Training Course on:

Civil Registration and Vital Statistics Systems

Participant's Notes — September 2015

International Statistics Program

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Overview of Civil Registration and Vital Statistics Systems

Civil Registration And Vital Statistics Systems

Introduction and Course Objectives

This course in Civil Registration and Vital Statistics Systems is intended to provide information to epidemiologists, statisticians, demographers, and others working in public health about vital statistics data gathered from the civil registration system. Even though civil registration systems may differ somewhat from country to country, there are many similarities among countries and the course contains a general description of the administrative process of civil registration. The intent is to provide background information for persons using vital statistics data so they understand how those data are obtained, ways to use and disseminate the data, and some problems and limitations of the data. The course does not cover the detailed legal and administrative issues that would be of use to persons working in a country's office of civil registration. Instead, a general overview is provided about the civil registration process with emphasis on the issues that are related to vital statistics data collection.

Since birth and death data are widely used to monitor public health and are available in most countries, the course goes into detail on the analysis of vital statistics information for public health using standard measures of natality and mortality data. Examples of types of data that can be collected from birth and death records are given so participants are aware of different types of analyses that can be done even if those particular data items are not collected in their country. Standard methods for collection and tabulation of cause of death information are provided so participants understand how these data can be used and how comparisons among countries can be made. To make vital statistics data available to government officials, researchers, and the public, various methods for distribution and dissemination of these data are also presented.

Because it is very important to have timely public health information as well as high quality vital statistics data, part of the course is devoted to assessing and improving civil registration and vital statistics systems. The intent is to provide participants with some methods to evaluate the civil registration and vital statistics systems in their own countries and to better understand any problems or issues with their vital statistics data.

Along with the general information on civil registration that is similar from country to country, examples and details specific to the participants' countries have been inserted into the course. Participants should be familiar with the structure and process for civil registration in their own countries, the data items collected on their vital records, and the types of vital statistics available in their country for public health analysis.

At the end of the course participants should:

- Understand how vital statistics are obtained from the civil registration system;
- Be able to describe the main characteristics and functions of a civil registration system;
- Know the structure of the civil registration system in their country;

- Know who is responsible for providing information on vital records and who is responsible for registering vital records in their country;
- Understand how vital records are processed and how the data are prepared;
- Know what data can be obtained from birth records and how the data can be used for health analyses;
- Know what data can be obtained from death records and how the data can be used for health analyses;
- Be able to calculate various natality and mortality rates;
- Understand how the leading causes of death are determined;
- Be able to present vital statistics data in tables, graphs, and figures;
- Understand possible problems with vital statistics data;
- Be able to assess the vital statistics system in their country and suggest ways to improve the system;
- Understand the various uses of vital statistics data and how those data are disseminated.

Overview of Civil Registration and Vital Statistics Systems

Civil Registration is the process government uses to record the vital events such as birth, death, marriage, and/or divorce that are required by the laws and regulations of the country. The primary purpose of civil registration is to establish the legal documents required by law. The goal of civil registration is to record all vital events that occur in a country as they occur.

The United Nations defines civil registration as "the continuous, permanent, compulsory and universal recording of the occurrence and characteristics of vital events pertaining to the population as provided through decree or regulation in accordance with the legal requirement in each country."[1-1] The civil registration system includes all of the processes and procedures involved in the recording, maintenance and storage of vital events as required by law.

Vital Statistics are the data related to vital events with the civil registration system being the best source for those data. The vital statistics system includes all of the processes involved in collecting, compiling, analyzing and disseminating information obtained from the vital events filed through the civil registration system. The goal of the vital statistics system is to have complete, accurate, and timely data for all vital events that occur in a country.

The United Nations defines a vital statistics system as *"the total process of*

A. *collecting information by civil registration or enumeration on the frequency of occurrence of specified and defined vital events, as well as relevant characteristics of the events themselves and of the person or person concerned, and*

B. *compiling, processing, analyzing, evaluating, presenting and disseminating these data in statistical form."*[1–2]

In some countries where the civil registration system does not cover the entire geographic area of the country, vital statistics may be compiled for some cities or other geographic areas that have good coverage and vital statistics are complete. Vital statistics may also be obtained through other statistical methods such as sampling or through a census of the population. However, census data are periodic and not continuous, and data from sample surveys contain sampling and recall error. (Note that census data do provide the denominators or population-at-risk used in calculating vital statistics rates.) In some cases administrative records from other government agencies such as those that provide health or social services may be used to supplement data in the vital statistics system. However, the ultimate goal should be to have complete coverage of all vital events occurring in the country through the civil registration system.

Types of Vital Records

The types of vital events registered through the civil registration system in a country are determined by the country's laws and regulations. The United Nations recommends that 10 types of vital events should be recorded in a country's civil registration system. However, not all countries register all of these events while other countries register some additional types of vital events. Also, different names are used for some of these types of records in different countries.

The following are the 10 types of vital events[1–3] recognized by the United Nations with brief definitions:

1. **Birth**–a live born infant
2. **Death**–the disappearance of life
3. **Fetal Death**–a dead born fetus
4. **Marriage**–the legal relationship of a husband and wife
5. **Divorce**–the legal termination of a marriage with the right of the parties to remarry
6. **Annulment of Marriage**–the invalidation or voiding of marriage
7. **Judicial Separation of Marriage**–the parting of married persons without the right to remarry

8. **Adoption**–the legal taking of a child of other parents as one's own
9. **Legitimation**–legally giving a person the rights of a person born in wedlock
10. **Recognition**–legal acknowledgement of paternity of a child born out of wedlock

(Note that more detailed statistical definitions of birth, death and fetal death will be presented later in the course.)

Generally vital statistics are not complied and tabulated for all of these types of vital events. The main vital events used for public health analyses are births and deaths, and they will be the main focus of this course. Fetal deaths are also very useful for public health although they are not collected in all countries. Some countries also produce vital statistics on marriages and divorces (may include annulment and judicial separation) which are useful for demographic studies. Records of adoption, legitimation, and recognition are primarily used for administrative and legal purposes.

Uses of Vital Records

All records of vital events filed through the civil registration system of a country are used for various legal and administrative purposes by government agencies, businesses and individuals. As noted previously, some records are used to produce vital statistics for use by statisticians, epidemiologists, demographers, and other researchers. Birth and death records are the main source of vital statistics for many public health and other research studies.

Some examples of uses of vital records are as follows:

Births

- Legal proof of identity for an individual
- Individual proof of age, date of birth, place of birth, parentage and citizenship
- Maintaining population registries and identity card systems
- National security and issuance of passports
- Creating and maintaining election rolls
- Administering social service programs
- Public health programs and registries
- Natality rates and trends
- Maternal and infant health studies
- Population estimates and predictions
- Sampling frames for research studies
- Identify populations at risk for medical problems
- Fertility data for family planning studies

Deaths

- Evidence of death for heirs
- Probate an estate and collect life insurance
- Purge population registries and election rolls
- Genealogical research
- Mortality rates and trends
- Study specific disease patterns and causes of death
- Examine differences in mortality by age, sex, ethnicity, geographic areas, etc.
- Infant and maternal mortality studies
- Creation of life tables
- Population estimates and predictions
- Monitor infectious diseases

Marriages and Divorces

- Legal proof of marriage or divorce
- Administering social and family benefit programs
- Genealogical research
- Marriage and divorce rates and trends
- Demographic studies
- Sampling frames for research studies

While the examples above are not all inclusive, it is easy to see that birth and death records are extremely valuable for many public health purposes. Lack of a good civil registration system in a country to obtain high quality, accurate, complete and timely vital event registration would make it very difficult to have the information necessary to monitor and assess public health issues in maternal and infant health and mortality including disease patterns and causes of death.

Review

- Civil registration is the legal process to record a country's vital events.
- The goal of civil registration is to record all vital events occurring in a country as they occur.
- Vital statistics data are obtained from the vital events filed through the civil registration system.
- The goal of the vital statistics system is to have complete and accurate data for all vital events occurring in a country.
- Vital records are used for legal and administrative purposes, tabulation of vital statistics data, and public health and other research.
- The main source of birth and death information for public health is from vital records filed through the civil registration system.

