

A Guide on Conducting a Post-Census Verbal Autopsy to **Estimate Maternal Mortality**

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List of Abbreviations

ICD	International Classification of Disease
LTR	lifetime risk of maternal death
MMR	maternal mortality rate
MMRatio	maternal mortality ratio
PCVA	physician-coded verbal autopsy
PMDF	proportion of maternal deaths to females
SAVVY	Sample Vital Registration with Verbal Autopsy
UN	United Nations
URL	universal resource locator
USAID	U.S. Agency for International Development
VA	verbal autopsy
WHO	World Health Organization

Chapter 1. Background on Pregnancy and Maternal Mortality Measures and Estimation

Importance of the Topic

The United Nation's Universal Declaration of Human Rights states that:

*Motherhood and childhood are entitled to special care and assistance.*¹

Yet we know that millions of women and children do not get the services they need. Large disparities exist in terms of maternal and under-five mortality between rich and poor countries and also between rich and poor within countries. In order to improve maternal and child health, countries need data to inform programs and policies. In terms of maternal mortality, getting accurate estimates is a challenge for many low- and middle-income countries. These countries often lack complete vital registration systems which include reporting of all births and deaths. Data from health facilities alone do not capture the deaths that occur in homes or non-facility environments. Countries that are able to obtain estimates often only have these estimates at a national level, though maternal mortality may vary widely by sub-region within a country. In addition, few low- or middle-income countries have information regarding cause of maternal mortality at either a national or sub-national level. In this guide we present a methodology of using a post-census verbal autopsy in conjunction with the International Classification of Disease (ICD) guidelines. This methodology can enable countries to obtain the information they need at both national and subnational levels for effective programs and policies.

Definitions of Maternal Mortality versus Pregnancy-related Mortality

Maternal death: Maternal death is the death of a woman while pregnant or within 42 days of the termination of pregnancy, irrespective of the duration and the site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes.²

Pregnancy-related

death: This is the death of a woman while pregnant or within 42 days of the termination of pregnancy.²

A key difference between these two measures is the need for cause of death information. To measure maternal mortality both the timing of the death in relation to a pregnancy and the cause of death need to be known. With pregnancy-related mortality, only timing of the death in relation to a pregnancy needs to be known. More causes of death, including accidents and violence, apply to a pregnancy-related death rather than to a maternal death. It should be noted that some data sources such as surveys and censuses yield pregnancy-related mortality estimates because information on the cause of death is missing or not collected. However, such estimates are often mistakenly called maternal mortality estimates to simplify the terminology, particularly for those without substantial background in the technical issues regarding measurement.

Common Measures

Maternal mortality ratio (MMRatio) = Number of maternal deaths per 100,000 live births

The MMRatio is the most common measure used to present data on maternal mortality. This measure presents the risk of dying once a woman is pregnant and is designed to capture obstetric risk. Because the denominator typically is focused on live births rather than all births, obstetric risk may actually be overestimated. However, data on pregnancies that do not end in a live birth are often unavailable in low- and middle-income countries.

*Maternal mortality rate (MMR) =
Maternal deaths divided by the number of women aged 15–49 times 1,000 live births*

The MMR presents an indication of the burden of maternal death in the female population of reproductive age. This measure is influenced by the level of fertility, and that must be considered when making cross-country or cross-population comparisons.

*Proportion of maternal deaths to females (PMDF) =
Maternal deaths divided by the number of deaths of women aged 15–49*

The PMDF presents the magnitude of maternal mortality as a cause of death to women of reproductive age relative to other causes of death. This measure is presented as a proportion.

Lifetime risk of maternal death (LTR) = 35 times the MMR

The LTR reflects the risk that a woman who survives to age 15 will die of maternal causes at some point during her reproductive lifespan given current rates of maternal mortality and fertility. This indicator takes into account the probability of a maternal death each time a woman is pregnant and is often used for advocacy purposes.

