systematically assess death registration completeness.

In addition to the links to computational resources in Section 7 above, we provide detailed technical references and suggested further readings below in Section 9.

9 List of References and Suggested Further Reading

For a complete understanding of death distribution methods (DDMs) for estimating completeness of death registration data, including implementation, assumptions made, and other technicalities, refer to the following resources:

Bennett NG, Horiuchi S, "Estimating the completeness of death registration in a closed population," Population Index, vol. 47, no. 2, pp. 207–221, 1981, https://doi.org/10.2307/2736447

Hill K, You D, Choi Y, "Death distribution methods for estimating adult mortality: Sensitivity analysis with simulated data errors," Demographic Research, vol. 21, no. 9, pp. 235–254, 2009, https://doi.org/10.4054/DemRes.2009.21.9

Hill K, "Estimating census and death registration completeness," Asian and Pacific Population Forum, vol. 1, no. 3, 1987. https://unstats.un.org/unsd/vitalstatkb/KnowledgebaseArticle50331.aspx

For a detailed discussion on the Adair-Lopez method of estimating completeness of death registration, please refer to the following article:

Adair T, Lopez AD, "Estimating the completeness of death registration: An empirical method," PLoS ONE, vol. 13, no. 5, p. e0197047, 2018

https://doi.org/10.1371/journal.pone.0197047

These resources provide more information on the Capture-recapture method of estimating completeness of death registration and its implementation is different settings:

Costa et al. "Estimating completeness of national and subnational death reporting in Brazil: application of record linkage methods," Population Health Metrics vol 18, no 22. 2020. https://pophealthmetrics.biomedcentral.com/articles/10.1186/s12963-020-00223-2

Kabudula et al. "Evaluation of record linkage of mortality data between a health and demographic surveillance system and national civil registration system in South Africa," Population Health Metrics vol. 12, no 23. 2014 https://pophealthmetrics.biomedcentral.com/articles/10.1186/s12963-014-0023-z

Li et al. "Assessing record linkage between health care and vital statistics databases using deterministic methods," BMC Health Services Research vol. 6. 2006. https://bmchealthservres.biomedcentral.com/articles/10.1186/1472-6963-6-48

Ian Timaeus' work on estimating adult mortality using the orphanhood method offers great insights into the different variants of the method. For a start, look at the following resources:

Timæus I. 1986. "An assessment of methods for estimating adult mortality from two sets of data on maternal orphanhood", Demography 23(3):435-450. doi: http://dx.doi.org/10.2307/2061440

Timæus IM. 1991. "Estimation of adult mortality from orphanhood before and since marriage", Population Studies 45(3):455-472. doi: http://dx.doi.org/10.1080/0032472031000145636

Timæus IM. 1992. "Estimation of adult mortality from paternal orphanhood: a reassessment and a new approach", Population Bulletin of The United Nations 33:47-63.

Some key references to estimating adult mortality using the sibling survival method, in addition to TDE, include the following:

Timæus IM, B Zaba and M Ali. 2001. "Estimation of adult mortality from data on adult siblings," in Zaba, B and J Blacker (eds). Brass Tacks: Essays in Medical Demography. London: Athlone, pp. 43-66. https://researchonline.lshtm.ac.uk/id/eprint/17810

UN Population Division. 2002. Methods for Estimating Adult Mortality. New York: United Nations, Department of Economic and Social Affairs, ESA/P/WP.175. http://www.un.org/esa/population/techcoop/DemEst/methods_adultmort/methods_adultmort.html

And for more information on the methods presented here, including DDMs, orphanhood, and sibling survival methods, examples and step-by-step instructions on how to implement them, see the following resources:

Moultrie, T. A., Dorrington, R., Hill, A. G., Hill, K., Timus, I., and Zaba, B. (2013). Tools for Demographic Estimation. Paris, France: International Union for the Scientific Study of Population. http://demographicestimation.iussp.org/

United Nations, Department of Economic and Social Affairs, Population Division, Manual X: Indirect techniques for demographic estimation. 1983. https://www.un.org/en/development/desa/population/publications/pdf/mortality/Manual_X.pdf

For country-specific examples of death registration completeness assessments, the following resources on Ecuador and Brazil may be useful:

Peralta, A., Benach, J., Borrell, C. et al. Evaluation of the mortality registry in Ecuador (2001–2013) – social and geographical inequalities in completeness and quality. Popul Health Metrics 17, 3 (2019). https://doi.org/10.1186/s12963-019-0183-y

Queiroz, B.L., Gonzaga, M.R., Vasconcelos, A.M.N. et al. Comparative analysis of completeness of death registration, adult mortality and life expectancy at birth in Brazil at the subnational level. Popul Health Metrics 18, 11 (2020). https://doi.org/10.1186/s12963-020-00213-4

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