Section 1 References

1-1. *Handbook on Civil Registration and Vital Statistics Systems, Management, Operation and Maintenance*; Studies in Methods, Series F, No. 72; United Nations, New York, 1998 (Paragraph 22) http://unstats.un.org/unsd/publication/SeriesF/SeriesF_72E.pdf

1-2. *Handbook on Civil Registration and Vital Statistics Systems, Management, Operation and Maintenance*; Studies in Methods, Series F, No. 72; United Nations, New York, 1998 (Paragraph 26) http://unstats.un.org/unsd/publication/SeriesF/SeriesF_72E.pdf

1-3. *Handbook on Training in Civil Registration and Vital Statistics System*; Studies in Methods, Series F, No. 84; United Nations, New York, 2002 (Module 2) http://unstats.un.org/unsd/publication/SeriesF/SeriesF_84E.pdf

Section 2

Civil Registration Systems

Civil Registration And Vital Statistics Systems

Characteristics of Civil Registration Systems

As a reminder, the United Nations defines civil registration as "the continuous, permanent, compulsory and universal recording of the occurrence and characteristics of vital events pertaining to the population as provided through decree or regulation in accordance with the legal requirement in each country."[2-1] Thus, the primary purpose of civil registration is to establish the legal documents required by the laws and regulations of the country. The goal of civil registration is to record all vital events required by law, such as births, deaths, marriages, divorces, etc., that occur in a country as they occur.

Legal Framework: The legal framework for the civil registration system should contain all of the requirements for civil registration in a country. Ideally, the laws and regulations should require that records of all vital events occurring in the country be recorded. In addition to specifying which vital events are to be reported, the laws should include the time period in which they must be reported and who is responsible for reporting each type of vital event. The law should also specify which organization or government agency is authorized to register the vital events. Some civil registration laws contain a requirement for tabulation and/or publication of vital statistics, although not all countries have this in their law. In order to enforce the requirements of civil registration, the law should also contain some penalties on authorities or officials who fail to comply with the law. A good civil registration law provides the fundamental structure for the efficient administration of a country's civil registration system.

Full Coverage of the Population: In an ideal situation, the civil registration system should provide full coverage of the population of the entire country. That is, all vital events as specified in the civil registration law should be reported for the entire geographic area of the country. However, this may not be possible in all countries due to economic or cultural conditions. In some countries, only certain provinces, states or cities have legal requirements for full coverage reporting of all vital events. In other countries, only some vital events may have requirements for full reporting. Generally if all vital events cannot be registered in a country, emphasis is given to reporting of births and deaths since these are most often needed for legal purposes and also provide the basic information for public health analyses.

Continuous and Permanent: As stated in the United Nations definition, civil registration is continuous and permanent. This means that new records of vital events must be continually added to the system, preferably as the events occur. In addition, records of all vital events must be maintained in a secure and permanent way so they will be available when needed for administrative or individual purposes in the future. Methods and procedures must be established by the government agency responsible for civil registration to ensure that current records are added to the civil registration system in an appropriate manner and that all records of vital events are preserved and maintained for future use.

Confidentiality of Personal Information: Many civil registration laws also provide for confidentiality of personal information collected on individuals by limiting release

of information from vital records. Often detailed information on vital records could be sensitive, potentially embarrassing, or very personal. For example, birth records may contain information on legitimacy of the child or information about the mother's pregnancy, or death records may have a cause of death that could be embarrassing to the family of the deceased. Many believe that restricting release of information on vital records will help to improve reporting of vital events and increase accuracy and completeness of items collected on the records. Ideally safeguards should be available to protect the confidentiality of individual information from vital records. However, in some countries information from vital records is not restricted, and some or all vital records are open to public inspection.

Structure Of Civil Registration Systems

Legal Basis: As noted previously, civil registration systems are structured on a legal basis that should provide clear guidelines on how the system will function. The civil registration law should include provisions for the general organization of the system and methods of its operation, but not be so detailed as to prevent management from making administrative adjustments for efficient operation of the system. The law should be flexible enough to allow management to take advantage of advancements in technology as they occur.

The civil registration law should specify the government agency where the central or national authority for the civil registration system will be located. A Registrar General or Director General is usually appointed to provide oversight of the civil registration system, and the law should specify the general authority and duties of the Registrar General. The civil registration law may also designate the agency for tabulating and compiling vital statistics which may or may not be the same agency responsible for civil registration. In an ideal situation, the civil registration law should also specify:

- the types of vital records that have to be reported, and when and where they should be reported
- that civil registration is compulsory
- if information on vital records is confidential
- who may obtain copies of vital records or information on those records
- requirements for release of vital records
- a method for funding the system or the financial basis for the system
- penalties for failing to comply with requirements of the law

In practice, civil registration of vital events usually takes place at a **local registration office** or **local registration unit**, and the civil registration law should include provisions for establishing those offices. Sometimes smaller secondary registration areas are established under a primary local area to improve the registration process. Generally, a **local registrar** is appointed to administer the local office, and the civil registration law generally establishes their duties and responsibilities. In most cases, local registrars are full time positions whose duties include the following:

- ensuring compliance with the civil registration law
- registering vital events and recording or entering specific information on the records
- ensuring vital records are accurate and complete
- informing the public of procedures for registering vital events

In many countries the person responsible for registering a vital event goes to the local registration office to provide information about that event to the local registrar. The local registrar, or someone on his or her staff, often enters the information on a paper form or into a computer program or assists the person responsible for reporting the event in completing the appropriate form. The local registrar also has responsibility for following up on questionable or problem items on a vital record to make sure the information is accurate and complete (more will be covered on this later under querying).

In some countries local registrars also preserve and store vital records locally and issue certified copies of those records, but in other countries, these functions are only done at the national level or at a regional level. Sometimes the local registrar is required to complete statistical reports and forward those reports to the statistical agency responsible for compilation of national data. The duties of the local registrar depend on the civil registration laws and regulations of the country where the vital events occur.

Organization: Depending on the size and conditions of the country, the structure of the civil registration system can take several different formats. If the civil registration law places responsibility for civil registration at the national government level, the system is **centralized**. If the responsibility is placed at a state or provincial government level, the system is **decentralized**.

In a **centralized system**, civil registration is coordinated by one set of standards for operation of the system. The laws and regulations are consistent and the same forms and procedures are used throughout the country. In centralized systems local registration districts all have the same requirements making it easier for the central authority to provide training and technical assistance. Preservation of vital records also generally follows more uniform archival practices. However in a centralized system, it may be more difficult for local areas to alter data collection forms to add items of public health interest specific to their areas.

In a **decentralized system**, each state or province may have its own civil registration laws and procedures that may differ throughout the country. Registration processes, data collection forms, and data items may be not be consistent throughout the country making tabulations of national statistics more difficult. However, states or provinces can more easily collect items of public health interest to their own areas. Also, in decentralized systems, individuals have to obtain copies of vital records from the state or province where the record was originally registered.

The civil registration law can also place responsibility for both the civil registration and vital statistics functions in one **single agency**, or it can separate those functions into **multiple agencies** with one government agency responsible for civil registration functions and a different government agency responsible for producing vital statistics data. If the civil registration and vital statistics functions are in different agencies, some type of formal structure for coordination and communication between those agencies should be established for efficient operation of the system.

All types of combinations of these structures are found throughout the world. Many countries have centralized multiple agency structures where responsibility for both civil registration and vital statistics are at the national level, but they are in different government agencies such as the Ministry of the Interior or Justice for civil registration and the Ministry of Health or Finance for compilation of vital statistics. For example, in Costa Rica civil registration is under the jurisdiction of the Supreme Tribunal of Elections, an independent institution that administers the country's electoral procedures and preparation of identity cards, and vital statistics are compiled by the General Directorate of Statistics and Censuses under the Ministry of Economy, Trade and Industry. In Thailand civil registration is in the Civil Registration Division of the Department of Local Administration, Ministry of the Interior, and vital statistics are compiled by the Health Statistics Division of the Ministry of Public Health.

Some larger countries have decentralized systems where local governments such as states or provinces operate the civil registration system under national laws or they may operate under their own local laws. In some countries local governments also compile vital statistics or they may pass information to a national office for compilation of national statistics. In Canada vital events are registered in the provinces or territories where they occur and data on the vital events are transmitted to the national authority (Statistics Canada) for inclusion in the national data base. Each of the 32 states in Mexico has its own civil code and civil registration requirements, although all are similar. In the United States, registration of vital events and compilation of vital statistics occurs in the 50 states, 2 cities, and 5 territories, and statistical information is also forwarded from each of the 57 areas to the national government for preparation of national vital statistics.

In civil registration and vital statistics systems with decentralized structures or with responsibility in multiple agencies, it is important to have communication among the different government units to promote consistency in civil registration methods and consistency in data collection so that statistics can tabulated for the entire county. Often, a national or professional advisory committee is established to make

recommendations for model laws, standard forms, common definitions, and uniform collection and processing methods to ensure that vital statistics data collected under different civil registration laws can be combined for use in studying and analyzing public health concerns at the national level.