Methods to Obtain Pregnancy-Related or Maternal Mortality Estimates

Vital registration: In populations where the vast majority of births and deaths are registered, vital registration data are used to calculate maternal mortality. In such populations, cause of death is recorded so maternal mortality can be calculated; and subnational level estimation is possible. Most low-income and middle-income countries do not have complete vital registration systems so using such data is not a feasible option for many of these countries.

Household surveys: With nationally representative household surveys, the two most common methods to estimate pregnancy-related mortality or maternal mortality are (1) the sisterhood method and (2) asking household heads about all deaths in the household during a specified time period. These two methods are described next.

Sisterhood method: In the sisterhood method, a woman is asked about the age of all her sisters if still alive or their ages at death if no longer alive; and years of death, if dead. For any sister who died during her reproductive life span, additional questions are asked to ascertain whether she was pregnant, delivering, or within six weeks of delivery at the time of death. The sisterhood method does not yield cause of death and thus provides pregnancy-related mortality estimates rather than maternal mortality. This method does not provide subnational level estimates of maternal mortality because questions on geographic location of the deaths are not asked. A large sample size is generally needed with this method.

Direct questions on

household deaths:

A household respondent, generally a household head, is asked about all deaths of household members in a particular time frame. For deaths that occur to women of reproductive age, follow-up questions are asked to ascertain whether the woman was pregnant, delivering, or within six weeks of delivery at the time of death. A challenge with this method is that large sample sizes are needed to obtain an adequate number of pregnancy-related deaths. In cases where the sample size is sufficiently large, it may be possible to obtain sub-national level mortality rates. If a follow-up verbal autopsy is performed, it is then possible to get cause of death information and thus maternal mortality estimates.

Estimation from

census data:

When the appropriate questions are included in a census, we naturally have a large number of births and deaths, and this information can yield pregnancy-related maternal mortality. In addition to the typical census questions on population by age and gender, questions on mortality and fertility must be included. Before using the census method to obtain pregnancy-related mortality estimates, data quality must be checked. There are adjustments that can be applied to improve the quality of data, but the quality of the data needs to be at a sufficient level in order for this method to yield accurate estimates. The World Health Organization (WHO) has a manual and spreadsheet that can be used to assist individuals with calculations needed to apply the adjustments and to get the estimates, called *WHO Guidance for Measuring Maternal Mortality from a Census*.³ With this method, subnational level estimation is possible. Post-census verbal autopsies can be employed to get cause of death information and maternal mortality estimates. Chapter 2 briefly discusses the steps needed to obtain pregnancy-related and maternal mortality estimates from a census with a post-census verbal autopsy in mind.

Verbal autopsy:

Verbal autopsies can be used after either a household survey or a census to get cause of maternal death information. With this method, interviewers return to a household where a pregnancy-related death was reported in the corresponding survey or census. A verbal autopsy questionnaire is administered to a knowledgeable respondent to understand the events surrounding the death of the individual in question. With such information it is possible to get cause of death information by using the latest ICD guidelines for maternal mortality. The most recent version is ICD-10, which is available online.⁴ WHO also offers manuals on verbal autopsies with sample questionnaires included, called *Verbal Autopsy Standards: Ascertaining and Attributing Cause of Death*⁵ and *Verbal Autopsy Standards: WHO 2012 WHO Verbal Autopsy Instrument Release Candidate 1*.⁶ Physician review or algorithms/automated methods are then used to classify cause of death. Chapter 3 discusses the key steps needed to conduct a post-census verbal autopsy.

Chapter 2. Key Steps in Estimating Maternal Mortality from a Census

Overview

Collection of data on a population by age and sex is part of any census effort. Detailed information on collecting such information is presented in the United Nations manual titled *Principles and Recommendations for Population and Housing Censuses*.⁷ In order to obtain pregnancy-related mortality estimates, questions about both mortality and fertility must also be included. Household identified as having a pregnancy-related death can then be returned to for the post-census verbal autopsy. Below are important questions for inclusion in a census when there is a plan to obtain pregnancy-related mortality and when a verbal autopsy following the census is being considered. Issues to consider for fieldwork and linking to a post-census verbal autopsy are also discussed. The manual titled *WHO Guidance for Measuring Maternal Mortality from a Census*³ is an important resource that takes users through the steps of using these methods to identify pregnancy-related deaths from questionnaire design to performing the data checks and adjustments to dissemination. In this chapter, we highlight the key points and particular issues to consider when planning a post-census verbal autopsy.