Process of Civil Registration

Place of Registration: The civil registration law should specify the place of registration for each type of vital event. In most countries the designated place of registration is a local civil registration unit. However, vital events can be registered in the **place of occurrence** which is the geographic location where the event occurred, or they can be registered in the **place of residence** of a person involved in the event. Generally, registration by place of occurrence is easier to accomplish, and many countries use this method. Countries that register vital events by place of residence usually use the residence of the deceased for a death and the residence of the mother for a birth or fetal death although some use the residence of the father for a birth. Residence is generally defined as the location or address where the person usually resides. However, using residence for registration can be problematic for people with more than one residence, people with no usual residence, children found with unknown parents, or foreign nationals living temporarily in a country. The civil registration law should specify how to handle these and other problem events.

For statistical purposes both place of occurrence and place of residence should be collected for all vital events regardless of which is used for registration purposes. Having both locations allows statistical tabulations to be done by either place of occurrence or by place of residence depending on the needs of the researcher. One might use place of occurrence for studying distribution of medical facilities, while place of residence would be more useful for studying demographic characteristics of mothers delivering low weight babies or persons dying from a specific type of cancer. For public health purposes, collecting the residence of the deceased for a death and of the mother for a birth or fetal death is preferred for statistical tabulations.

Person Responsible for Registering Event: For each type of vital event, the civil registration law should also designate the person responsible for registering the vital event. The person who states that the event occurred and provides information on the circumstances and the individuals involved in the event is usually called the informant. In some countries, the **informant** may have to provide a written or oral declaration attesting that the event occurred.

The person acting as the informant should be the most knowledgeable person about the parties involved in the vital event and the circumstances of the event. Informants for a vital event may differ depending on whether or not the event occurred in a medical facility. Alternate informants should be specified if the preferred informant is not available. Examples of informants for births occurring in a medical facility are the person in charge of the facility or the medical attendant at birth. For births outside of

a medical facility, examples of informants are the mother, the father, the attendant at delivery, the nearest relative of the mother, or another adult person who knows the facts of birth. For deaths in a facility, examples of informants are the person in charge of the facility or the medical attendant. For deaths outside of a facility, examples are the surviving spouse, the mother or father of the deceased (particularly for deaths of children), another relative of the deceased, or another adult who knows the facts of death. When a birth or death occurs in a medical facility, the informant usually obtains demographic information from the mother for a birth or a family member for a death and provides information about the event from the medical records.

Persons responsible for registering vital events may vary from country to country. In some countries the funeral director who handles the disposal is responsible for obtaining information about the deceased from the informant, who is generally the surviving spouse or next of kin, and entering it on the death record and then presenting the completed death record to the local registrar. The cause of death information may be part of the civil registration of death or it may be collected as a supplemental statistical item. Cause of death information is best collected from the physician or medical attendant at death or the coroner or medical examiner who handled the body. If the cause of death is part of the civil registration process, the part of the death record pertaining to the cause of death should be completed by the medical certifier. In a similar fashion, supplementary medical information is collected for births in some countries, and that information is best obtained from the physician or medical attendant at birth. Much more detail will be covered on cause of death and on other information on births and deaths in later sections of the course.

Time to Register Vital Event: The civil registration law should specify the time to register each type of vital event. Time periods for registration will depend on the specific conditions in a country. Generally, the time should be short but reasonable, and should be set to allow for most vital events to be registered within in the period specified. Some common time periods are one month for births, five days for deaths, and five days for fetal deaths, but there is lots of variation around those periods. Use of electronic technology for registration of vital events has decreased the time for registration, and in the United States, births are generally required to be registered in five days.

Vital events that are not registered within the time period specified in the civil registration law are called **delayed** or **late registrations**. Many countries impose additional requirements or request documentary proof to register vital events after the period specified in the law.

Delayed registrations that occur more than one year after the event are often not included in the official vital statistics tabulations for that year. Statisticians and researchers using vital statistics data should be aware of how delayed events are handled in the country and how they can affect statistical data. Often deaths that require autopsies or toxicology testing are not reported within the required time period. To prevent delays in reporting deaths, some countries allow a death to be registered with the cause of death as “pending” and then follow-up to obtain the cause of death at

a later time. Other countries require that permits be obtained before final disposition to have deaths registered in a timely manner.

Attempts should be made to decrease the number of delayed or late registrations through educational programs and training of persons responsible for registering vital events. Implementing technology to improve the efficiency of registration also generally improves timeliness. Usually imposing fines and penalties does not improve timeliness of registration and may actually discourage late registrations.

Documentation to Support Registration: To prevent fraudulent registration of vital events, many countries require documentation to support registration, particularly for delayed or late registrations. Usually the type of documentation needed for registration depends on the length of time after the event occurred. Many countries do not require any additional documentation if registration of a vital event occurs within the time specified in the civil registration law. Frequently, the time period for requiring additional documentation to register a vital event is one year after the occurrence of the event.

The kinds of documents required for registration depend on the type of event and the requirements in the civil registration law. Generally, legal documents, certifications from medical attendants, witness statements, baptismal records, school records, military service records, health records, or a combination of these are used to support the facts of the vital event. In some cases where there are insufficient documents to support the facts of the vital event as required in the law, court action may be needed to determine the facts of the event prior to registration. The registrar must be familiar with all types of documents, and any documentation presented for delayed registrations, particularly for birth registration, should be examined very carefully to protect against fraudulent registrations. In some countries, delayed registrations over one year after the event are only done at the national level.

Format for Registration of Vital Events: The format used to register vital events in a county depends on the development of the country, the education level and technical skills of staff, and the resources available. Different types of formats may be used for registration of different vital events, and the formats used may change over time. Examples of formats and how they are used in different countries are as follows:

- **Book Register**–Usually a hard bound book of preprinted forms with events entered by hand as they are registered
  - ▶ Information entered usually just relates to the legal requirements for the vital event with statistical information gathered separately
  - ▶ Separate registers are used for each type of vital event
  - ▶ A back up system must be kept either as another book register or in a different format

- **Card Register**–A preprinted card is used to enter the information by hand or with a typewriter
  - ▶ Cards can be easily sorted by date or by surname for storage
  - ▶ Late or delayed events can easily be added in the appropriate place
  - ▶ Cards can be lost or filed out of order making records hard to find
- **Paper Record**–Similar to card system, but on paper with a preprinted form used to enter the information
  - ▶ Statistical information can be gathered along with the legal information
  - ▶ Records can be easily photocopied
  - ▶ Paper records can be lost or filed out of order making records hard to find
  - ▶ Paper records can be damaged if handled improperly
- **Electronic Records**–New method since introduction of computers
  - ▶ Record is prepared on a computer allowing for collection of legal and statistical information
  - ▶ Storage of record electronically eliminates the need for storage of paper or books
  - ▶ Information can easily be sorted and tabulated
  - ▶ Records can be easily located making issuance of certified copies much faster
  - ▶ Backups of files can easily be made
  - ▶ High cost for equipment and software
  - ▶ Need for qualified technical staff–programmers and system management
  - ▶ Need for electronic backup

Formats used in a country may have changed over time as new methods were introduced, and in some countries, combinations of all of the above formats have been used. Having multiple formats generally makes storage, preservation and issuance of certified copies more difficult to manage. The use of electronic records is increasing as the technology becomes available. Some countries are converting their older records in books or on cards or paper into electronic format for ease of storage and issuance of certified copies. In some places, paper records are used locally to collect information on vital events, and then the information is converted to electronic format at the national level. Other countries are using technology to collect information electronically directly from the source such as the medical facility where the birth occurs or the funeral director who handles the disposition.

Storage of Vital Records: Since records of vital events are official government documents that have legal value, they must be kept in a secure, permanent way. Vital records can be stored both centrally and locally. Care must be taken to ensure that the records are secure and protected from catastrophic events such as fires, floods or

other weather related issues. Many countries store records in a vault with fire protection features. Backup methods must also be used to ensure that the records are preserved and can be restored in the event of loss of the original records. Backup copies should be stored in a safe, remote location away from the geographic area where the original records are kept.

The methods used for storage and backup of vital records depend on the format used to collect the vital event information. In addition to being secure, records must be accessible and easy to locate when needed for certified copies. Book registers are usually stored on open shelves, and backups are made by copying information from one register into another register or into a different format. Card registers are generally kept in file drawers with backups prepared by copying information onto another set of cards or making microfilm copies of the cards. Paper records are either permanently bound or placed in archival boxes or loose leaf binders and stored on open shelves. Microfilm has been the traditional method used for backup of paper records, but more paper records are being converted to electronic format either by keying the information into an electronic file or by scanning images of the paper record. Electronic records are stored electronically and backup copies of the electronic files should be stored offsite. Also if electronic records are used as the original format or for backup, care must be taken to transfer those electronic records to new systems as technology changes.

Issuance of Copies: Issuance of certified copies of vital records is a key function of civil registration. The civil registration law should specify how copies should be issued and who may obtain them. Most, but not all, countries have restrictions on who may obtain copies of records. The civil registration law should specify who is authorized to obtain each type of vital record. For a birth record, the registrant and usually the mother or father or their legal representatives are usually authorized to obtain copies. For death records, the next of kin or other family members and their legal representatives are usually authorized. Most countries also allow government agents to obtain copies or have access to the information on vital records as long as the information is needed for official government purposes.

Generally, the strictest requirements are on birth records since those are the ones most often used for fraudulent purposes. Using someone else's identity or altering information such as date of birth or parents' names to fraudulently obtain benefits or inheritance has happened. Death records have been used to falsely declare someone dead to collect insurance, and death records have been altered to change information to improperly claim benefits, such as changing the name of the surviving spouse to collect survivors benefits.

Certified copies of vital records may be issued as full images of the original record or they may just contain excerpts from the original record. Often, if statistical information is collected along with the legal information, the statistical information is not shown on the certified copy. Certified copies may be produced by handwriting or typing information on another form, making copies from microfilm, using a photocopier, or creating a copy from information on a computer file. For prevention against fraud, many countries use special safety paper to make alteration of copies difficult. Generally the certified

copy will also contain a certification statement that has a seal and/or signature of the Registrar General or local registrar who issued the copy.

Certified copies of vital records may be issued at the national level, the local level, or both, depending on the country. Some countries require that copies of vital records, particularly births, be obtained in person. Other countries accept mail requests for certified copies. Some countries also allow certified copies to be ordered over the phone or over the Internet with proper security requirements if release of records is restricted. In some places, if certified copies of vital records are restricted, applicants may have to provide identity documents to show they are entitled to obtain the copies they are requesting. Requirements for identity documents to obtain copies of records vary from country to country.

Registered Records Processing

Most civil registration offices have specific steps that must be followed after a vital event has been registered in the local registration office. To meet the requirements of the civil registration law for storing, preserving, and maintaining vital records, for issuing certified copies of those records, and for producing tabulations of vital statistics data, most countries follow similar steps in processing the records, and today, most countries use some form of electronic technology as part of the process.

Numbering: Generally the first step in processing a vital record is assigning it a **unique number**. The number may be assigned at the local registration office or at the national office depending on the country. However, wherever the numbers are assigned, they should follow an established scheme with specific criteria so they are not duplicated. In some countries that have population registries, a unique personal identification number is assigned to each individual at birth, and this number is used on vital records.

One common method for assigning numbers is numbering each vital record sequentially within each calendar year by each type of event. For example, the first birth occurring in 2011 is 000001 continuing until all births for that year are numbered. To be unique for computerization in this type of scheme, the year must be included such as 2011-000001. Another method is to use the date of the event followed by a sequential number such as 20110915-0001 for the first birth occurring on September 15, 2011.

Coding Data: To facilitate tabulation and processing of data on vital records, and particularly for computer entry, some items entered as text on vital records are coded or changed into a numerical format. Items frequently coded include sex, geographic location, race or ethnicity, marital status, education level, cause of death and occupation.

Standards for coding items must be established, preferably at the national level, and should follow international statistical classifications where possible to allow for data comparisons. Coding standards must also allow for comparison of items over time.

Items such as sex or marital status have a limited number of entries, so coding is relatively simple. Items such as geographic location, occupation or cause of death may have many possible entries and must have strict rules for converting the text to coded data.

Coding staff must be well trained in the requirements for coding particular items so errors do not occur. Data that has been coded should be verified to check that the coding has been done correctly. This check is particularly important for the application of codes to items with many possible entries (and thus codes). In some cases, a sample of records may be re-coded by a different person to verify that the appropriate codes have been applied. More detail on coding information, particularly cause of death, will be covered later in the course.

Computerizing: Today nearly all countries use some form of computerization in processing their vital records even if it is only for doing statistical tabulations. The method used for computerization of vital event information in a country depends on the technology available and the capabilities of the staff. In some cases, paper records are forwarded to the national office for data entry while in others, data entry may be at a local level and the electronic information is forwarded. The ideal system is to have vital event information entered into an electronic vital record by the informant or the person responsible for providing the information (such as the physician or medical examiner for a death) or by someone (clerk in a medical facility, funeral director, or local registrar) obtaining the information from that person. Some countries are starting to take advantage of laptops, tablets, and smart phones to collect vital event information directly from the informant.

Programs for data entry should be designed to capture all information necessary for both legal and statistical purposes. When records are data entered, there should be a process in place to prevent inadvertent keying errors. Built-in edits should prevent keying of impossible data items and double keying of information should catch most errors. Double keying to verify information is necessary for critical items such as names and dates used to locate vital records for legal purposes and for crucial statistical items.

In countries where the civil registration and vital statistics functions are in separate agencies, computerization is usually done by the civil registration authority rather than the vital statistics agency. In this case, all vital statistics data should be collected during the civil registration process and coded and keyed by the civil registration staff. Statistical data files are then passed to the vital statistics agency. However, there are variations to this process. In South Africa, for example, the civil registration office lends registration forms to the statistical agency for data entry and preparation of vital statistics.

Whether statistical data files or paper records are passed from the civil registration agency to the statistical agency, it is extremely important to ensure that the confidentiality of individually identifiable information is protected. Staff in the statistical agency must be aware of the need to protect this information, and appropriate

agreements should be in place between the agencies to maintain confidentiality. Statistical agency staff should have procedures in place to avoid publishing or releasing tabulated information that is so detailed that specific individuals can be identified.

Editing: Editing of data items on vital records should be done as early in the registration process as possible. When paper records are presented to the local registrar, they should be reviewed for missing information and obvious errors. The local registrar should try to obtain any missing information or correct any obvious errors before forwarding the record to the central office.

When electronic records are used to register vital events, edits should be built into the computer entry programs at the source to prevent as many errors as possible. The programs should be designed to alert the person entering information if items are left blank or obvious or inconsistent errors are made. The programs should also be designed to prevent impossible entries (such as dates like February 31). Sometimes edits are also designed to question entries that are possible, but not likely (such as a mother whose age is 52 years old), and those edits might require a verification to be made by either rekeying or confirming the information. If paper records are converted to electronic format, they should be checked as they are converted with appropriate edits built into the programs used for data entry.

After the information from vital records has been converted to electronic format, additional edits should be done electronically to check for inconsistent, inappropriate, or unusual entries. Records can also be “flagged” or marked for further review if an entry is outside of a standard range. Statisticians in the statistical agency should also check the data by comparing it to previous years to look for inconsistent or unusual trends. Any questionable or uncommon entries or patterns should be reviewed to determine if there are any reporting, coding, or entry problems.

Querying: To have useful data for assessing health problems, it is very important that complete and accurate information be entered on vital records. Civil registration offices should have an ongoing query program to ensure high quality statistical data. Data items on vital records that are found to have missing, incomplete, inconsistent or inappropriate entries should be followed up by contacting or “querying” the person responsible for providing the information. Querying should be done as soon as the questionable or missing entry is found. The earlier querying is done in the registration process, the more likely it will be that the correct or missing information can be obtained.

Ideally, querying should be done at the local office when the vital event is registered. However, many times errors are not found until the record reaches the national office where keying and editing are done. In some countries, the national office sends queries back to the local office for obtaining the correct information since local staff are more likely to know the appropriate person to contact. If querying is done at a local office, a procedure must also be established to forward the corrected or missing information back to the national office for inclusion in the vital record or on the data file.

Correcting Errors: The civil registration office must have a procedure to correct errors found through edits and other consistency checks in both legal and statistical items. If duplicate records are kept at both national and local levels, care must be taken to ensure that corrections are made in both locations. Otherwise, problems can occur when the records are used for legal purposes and they do not contain the same information at both places. It is also essential that all corrections made to statistical items are added to statistical files prior to sending the files to the statistical agency or are transmitted to the statistical agency through a separate process.