Mortality Questions

These questions involve all deaths in the household within a specified time period:

- A key question to ask might be: Has any member of this household died in the last 12 months?
- The time period used is most often 12 months, but could be increased up to 24 months in order to increase the number of events. More than 24 months is not recommended as this is likely to increase recall error.

The name, sex, and age at death of each deceased person are needed:

- One way to record this information is through the use of a table. An example table (table 1, adapted from the WHO guidance for measuring maternal mortality from a census) is

below. This table includes information collected for this section and the next section (timing of deaths of women aged 15 to 49 years, relative to pregnancy, childbirth and the postpartum period).

- The name is not necessary, but asking for the name of the deceased is thought to improve recall and is important when following up with a verbal autopsy.
- The question on the age at death can be replaced with two questions: (1) month and year of birth and (2) month and year of death

Table 1. Example of a Table Used to Collect Mortality Questions

Name	Sex	Age at death (in completed years)	If the deceased was female aged 15-49 years at the time of death, was she:		
			Pregnant?	Giving birth?	Within 6 weeks of the end of a pregnancy or childbirth?

The timing of deaths of women aged 15 to 49 years, relative to pregnancy, childbirth and the postpartum period, involves the following:

- Where childbearing among younger adolescents is more common, it may be important to expand the age range to 12-49. Deaths to individuals 12-14 can be included in a 12-19 age bracket.
- The three questions about the timing of death can be combined into one question, rather than divided (as they are in table 1), but combining is thought to decrease recall.
- Different surveys often use a different number of days/weeks for the postpartum period, ranging from six weeks to two months. This difference will make a negligible difference in results and it is recommended to choose a length and phrasing that makes the question clear for those collecting and providing information.

Fertility Questions

The number of their live-born children, how many are still alive, and how many have died involve questions about fertility.

There are several acceptable ways to phrase a question that asks for the above information. More detailed questions are recommended (compared to more broad), as detailed questions are thought to improve recall. An example of a more detailed set of questions is the following:

- How many live-born sons have you given birth to who: (1) are still alive and live with you? (2) are still alive but live elsewhere? (3) have died?
- How many live-born daughters have you given birth to who: (1) are still alive and live with you? (2) are still alive but live elsewhere? (3) have died?

Asking the question separately for sons and daughters is thought both to improve recall and to provide information necessary for calculating sex-specific estimates of child mortality. However, it is also acceptable to ask the question once (for all children) rather than twice (for sons and daughters).

Information on *a woman's last child born alive* also involves fertility:

- In order to gather information on recent fertility, a question can either be asked about whether or not the respondent has given birth in the last 12 months or to ask the respondent for the month and year of her last birth. There is some suggestion that asking the respondent to produce the month and year of her last birth decreases omission of births.
- An example question for gathering information on the last child born alive is: *In what month and year did you have your most recent live birth?*

Interviewer Training and Fieldwork

Training of census workers often proceeds at several stages. The first stage often involves training of staff at the level of a country's central statistics office. These individuals in turn then train district trainers, who in turn train field supervisors. It is then often the field trainers who are

responsible for training the actual interviewers. At each level training on the pregnancy-related questions is essential and should include both classroom instruction and field practice to ensure that each interviewer understands the questions, knows how to complete the relevant sections of the questionnaire and is prepared to handle common scenarios that may occur during actual fieldwork. Careful training of field staff is important to help ensure good quality data.

Data quality checks in the field are also important. Interviewers should be supervised in the field and completed questionnaires can be spot checked for common potential errors. In some cases, a questionnaire is not completed during the first visit (for example, a household where members are not present on the first visit and must be revisited later) or a mistake may be found through spot-checking.