Corrections to legal items on vital records can be made any time after the record has been registered. Many times errors are not found until a copy of a record is first issued. Therefore, some corrections, especially those to legal items, may not be included on the statistical file. Corrections to errors in statistical items that were found through the editing process should be made as soon as possible after the error is found and prior to preparation of annual statistical tabulations.

The procedure for correcting errors generally depends on the type of vital event, the data item, and the particular error made. The civil registration law and regulations should specify how correction of errors or changes to legal items, often called amendments, can be made. Many types of errors in legal items require evidence or documentation to support the correction. For example, an incorrect birth date on a birth record might require a document from the medical facility where the birth occurred. Some obvious clerical errors, such as the minor misspelling of a child's surname when the parents' names are correct, require little evidence. Other corrections might require a court action to determine the correct information if there is no documentation to support the correction or a dispute in the facts. For example, for a death, the surviving spouse may not be clear if the deceased had been married more than one time. For death records in some countries, only the medical certifier who provided the cause of death or other medical personnel as authorized by the civil registration law can make changes to the cause of death.

Various methods are used to physically make corrections to vital records. Often the method used depends on the type of error, whether the item being corrected is a legal or statistical item, and the length of time after the vital event occurred. Some common methods used include:

- **Item is left blank**
  - The correct information may be inserted in the space with no indication it was added.
  - Or particularly for a legal item, a notation may be placed on the record stating the information was added to the record.

- **Minor clerical error**
  - ▶ Information in error may be lined through with a single line (so it is still readable) with the correct information written above and a notation about the correction may or may not be added to the record.
  - ▶ An entirely new record may be prepared with the corrected information shown and a notation may or may not be added stating that a correction was made. If a new record is prepared, it may replace the old record or the old record may be voided and the new record added to the system.
- **Wrong legal information entered on a paper record**
  - ▶ Errors may be corrected as above by lining through the error and the correct information written above with a notation added to the record.
  - ▶ An affidavit with the correct information may be attached to the original paper record.
  - ▶ Usually some type of notation is added to the paper record to indicate the item corrected and the evidence used to make the correction.
- **Wrong legal information entered into electronic record**
  - ▶ The correct information may be added to the computer file with a notation added to the file to state the original information and the evidence used to make correction.
  - ▶ A new computer record may be prepared with the corrected information shown, and a notation stating the correction and evidence may or may not be added. The new record may replace the old record or the old record may be voided and the new record added to the system.
- **Error in statistical item**
  - ▶ If the item is not shown on the certified copy, it may just be corrected on the statistical file with no indication that the information was corrected.
  - ▶ Any of the above methods may also be used depending on the civil registration law.

In some countries all of the above methods are used depending on the age and format of the record and/or the item to be corrected.

Although not corrections of errors, the civil registration law usually also provides the authority to process changes to birth records due to certain legal actions such as the following:

- **Adoption**–The legal and voluntary taking and treating of the child of other parents as one's own as provided by the laws of a country.
- **Legitimation**–The formal investing of a person with the status and rights of a person born in wedlock according to the laws of a country.

- **Recognition**–The legal acknowledgment, either voluntarily or compulsorily, of the father of a child born out of wedlock.

- **Paternity determination**–Usually a court action to determine the legal father of a child.

The civil registration law should specify how any changes made to vital records should be processed and what must appear on certified copies of those records. Laws in many countries require that certified copies of corrected or amended records show which items were corrected and also show any notations added to the record that describe the evidence or documentation used to make the correction. Usually new birth records are prepared after legal actions such as adoption, legitimation, recognition or paternity determination, and to protect the child, certified copies of the new birth record do not indicate that any change was made; however, this method is not used in all places.

It is important for those using vital statistics data to understand how corrections, amendments, and other changes are made to vital statistics files. The more complicated the process for making corrections, such as requiring court actions prior to making changes, the more likely the change will not be included in the annual statistical data. Any process that can cause a delay in adding a correction to the statistical file, particularly for items that are both legal and statistical, is a drawback to having high quality data. Also, depending on how vital events are processed and when the annual files are prepared, some errors occurring on vital event records that are registered near the end of the calendar year may not have corrections completed in time to appear on an annual statistical file.

Review

- Civil registration is based on system of laws.
- The primary purpose of civil registration is to obtain the legal documents required by law.
- The ideal civil registration system
  - should cover the entire population of the country,
  - have vital events reported as they occur,
  - maintain vital records permanently, and
  - provide for confidentiality of personal information on vital records.
- The civil registration law should specify the basic structure of the civil registration system.
- Authority for civil registration system may be centralized or decentralized and located in a single agency or multiple agencies.
- The person responsible for registering vital events should be designated in the civil registration law.

- Formats used for registration of vital events include book registers, cards, paper records, and/or electronic records.
- Vital records must be preserved and stored in a secure manner with backup copies available.
- Issuance of certified copies of vital records is a key function of civil registration.
- Most countries have restrictions on who may obtain certified copies of vital records and take precautions to prevent their use for fraudulent purposes.
- Vital records are given a unique number.
- Coding schemes used for data entry and statistical tabulation should follow international standards.
- Computerization of vital records is done in various ways depending on the country, but the ideal system has the registration staff entering vital event information directly into computer software.
- Editing of vital record information for errors and missing or inconsistent information should be done as early in the process as possible.
- If errors are found, the person providing the information should be queried to obtain the correct information.
- Errors in both legal and statistical items should be corrected.
- Documentation or evidence may be required to correct some items, particularly legal items, on vital records.

Section 2 References

2-1. *Handbook on Civil Registration and Vital Statistics Systems, Management, Operation and Maintenance*; Studies in Methods, Series F, No. 72; United Nations, New York, 1998 (Paragraph 22) http://unstats.un.org/unsd/publication/SeriesF/SeriesF_72E.pdf

Section 3

Birth Records

Civil Registration And Vital Statistics Systems

Definition

A live birth is the delivery of a child that breathes or shows signs of life regardless of the length of the pregnancy. A country's official definition for a live birth should be specified in the civil registration law for consistency in reporting of birth events. Many countries use the statistical definition from the World Health Organization (WHO) as follows:

> *"the complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of the pregnancy, which, after such separation, breathes or shows any other evidence of life such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles, whether or not the umbilical cord has been cut or the placenta is attached."*[3-1]

Based on the WHO definition of live birth, all live births should be registered in the civil registration system irrespective of gestational age or whether the infant is alive or dead at the time of registration. If an infant is born alive and subsequently dies, that infant should be registered as a both live birth and a death. For statistical purposes, infants that are born alive and die within the first year of life are counted as infant deaths (not fetal deaths).

For multiple pregnancies, each live birth should be registered separately. If the country requires registration of fetal deaths (definition is given later in this section), members of a multiple pregnancy born alive should be registered as live births while those not born alive should be registered as fetal deaths.

Information Collected

While civil registration of vital events is primarily for legal purposes, the system can also be used to obtain vital statistics data to monitor public health. Birth data from vital records provides one of the best sources of information on maternal health and pregnancy outcomes for statistical research. While most countries require registration of births in their civil registration systems, the information collected on the form or computer program used for registration varies greatly. Some countries just collect information needed for legal purposes while others also collect a large amount of data about the pregnancy and health of the mother and the delivery of the infant. Examples of the different types of data that are collected on birth records in various countries are given below to show the extent of data that can be obtained during civil registration. However, the list of examples does not imply priority or necessity of information that should be collected. It is also important to consider the degree to which quality in accuracy and reliability of information can be ensured for the various items.

Birth Information Collected for Legal and Administrative Use: Note that many items collected for legal and administrative use are also used for statistical purposes.

- **Date of birth**–Format should be day, month, and preferably a four-digit year. Collecting a four-digit year for date of birth makes tabulations easier and eliminates any problems after events are collected for over 100 years.

- **Time of birth**–Hour and minute are often collected.

- **Place of birth**–The geographic location where the birth occurred. Enough detail should be included so that tabulations can be made for appropriate subdivisions such as town or city, and in some places the actual address is collected. Occasionally issues arise on place of birth if the birth occurs in a moving vehicle such as a boat or airplane. Procedures should be in place to determine the location of birth for civil registration purposes (e.g., the location where the infant is first removed from a moving vehicle) for unusual circumstances.

- **Full name of child**

- **Sex of child**

- **Type of birth**–Single, twin, triplet, quadruplet, etc.

- **Mother's name**–Usually her name as given at birth or her name prior to first marriage.

- **Father's name**–Usually his name given at birth.

- **Marital status of mother** (or parents in some countries)–In some countries "marital status of the mother" is not shown on the legal record but is instead placed with the statistical information. The intent is to prevent stigmatizing the child since the birth record is used by that child throughout his/her life.

- **Other information about mother**

  - **Date of birth or age**–Note that it is usually more accurate to obtain the exact date of birth and calculate the age. However, if the date is unknown, the age at last birthday should be obtained. The question used in a country may depend on the literacy of the population and the degree to which records have been kept.

  - **Place of birth or nationality**

  - **Names of mother's parents** (in some countries)

  - **Identification number** (in some countries)

- **Other information about father**

  - **Date of birth or age**
  - **Place of birth or nationality**

- ► **Names of father's parents** (in some countries)
- ► **Identification number** (in some countries)

- **Place of residence of mother or family**–The place where the mother usually resides. The complete address of the residence may be collected, but at minimum, at least the town or city should be obtained. Place of residence should include enough information to tabulate data to appropriate geographic subdivisions of interest for public health monitoring or demographic research. There may be confusion over the usual place of residence for persons who have more than one residence or are away from their usual home such as participants, members of the armed forces, or persons living temporarily in another location. Rules for determining usual residence should be clearly established and made known to those completing information for birth registration.

- **Duration at residence**–This usually means within a civil division and not at a specific house. Along with duration at residence, some countries collect "previous residence" if duration is less than a certain time period.

- **Type of place of birth**–Generally hospital, other medical facility, home, etc.

- **Attendant at birth**–Usually includes name and address; type such as physician, midwife, nurse, etc.; and in some countries, license number.

- **Date of registration**

- **Place of registration**–Identification of local office where the birth is registered.

- **Name and relationship of informant or person providing information for registration**

- **Attestation statement with signature of attendant, informant or registrar**–For birth records registered electronically, the person signing onto the computer program to enter the data is sometimes recorded as the one attesting to the facts of birth.

- **Birth registration number**–This is generally added at the local registration office and/or the national registration office. Some countries have both local and national registration numbers.

Birth Information Collected for Statistical Purposes: Some statistical items may appear in the legal portion of the birth record. Other items, such as those dealing with medical information about the pregnancy or delivery, may appear in a separate section of the birth record that is not shown on legal copies.

- **Characteristics of the father**
  - ► **Educational level**–Usually collected as the highest grade completed.

- **Occupation**
- **Ethnicity, race or religion**–Collection of ethnicity, race or religion depends on the particular circumstances in a country. Definitions and groupings for these categories vary from country to country. If definitions have been established for other official purposes such as a census, then those definitions should be followed to make vital statistics data comparable.

- **Characteristics of the mother**
  - **Educational level**–Usually collected as the highest grade completed.
  - **Occupation**
  - **Ethnicity, race or religion**

- **Medical information related to the birth**–In some countries, these items appear in the legal portion of the birth record.
  - **Birth weight of child**–Birth weight should be collected in the units used by the country. If units other than grams are used, any conversion to grams for tabulation should be done by the statistical office when the data are tabulated. The gram conversion could be added to the file as a derived item.
  - **Length of gestation**–Duration of pregnancy usually collected in weeks.
  - **Number of previous children born alive to mother**–Instead of the question "previous children born alive to mother" which does not include the present birth, the question is sometimes asked as "total number of children born alive to mother" which should include the present birth. No matter how this question is asked, it is often completed incorrectly, particularly if a multiple birth occurs. Many times if this is the second or higher order birth, the previous births delivered in a multiple pregnancy are not included. Extra care should be taken in editing birth data to account for all births in a multiple pregnancy.
  - **Number of fetal deaths** (or stillborn children) of mother
  - **When medical care began**–This question may be asked as date of mother's first visit to doctor or month of pregnancy care began. If "month of pregnancy care began" is collected, the person completing the information needs to understand that this is elapsed month of pregnancy such at the first month of this pregnancy, second month of this pregnancy, third month of this pregnancy, etc., and not the calendar month.
  - **Number of prenatal visits**

- **Other medical information that may be collected on mother in some countries**
  - **Date of last previous live birth** (or interval since last live birth)

- **Weight of mother prior to pregnancy and weight at delivery**
- **Medical conditions that may cause problems during pregnancy** such as anemia, hypertension, diabetes, previous preterm birth, other diseases
- **Method of delivery** such as cesarean section or use of forceps
- **Other complications of delivery or pregnancy** such as breech, premature rupture of membranes, prolonged labor, etc.
- **Crown-heel length of infant at delivery**
- **Abnormal conditions of the infant** such as birth injuries, assisted ventilation required, seizures, etc.
- **Congenital anomalies of the infant** such as anencephaly, down syndrome, cleft palate, limb defects, etc.

Derived Data from Birth Items: The items above are collected directly on the birth record using specific questions to obtain the information. It is also possible to derive additional data items from items collected directly and add those derived items or a code for the derived item to computer files for use in statistical tabulations. Any item that is used frequently in tabulations and that must be calculated from one or more other birth items, or that is obtained by grouping coded data, can be added to a computer file for ease in doing statistical calculations and tabulations.

- **Age of mother and father**–Date of child's birth minus date of birth for parents.
- **Live birth order**–Previous live births plus this birth.
- **Socio-economic indicator**–From education and/or occupation using some type of grouping possibly similar to one used for a census or other research study.
- **Detail on residence**–An indicator may be added to the file to group data into areas such as urban, rural, regional, etc., based on the mother's residence address.
- **Other geographic groupings**–Codes can be added to computer files for a variety of geographic groupings that are useful for tabulation. For example, tabulations by regions of the country may be made for health purposes. One code could be added to a geographic subdivision so it is included in a specific health department service area and another code added to include the same subdivision in a service area for a hospital with a neonatal unit. Other codes may be added to group localities by size, (e.g., Under 5,000; 5,000-9,999; 10,000-19,999; 20,000-49,999; 50,000-99,999; etc.) or whatever groupings are appropriate for the country.
- **Weight gained by mother during pregnancy**–Weight at delivery minus weight prior to birth.

- **Trimester care began**–Groupings based on month prenatal care began or date of first visit. Generally, trimester care began is grouped as follows:
  - First trimester–months 1-3
  - Second trimester–months 4-6
  - Third trimester–months 7-9
  - No prenatal care should be a separate category.
- **Adequacy of prenatal care**–Usually an index for adequacy of prenatal care is developed from a formula using the number of prenatal visits and the date of the first visit. Some formulas also use duration of pregnancy and other factors related to the mother's health.
- **Birth weight categories**–The categories below are the ones recommended by WHO for tabulating birth weight.[3-1] These categories are not mutually exclusive and they overlap (low includes very low and very low includes extremely low).
  - Low birth weight–Less than 2500 grams
  - Very low birth weight–Less than 1500 grams
  - Extremely low birth weight–Less than 1000 grams

It is important that each item collected on a birth record be clearly defined so that the informant and others involved in civil registration and the data collection process can complete the information completely and accurately. Definitions for birth items should be compatible with international standards to allow country to country comparisons. Definitions should also be compatible with those used in other data collection systems, particularly the population census since census data are used as denominators for many vital statistics rate calculations. Statisticians and researchers using vital statistics data also need to know and understand the definitions used in the civil registration process to be able to make appropriate calculations and conclusions in studying and monitoring public health problems.

Problems with Data

In any data collection system there can be problems with the data collected. All efforts should be made to identify and prevent as many problems as possible as early in the collection process as possible. Problems in birth data can be caused during the civil registration process when information is collected from the source; during the processing of the birth record after it has been registered, particularly in the keying and coding of data items; during the correction of errors on a record; and in computer software used to process or tabulate the data. Different types of problems with birth data are as follows:

- **Source and accuracy of information**
  - The informant may not know correct information. For example, information about the mother and father may be provided by the mother who may not know some of the father's information.
  - The informant may not accurately recall information. Medical items related to the pregnancy and mother's care are generally considered more accurate when obtained from the medical provider than when the mother is asked to recall the information.
  - Sensitive information may not be given accurately. For example, the correct information on items such as marital status or certain medical conditions may be embarrassing and thus not be accurately stated.
- **Missing records**
  - Birth records may not be filed in certain geographic areas or for some population groups.
  - Birth records filed late may not be included in statistical files.
  - Birth records for infants of very low birth weight, especially those who die, are known to be poorly reported or they may be misclassified as fetal deaths.
- **Missing information**
  - Some items, particularly those related to medical care of the mother, may be left blank.
  - Certain population groups may be more likely to have missing information which could skew the data. Some ethnic or religious groups may not want to report certain information about the mother's medical care, or collecting information on medical care may be a problem in certain geographic regions of the country, particularly if births do not occur in medical facilities.
- **Errors in preparation and processing**
  - Statistical information collected separately from the legal information may not be accurately linked to data from the correct legal record.
  - Transcription or other clerical errors may be caused when the information is entered into the birth record.
  - Coding errors may occur when the information is coded.
  - Keying errors may occur in entering information into the computer.
  - Errors may occur in computer software programs used for entering or keying data, extracting data for vital statistics files, creating derived variables, or tabulating data.