Questions on age are essential for maternal mortality estimation. Census questionnaires often include two methods of asking about age: (1) age in years or months for young children; and (2) birthdate (when known). Calendars on important local events can be used to estimate a respondent's age, when necessary. Spot checks should include a review of pregnancy-related deaths and births to ensure that the reported ages are in the reproductive age range.

How to Ensure Households Can Be Identified in a Post-Census Verbal Autopsy Study

It is essential that households in the census are clearly enumerated and identified so that it is possible to find them for the post-census verbal autopsy. In some settings in low- and middle-income countries, a permanent system of numbering streets and/or households may not exist. In such cases it is particularly important that each household structure be given a number and that sufficient detail is provided on the location of each household so that it is possible to identify them in future surveys. Many studies use such household listings from a census for their own sampling designs, thus the importance of these listings.⁷ To aid in the actual fieldwork, maps of household locations may be helpful in enabling interviewers to quickly find households.

Calculations and the WHO Spreadsheet

Several manuals explain the steps needed to use the data collected by the census to actually calculate and present pregnancy-related mortality.^{3,7} Before the calculations can be conducted the

data quality of the census must be checked including the (1) population structure, (2) completeness of reporting of number of deaths, (3) completeness of reporting of live births, and (4) the classification of adult female deaths as pregnancy-related. If data quality is an issue, the referenced manuals outline the necessary adjustments that could be performed to arrive at reliable estimates of pregnancy-related mortality. In addition, WHO has generated a spreadsheet which assists users by going through each of the steps needed to both evaluate and adjust the data.³

The WHO guide is available at the following URL:

<http://www.who.int/reproductivehealth/publications/monitoring/9789241506113/en/#>

The maternal mortality estimation from census data spreadsheet is at:

[http://www.who.int/entity/reproductivehealth/publications/monitoring/
CENSUS_spreadsheetsMMR.xlsx?ua=1](http://www.who.int/entity/reproductivehealth/publications/monitoring/CENSUS_spreadsheetsMMR.xlsx?ua=1)

Chapter 3. Conducting a Post-Census Verbal Autopsy

In this chapter, we highlight the key points to consider when conducting a post-census verbal autopsy including questionnaires, interviewer training, fieldwork and sampling, determining cause of death, and presentation of results. WHO has produced two sets of verbal autopsy instruments and related reference materials that should be consulted.^{5,6}

Questionnaires and ICD-10 Cause of Death Coding

WHO first issued international standardized verbal autopsy questionnaires in 2007.⁵ The questionnaires cover three age groups — children under four weeks, children four weeks to 14 years, and individuals aged 15 and older. A second set of questionnaires was released in 2012⁶ that reduced the number of conditions and questions contained in the 2007 version. Some of the questions were revised to allow for a simple yes or no response, which facilitated the use of software that assigns cause of death. Both the 2007 and 2012 versions allow for direct estimation of the cause structure of mortality at a community or population level. The questionnaires are designed to identify maternal and perinatal deaths, deaths caused by injuries, and many other leading causes of death. Efforts are currently underway to agree upon a single standardized verbal autopsy instrument that will be suitable for both physician-based diagnosis as well as computer-coded diagnosis.

These questionnaires contain both common questions and unique questions for the different age groups. Questions on pregnancy and childbirth are included in the instrument for children under four weeks, as issues surrounding childbirth and its management could be a factor in a neonatal death. The questionnaire for children aged four weeks to 14 years includes a section called “symptoms and signs associated with pregnancy”, to be asked if the decedent was a female between 12 and 14 years of age. Each questionnaire is designed to provide information necessary to determine the cause of death from the responses provided, often relying on the ICD coding system — the standard diagnostic tool for disease classification in the fields of epidemiology and health management and for clinical purposes.² The ICD-10 (the 10th revision) was updated through 2010 and an 11th revision was being developed at the time this guide was written. More information can be found online in the manual and ICD site.⁴

The 2012 version of the WHO verbal autopsy questionnaire is divided into the following sections: (1) basic information about the interview and respondent; (2) information on the deceased and date/place of death; (3) death registration and certification; (4) respondent's account of illness/events leading to death; (5) context and history of previously-known medical conditions; (6) history of injuries/accidents; (7) symptoms and signs associated with illness of women; (8) symptoms and signs associated with pregnancy; (9) symptoms noted during final illness; (10) treatment and health service use for the final illness; (11) risk factors; and (12) background on any final treatment.

Key questions for determining maternal causes of death are described in the following subsections. The full questionnaire can be found in WHO's verbal autopsy manual⁵ available at:

<http://www.who.int/healthinfo/statistics/verbalautopsystandards/en/>.

Information on the Deceased

The information gathered in the section is important for assessing cause and defining the skip pattern for the rest of the interview. Some of the questions overlap with those recommended for inclusion in the census, including sex, age, and age at death. However, it is important to ask these questions again during the verbal autopsy interview. The verbal autopsy interview is focused exclusively on the death of the household member while the census covered a wide range of topics. The verbal autopsy interview provides a cross-check of information reported in the census. Also, the verbal autopsy should be usable as a stand-alone data source, and thus such information is important to include.

Background information on the deceased can be used both to confirm the link to a death reported in the census and to confirm that the death is eligible for inclusion. A common reason for exclusion would be a death outside of the designated period. For example, in the census household respondents may have been asked about deaths in the past year, but upon conducting the verbal autopsy survey it may be discovered that the death actually occurred two years ago. Thus, confirming the date of the death is crucial.

- What was the name of the deceased?

- Was the deceased female?
- Is date of birth known?
 - When was the deceased born?
- Is date of death known?
 - When did she die?
 - How many years old was she at death?
 - How many months old was she at death?
 - How many days old was she at death?
- Was this a woman who died more than 42 days but less than one year after being pregnant or delivering a baby?

It is also important to ask questions about place. These include the geographic location (province, village, etc.) as well as the actual location (facility, home, etc.). Questions on place of death are important for subnational level presentation of the data. It is also important to confirm that the death happened to a person who was living in the particular household and not an individual who previously lived in the household (but is no longer living there). Place of death — facility or non-facility — is particularly relevant in settings where large proportions of maternal deaths occur in homes or non-facility environments.

- What was her/his place of birth?
- What was her/his place of usual residence?
- What was her/his place of normal residence one to five years before death?
- Where did death occur (country/province/village)?
- What was the site of death (hospital/other health facility/home/other/don't know)?

Other questions about the socioeconomic status and other characteristics of the deceased can also be included. Such questions might uncover issues surrounding differentials in cause of death or place of death (facility versus non-facility) by key socioeconomic factors.

- What was her/his citizenship/nationality?
- What was her/his ethnicity?

- What was the highest education level obtained?
- What was her/his occupation?
- What was her/his marital status?

Census Linking and Certification Information

It is important to have a section where unique numeric identifiers from the census household listing are recorded. This is a method to ensure that the two data sources, the census and the post-census verbal autopsy, can be linked.

Example of prompts for unique identifier for linking are:

- household identifier from census questionnaire
- individual identifier from census questionnaire

Information on the Respondent

While this information is not used to determine cause of death, it is important information to collect as part of a verbal autopsy (VA). This includes:

- name of VA respondent
- relationship of respondent to deceased
- whether the respondent lived with the deceased in the period leading to her/his death
- name of VA interviewer
- time at start of interview
- date of interview

Symptoms and Signs Associated with Pregnancy

This section includes important questions aimed at determining the exact cause of maternal death. Within maternal deaths there are direct and indirect obstetric causes.

Direct

obstetric deaths: These result from obstetric complications of pregnancy, labor or the postpartum period.

Indirect

obstetric deaths: Indirect obstetric deaths result from previously existing diseases or from diseases arising during pregnancy (without direct obstetric causes) that were aggravated by the physiological effects of pregnancy.

According to WHO statistics, 72.5% of maternal deaths worldwide are due to direct obstetric causes and 27.5% are due to indirect obstetric causes.⁶ The most common direct causes are hemorrhage, hypertension disorders, sepsis, abortion and embolism. Common indirect causes include HIV, malaria, anemia and cardiovascular diseases. It is important that a verbal autopsy questionnaire be designed to include both common direct and indirect obstetric causes.