Any of these errors can cause problems with statistical analyses and research studies making conclusions unreliable. All efforts should be made to find errors in the data and implement procedures to prevent them from occurring. Statisticians using birth data should be aware of the types of errors that can occur in birth data, and they should

review the data for deviations from earlier trends and differences in regions of the country or differences in population groups to be sure that any observed changes are real and not caused by inadvertent problems in processing the birth records.

Fetal Deaths

A fetal death is the delivery of a fetus that does not breathe or show any signs of life regardless of the length of the pregnancy. A country's official definition for a fetal death should be specified in the civil registration law for consistency in reporting. Many countries use the statistical definition from the World Health Organization (WHO) as follows:

> *"the complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of pregnancy; the death is indicated by the fact that after such separation the fetus does not breathe or show any other evidence of life, such as beating of the heart, pulsation of the umbilical cord or definite movement of voluntary muscles."*[3–1]

In some places a fetal death may also be called a stillbirth, or the term stillbirth may be used to refer to a fetal death over 20 weeks of gestation.

Requirements for registration of fetal deaths vary from country to country and even within countries. Many countries do not require that fetal deaths be registered as a vital event in the civil registration system. Most countries that do require registration of fetal deaths only require fetal deaths over a certain gestational age (usually 20 - 24 weeks) to be registered. The World Health Organization recommends that fetuses weighing at least 500 grams at delivery be reported. If weight is not available, then WHO recommends using reporting criteria of 22 completed weeks of gestation or a crown-heel length of 25 centimeters.

Information collected on fetal death records is usually the same as birth information where appropriate, although some items on birth records may need to be adjusted for fetal deaths. Additional items are often added to fetal death records to obtain the cause of the fetal death, but this is generally not well reported even in developed countries.

Information on fetal deaths is usually used along with birth information to study conditions related to pregnancy and to look at fertility patterns. In some studies, data on late fetal deaths and early infant deaths are combined to create a perinatal period of death around delivery to study problems related to pregnancy loss. WHO defines the perinatal period as starting at 22 weeks of gestation and ending seven days after birth (http://whqlibdoc.who.int/publications/2006/9241563206_eng.pdf). However, the WHO definition is not followed in all countries, and care must be taken in comparing perinatal data.

Fetal deaths are known to be poorly reported, even in developed countries, especially

at early weeks of gestation. In most countries, fetal death records are not used for legal purposes, so there is little incentive to report them, and these events are often not reported when they occur outside of a medical facility. Better registration of fetal deaths is often achieved for events that occur 2-4 weeks beyond the threshold set for reporting purposes. Thus, the requirement for reporting of fetal deaths could be set 2-4 weeks prior to the target desired. For example, if 22 weeks gestation is the desired reporting target, then the requirement could be set at 18-20 weeks of completed gestation to ensure better reporting of fetal deaths at 22 weeks.

Fetal deaths that are registered are also known to have a high number of missing or unknown data items particularly those related to medical issues and the cause of the fetal death. There are also problems with the accuracy of fetal death reporting caused by the confusion between fetal deaths and infant deaths. In some cases, infants born alive but at very low gestations, such as 19 or 20 weeks, are reported as fetal deaths because they are not viable, and it may be easier for the mother to process emotionally. Using fetal death data for research and statistical studies must be done cautiously.

Review

- A live birth is the delivery of a child that breathes or shows signs of life regardless of the length of pregnancy.
- Births records should be registered for all infants born alive regardless of gestational age or if the infant is alive at the time of registration.
- If an infant is born alive and then dies, both a live birth and a death should be registered.
- For a multiple pregnancy, each member born alive should be registered separately as a live birth and, if required by the country, any members not born alive should be registered as fetal deaths.
- Information on birth records is collected for legal, administrative and statistical purposes
- Items can be added to computer files for tabulation and analysis of data.
- Problems with birth data include:
  - Source and accuracy of information
  - Missing records
  - Missing information
  - Errors in preparation and processing
- A fetal death is the delivery of a fetus that does not breathe or show any signs of life regardless of the length of the pregnancy.
- WHO recommends reporting of fetal deaths weighing 500 grams or more.
- All fetal deaths meeting minimum reporting requirements should be registered.
- Birth and fetal death data may be combined to study conditions related to pregnancy.

Section 3 References

3-1. *International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Volume 2, Instruction Manual*, World Health Organization, Geneva, 1993 (Section 5.7.1) http://www.who.int/classifications/icd/en/ (See Appendix A)

Section 4

Death Records

Civil Registration And Vital Statistics Systems

Definition

The statistical definition of death from the United Nations publication Principles and Recommendations for a Vital Statistics System, Revision 2, is

> *"the permanent disappearance of all evidence of life at any time after live birth has taken place."* [4–1]

For civil registration purposes, all deaths should be reported including those of infants who are born alive and die immediately after delivery.

The civil registration law should specify who is responsible for reporting deaths for legal purposes. In some countries a family member or the head of the household is the person responsible for reporting the event and providing the information required on the death record. In countries where a funeral director or mortician handles most dispositions, he or she is often responsible for reporting the death for registration. Usually the funeral director obtains personal information about the deceased from a family member or the next of kin and enters the information on the death record. In a few countries, deaths that occur in hospitals or other medical facilities may be reported by an administrative person at the institution.

If the civil registration law requires information on causes of death, the physician in attendance at death is usually required to forward the information to the registrar. For some types of deaths, particularly deaths under suspicious circumstances, a medical examiner or coroner may be designated to determine and report the cause of death.

Information Collected

While civil registration of deaths is primarily done for legal and administrative purposes, death records are a very valuable source for monitoring public health and studying population changes. Depending on the information collected on death records, they can be used to study disease characteristics and trends, monitor the outbreak of infectious diseases, examine the characteristics of persons dying from certain causes, construct life tables, develop methods for prevention of certain diseases, and provide a sampling frame for additional research studies. Information collected on death certificates varies from country to country. Some countries just collect information for legal purposes that may also include some basic demographic characteristics of the deceased. Many countries also include information on the cause of death as part of the civil registration process while others obtain cause of death information as a separate process. Examples of different types of data collected on death records are given below to show the range of data that can be obtained during civil registration.

Death Information Collected for Legal and Administrative Use: Many items collected for legal and administrative use are also used for statistical purposes.

- **Date of death**–Format should be day, month, and preferably four digit year. Time of death may also be collected.
- **Place of death**–Geographic location where death occurred. The city or town and possibly the address should be included. Enough detail should be collected so that tabulations may be done for appropriate geographic subdivisions.
- **Facility or type of place where death occurred**–This may include the name of a facility or just the type as hospital, nursing home, public building, home, street, etc.
- **Full name of decedent**
- **Decedent's personal identification number**
- **Decedent's sex**
- **Decedent's date of birth**
- **Decedent's place of birth and/or nationality**
- **Decedent's marital status**
- **Name of surviving spouse**
- **Decedent's place of residence**–The place where the decedent usually resided. The complete address may be collected but at least the city, town, or other minor subdivision should be included so that tabulations can be done for small geographic areas. Some countries are starting to use geographic information systems to identify the residence to the specific latitude and longitude.
- **Duration at residence**–This usually means within a civil division and not at a specific house.
- **Names of decedent's parents**
- **Cause of death**
- **Certifier of death**–This usually includes name and type such as physician or coroner, and may also include address and license number.
- **Funeral director**–Name and address of person handling disposition of body.
- **Type of disposition**–Includes burial, cremation, etc. as appropriate to country.

- **Name and relationship of informant or person providing information for registration**

- **Date of registration**

- **Place of registration**–Identification of local office where the death is registered.

- **Attestation statement**–Usually a statement with the signature of medical attendant, informant or registrar.

- **Death registration number**–This is generally added at the local registration office and/or the national registration office. Some countries have both local and national registration numbers.

Death Information Collected for Statistical Purposes: In some countries cause of death is collected for statistical purposes and not included in the legal portion of the death record. Other items collected for statistical purposes may also appear on the legal portion of the death record and may be shown on certified copies of the record.