The following questions are important for determining the time of death in relationship to a pregnancy and establishing that the death was pregnancy-related:

- Was she neither pregnant, nor delivered, within six weeks of her death?
- Was she pregnant at the time of death?
- Did she die within six weeks of giving birth?
- Did she die six weeks within a pregnancy that lasted less than 6 months?
- Did she die within 24 hours after delivery?
- Did she die during labor, but undelivered?
- Was she breastfeeding at death?

The questions below are important to get at risk:

- How many births, including stillbirths, did the mother have before this baby?
 - Was this the woman's first pregnancy?
 - Did she have four or more births, including stillbirths, before this pregnancy?
- Did she have any previous Caesarean section?
- Did she die during or after a multiple pregnancy?

The questions below are important for determining whether a death was due to a direct obstetric maternal cause:

- During pregnancy, did she suffer from high blood pressure?
- Did she have foul smelling vaginal discharge during pregnancy or after delivery?
- During the last three months of pregnancy, did she suffer from convulsions?
- During the last three months of pregnancy did she suffer from blurred vision?
- Did she give birth to a live, healthy baby within six weeks of death?
- Was there excessive vaginal bleeding during pregnancy or after delivery?
- Was there vaginal bleeding during the first six months of pregnancy?
- Was there vaginal bleeding during the last three months of pregnancy but before labor started?
- Was there excessive vaginal bleeding during labor?
- Was there excessive vaginal bleeding after delivering the baby?
- Was the placenta not completely delivered?
- Did she deliver or try to deliver an abnormally positioned baby?
- Was she in labor for unusually long (more than 24 hours)?
- Did she attempt to terminate the pregnancy?
- Did she recently have a pregnancy that ended in an abortion (spontaneous or induced)?

The question on place of birth is important to distinguish maternal deaths after a facility delivery versus a non-facility delivery.

- Did she give birth in a health facility?
- Did she give birth at home?
- Did she give birth elsewhere, e.g. on the way to a facility?

The next questions are related to services received and type of delivery:

- Did she receive professional assistance during the delivery?
- Did she have an operation to remove her uterus shortly before death?
- Did she have a normal vaginal delivery?
- Did she have an assisted delivery, with forceps/vacuum?
- Did she deliver by Caesarean section?

The section on *context and history of previously-known medical conditions* is essential in uncovering indirect obstetric causes of maternal mortality. In addition, questions in the section on *symptoms noted during final illness* are needed for determining indirect causes of maternal death. For example answers to questions on severe weight loss, prolonged unexplained fever, diarrhea, persistent cough or known HIV status are essential for establishing HIV as a cause of death. In addition answers to questions on mouth sores, skin rash and swelling of lymph nodes are also used to make a HIV cause of death diagnosis. Questions on onset of high grade fever with chills, jaundice, breathlessness, decreased urine output, convulsion and headache and/or positive malaria test are essential for a diagnosis of malaria as a cause of death. Answers to questions on acute respiratory infection and body rash are important for excluding malaria as a cause of death.⁸

A comprehensive set of questions is important for establishing both direct obstetric and indirect obstetric causes of death as well as specific cause of death. Once again, WHO has put together comprehensive verbal autopsy instruments that can be used as a guide.^{5,6}

An *optional open narrative*, where the interviewer records his or her observations, can be included for quality assurance. While this section can be useful, it is optional.

Interview Training and Fieldwork

Interviewers must be trained to be sensitive throughout the interview process. It may be difficult for respondents to answer questions about loved ones who have died; thus, the interviewer needs to balance sensitivity with following through and asking all relevant questions. Interviewers will need both classroom training and practical field experience in order to be fully prepared to conduct actual verbal autopsies. They should also be trained on each age-specific verbal autopsy questionnaire.

Fieldwork and Sampling

A key question to determine the sampling approach is whether a country is interested in all causes of death or maternal mortality only. If the country is interested in the former, the sample would include all deaths and the sample size would need to be sufficient to study maternal deaths. If a country is only focused on maternal mortality, the sample would be based on deaths

reported among women of reproductive age. A limitation of this approach is that deaths misclassified as non-pregnancy-related in the national census would be entirely missed. Therefore, it would be advisable to start with a sample approach that includes all causes of death. Issues such as available budget, size of the country, and number of deaths reported will determine whether all households that reported a death or a sample of households can be visited for the follow-up verbal autopsy.

A common sampling approach is cluster sampling whereby enumeration areas from the census may be divided into rural and urban strata. A random sample of enumeration areas by strata and province may be selected. Stratification may be driven by variation in health conditions and causes of death within a country. For example in some countries malaria may only be endemic in certain areas. Also important is considering the health zones that a health ministry uses for programming and planning. All households that reported a death in the census in the selected enumeration areas can then be visited for a verbal autopsy interview. The exact number of enumeration areas to be selected may be determined by sample size needed to obtain accurate estimates and also budgetary constraints. Experience from other post-census VAs has indicated that some of the deaths reported in the actual census may ultimately be eliminated. For example in post-census VA in Mozambique, 35% of deaths were found to be outside the time period of reference, occurred to someone outside the household or occurred to someone outside the geographic area in question.⁹ In Bolivia a large proportion of deaths were eliminated because they occurred outside the time period of reference, occurred to a woman outside the reproductive age range or the household could not be located.¹⁰ With these experiences in mind, it is important that pregnancy-related deaths are correctly identified in the census for the appropriate time period. Also it is important that appropriate information is recorded such that households from the census can be found in the post-census VA. Thirdly, it may be necessary to increase the calculated sample size with the notion that some of the sample may be lost due to the above reasons. Key points to consider are presented in table 2.

Table 2. Sampling Issues to Consider

Point to Consider	Comment
Finding households from the census	<ul style="list-style-type: none"> Ensuring that households from the census are clearly marked will enable interviewers to go back to households reporting a death for the verbal autopsy.
Timing of deaths	<ul style="list-style-type: none"> During the verbal autopsy survey, interviewers should double check the timing of the deaths reported in the census to ensure they are in the appropriate timeframe.
Age	<ul style="list-style-type: none"> Interviewers should double check ages of women reported to have died due to pregnancy-related causes.
Geographic area	<ul style="list-style-type: none"> Confirmation of the usual place of residency of the deceased is needed.
Sample Size	<ul style="list-style-type: none"> It may be necessary to increase a calculated sample size with the assumption that part of the sample may be lost due to the above reasons

Ethical Issues

It is important to consult appropriate in-country ethical review boards at the planning stage of a post-census verbal autopsy. Depending on the nature of the purpose of the post-census verbal autopsy, informed consent may be needed prior to talking with any respondent. In addition, interviews should be conducted in a quiet and private location. Personal data, including names and contact information, should be kept separate and should not be recorded in the dataset. As mentioned previously, unique numeric identifiers should be used to link the verbal autopsy and census data.

Verbal Autopsy Cause of Death Coding

Once a verbal autopsy has been conducted, there are two main methods for assigning probable cause of death: physician-coded verbal autopsy (PCVA) and computer-coded verbal autopsy (CCVA). PCVA remains the most commonly used method for determining probable cause of death from a verbal autopsy.¹¹ With PCVA, a trained physician reviews the verbal autopsy questionnaire and assigns a probable cause of death. Typically, two physicians independently

review verbal autopsy questionnaires and assign probable cause of death, and discrepancies between physicians are generally resolved by consensus or by a third physician. In contrast to physician-coded verbal autopsy methods, computer-coded verbal autopsy methods use automated computer programs to assign probable cause of death based on standardized verbal autopsy questionnaires. CCVA strategies vary and include data-driven algorithms, such as Random Forest and Tariff methods, data-driven probabilistic methods (such as King-Lu and the Simplified Symptom Pattern methods), and Inter-VA, which uses probabilistic modeling with the a prior probability based on expert consensus.¹²

PCVA and CCVA have advantages and disadvantages. Generally, PCVA is resource-intensive, requiring a significant amount of time, training, and financing and, thus, may not be feasible in some resource-poor settings. In addition, because PCVA depends on expert opinion, PCVA is more susceptible to individual bias than CCVA methods. Concerns have been raised about inter-coder and intra-coder reliability of PCVA.¹² However, several advantages of PCVA have also been noted. With PCVA, physicians can incorporate the chronology of events leading up to death as well as relevant contextual factors in assigning cause of diagnosis.¹³ In addition, PCVA is generally seen as a more transparent and accessible methodology than CCVA. Several advantages of CCVA have also been noted. CCVA is often substantially faster and cheaper than PCVA. Because CCVA is an automated process, CCVA is also more reliable than PCVA, eliminating the potential for bias from individual coders. However, concerns have been raised about the lack of transparency of many CCVA methods, indicating that CCVA methods are akin to a ‘black box’ in which assumptions and the process for assigning cause of death are generally not readily accessible. In addition, CCVA largely cannot incorporate relevant contextual factors which may provide useful information when assigning a probable cause of death diagnosis.¹³ A systematic review examined 19 studies that compared PCVA with at least one of five methods of CCVA (Inter-VA, Tariff, Random forest, King-Lu, Simplified Symptom Pattern) and found that no one method of assigning cause of death consistently performed better than others.¹²

Presenting Results

Once a cause of death has been determined either through physician-coded or computer-coded verbal autopsy methods, the cause of death is assigned a standardized code which represents this cause of death in the ICD system. If more than one cause of death has been identified, the ICD-10 provides guidance for identifying the underlying cause of death, defined as “the disease or injury which initiated the train of morbid events leading directly to death or the circumstances of the accident or violence which produced the fatal injury”.² With maternal mortality it is important to present data on direct versus indirect obstetric causes as well as by specific cause of death such as hemorrhage, hypertension, HIV, malaria etc. The VA tools mentioned in this guide are meant to enable a high quality determination of cause of death.

Conclusion

Maternal mortality estimation through the use of a post-census verbal autopsy can provide countries with information on the magnitude of maternal mortality as well as cause of death at a population-level. These data can be compiled at both national and subnational levels and give program planners and policymakers information needed to improve programs and policies. This guide, along with the key references provided, are meant to outline the steps necessary for the successful implementation of this methodology.

Key Resources

The headings in this section are linked to the resources described, allowing access when reading this guide on a computer screen. The actual universal resource locators (URLs) are also listed in the descriptions.

[International Statistical Classification of Diseases and Related Health Problems](#)

The International Classification of Diseases (ICD) is the standard diagnostic tool for epidemiology, health management and clinical purposes. The WHO Web site includes links to the ICD-10 online, more information on the ICD-10, including the updating process, and additional resources, located at: <http://www.who.int/classifications/icd/en/>.

[WHO Guidance for Measuring Maternal Mortality from a Census](#)

The WHO guidance for measuring maternal mortality from a census is a tool for estimating Maternal Mortality Ratios. The guide, as well as an excel worksheet for calculating estimates from census data, and other resources are available on the WHO Web site at:

<http://www.who.int/reproductivehealth/publications/monitoring/9789241506113/en/>.

[Verbal Autopsy Standards: Ascertaining and Attributing Causes of Death](#)

The verbal autopsy standards release candidate 1 is designed for routine use and has been used in several field settings. The verbal autopsy standards include guidance on use, a full questionnaire, and links to several useful Microsoft Excel workbooks, available at:

<http://www.who.int/healthinfo/statistics/verbalautopsystandards/en/>

[SAVVY: Sample Vital Registration with Verbal Autopsy](#)

Sample Vital Registration with Verbal Autopsy (SAVVY) is a system for strengthening vital events monitoring and measurement, including causes of death. SAVVY resources on the

MEASURE Evaluation Web site include an overview of SAVVY, manuals for training, sample forms, and other useful resources, available at:

<http://www.cpc.unc.edu/measure/tools/monitoring-evaluation-systems/savvy>

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