- **Additional detail on age for children under 1 year**–Usually months, days, hours or minutes is collected to conduct research studies into factors involved in infant deaths.

- **Educational level**–Usually highest grade completed or degree received.

- **Literacy status**–Generally means the ability both read and write.

- **Usual occupation**

- **Ethnicity, race or religion**–Collection of this item depends on the particular circumstances in the country. If categories or definitions have been established for other official purposes such as a census, the information collected on death records should be consistent to make vital statistics data comparable.

- **Additional detail on cause of death**–Information of interest for conducting research into causes of death is often added to gain more specific detail on the circumstances involved in the death or other medical conditions of the decedent:
  - ▶ Specific question on manner of death such as natural, accident, suicide, homicide, or undetermined
  - ▶ Detail on injuries such as how injury occurred, the place and time of injury, and did injury occur at work
  - ▶ Smoking or other risk factors
  - ▶ Pregnancy information for females 15-44

Derived Data from Death Items: For the items above, specific questions on the death record are used to obtain the information. In addition to items collected directly, indicators derived from those items are often added to computer files for use in statistical tabulations. Any item that is used frequently in tabulations and that must be calculated from other items on the file, or that is obtained by grouping coded data, can be added to a computer file for ease in doing statistical tabulations and analyses.

- **Socio-economic indicator**–From education, literacy status and/or occupation using some type of grouping possibly similar to one used for a census or other research study.

- **Detail on residence**–An indicator may be added to the file to group data into areas such as urban, rural, regional, etc. based on the decedent's residence address.

- **Other geographic groupings**–Codes can be added to computer files for a variety of geographic groupings that are useful for tabulation. For example, tabulations by regions of the country may be made for health purposes. One code could be added to a geographic subdivision so it is included in a specific health department service area and another code added to include the same subdivision in a service area for a hospital. Other codes may be added to group localities by size, (e.g., Under 5,000; 5,000-9,999; 10,000-19,999; 20,000-49,999; 50,000-99,999; etc.) or whatever groupings are appropriate for the country. Geographic groupings should be comparable to the ones used on births for demographic research and studies involving infant deaths.

- **Age of decedent**–Calculated from date of death and date of birth if not collected directly.

  - For deaths under 1 year of age, categories such as neonatal or post neonatal or under 1 week, under 1 month, etc., can be added to the data file for ease of tabulation.
  - Age group category–Code can be added to the death file to group decedents by age group such as Under 1, 1-4, 5-9, 10-14, 15-19, etc.; or another grouping such as infants, children, young adults, middle aged adults and older adults with specific age definitions for these categories. Codes can be added for any standard age grouping that is frequently used for tabulation purposes.

- **Detail on injury deaths or deaths with risk factors**–Using the additional data collected codes could be added to the file to indicate the specific place of injury or specific type of risk factor.

- **Cause of death groupings**–Detailed causes of death can be grouped together for tabulation purposes.

All items on the death record should be clearly defined so those involved in registering death records can complete the information accurately. Definitions for items on death records should follow international standards and be compatible with definitions used in other data systems. Since census data are used as denominators for many vital statistics rate calculations, definitions used for data collection and categories for tabulations should closely follow those used for collection of census information. Items collected on both death and birth records, such as place of residence, education, occupation, etc., should also have compatible definitions since these two data sets are often combined to study infant deaths.

Cause of Death

Manner of Collection: Collection of cause of death information varies among countries. Some countries collect cause of death information as part of the death registration process and it appears on certified copies of the death record. In other countries, cause of death is collected separately and sent to either the civil registration agency or the vital statistics agency for tabulation. Some countries use other methods, such as verbal autopsy (covered later in this section) to collect cause of death information for statistical tabulations.

If the civil registration law in a country requires information on cause of death, the physician in attendance at death is usually the person required to provide cause of death information. Some civil registration laws require a coroner or medical examiner to conduct an investigation and provide the cause of death if a person dies under suspicious circumstances or from certain causes such as accident, suicide or homicide. In some areas, if the person dies in a hospital or other medical facility, the cause of death may be obtained from the hospital.

To have comparable data from country to country, the World Health Organization (WHO) has stated that the causes of death to be entered on the death record should include

> *"all those diseases, morbid conditions or injuries which either resulted in or contributed to death and the circumstances of the accident or violence which produced any such injuries."* [4–2]

Based on the WHO recommendation, the medical certifier or person providing the cause of death should state all relevant information including every disease or disease condition or injury that caused the death or contributed to the death. The medical certifier should not select some conditions and reject others. If the death was caused by an injury, information describing the accident or violence that produced the injuries should also be included. The intent is to have enough detail to be able to use the cause of death information for studying disease characteristics, monitoring public health, and implementing prevention programs.

Underlying Cause of Death: In following the WHO recommendation, the medical certifier may enter several different diseases or conditions that contributed to death. However, for public health prevention and treatment purposes, it is important to know the particular disease condition that started the sequence of events that led to a person's death. Therefore, to be able to analyze cause of death data and to have consistent data for international comparisons, the WHO has selected collaborating centers around the world to work with WHO in the development, dissemination, maintenance, and use of the WHO Family of International Classifications (FIC) and a classification scheme with rules for coding cause of death that has been adopted by WHO.

From all the diseases or conditions listed as part of the cause of death, WHO designated the cause of death to be used for the primary or main statistical tabulation as the **underlying cause of death** and defined it as follows:

> *"(a) the disease or injury which initiated the train of morbid events leading directly to death, or*
>
> *(b) the circumstances of the accident or violence which produced the fatal injury.* [4–3]*"*

In applying this definition, WHO said that symptoms and modes of dying, such as heart failure, respiratory arrest or cardiac arrest, are not considered to be underlying causes of death for statistical purposes.

To have consistent application of the underlying cause of death principle, WHO also developed a standard form for use in obtaining cause of death information. The **International Form of Medical Certificate of Death**, shown on the next page, was adopted by the World Health Assembly in 1948 and is currently used by all developed countries and the majority of developing countries worldwide.

The International Form of Medical Certificate of Death form is in two parts. In Part I, the medical certifier should use his or her best judgment to enter each of the conditions or diseases related to the chain of events that led to death. The condition or disease that led directly to death (immediate cause) should be entered on line (a), the first line of Part I. If the condition on line a was caused by another condition or disease, it should be entered in line (b), and so on with the condition or cause that started the chain of events leading to death entered on the last line. The medical certifier does not have to use all lines, but he/she should always have an entry on line (a) and should be careful to enter the underlying cause that initiated the chain of events leading to death on the lowest line used in Part I.

In Part II of the form, the medical certifier should enter any other significant conditions that contributed to death but that were not directly related to the death or the disease causing it. Examples of conditions in Part II might be such things as diabetes, hypertension, smoking, etc. that contributed to the death but were not part of the direct chain of events leading to death.

INTERNATIONAL FORM OF MEDICAL CERTIFICATE OF CAUSE OF DEATH

Cause of death		Approximate interval between onset and death
I Disease or condition directly leading to death*	(a)	.....
	due to (or as a consequence of)	
Antecedent causes Morbid conditions, if any, giving rise to the above cause, stating the underlying condition last	(b)	.....
	due to (or as a consequence of)	
	(c)	.....
	due to (or as a consequence of)	
	(d)	.....
II Other significant conditions contributing to the death, but not related to the disease or condition causing it	.....	.....
	.....	.....

**This does not mean the mode of dying, e.g. heart failure, respiratory failure. It means the disease, injury, or complication that caused death.*

On the right hand side of the form next to each line is a space to enter the approximate interval between the presumed onset of the condition or disease and the date of death. The medical certifier should enter this information, if known, in terms of years, days, hours, minutes, etc. If the events leading to death are entered correctly, the shortest interval should be on line a, with the intervals increasing to the longest interval on the lowest line next to the underlying cause.

Below is an example of a death from natural causes with the information entered in the correct sequence in Part I of the medical certification. The coronary atherosclerosis on line (c) began two years before the patient died. That led to the myocardial infarction on line (b) which led to the rupture of left ventricle minutes before the patient died. The underlying cause is the coronary atherosclerosis since it is the condition that began the chain of events leading to death. The smoking and hypertension entered in Part II are conditions that contributed to the death but were not part of the chain that led to death.

Part I		
	a. Rupture of left ventricle	Minutes
	b. Myocardial infarction	2 Days
	c. Coronary atherosclerosis	2 Years
Part II	Smoking, Hypertension	

Coding Cause of Death: Since the medical certifier enters the causes in literal text, WHO adopted a method to classify the diseases into groups for international comparison, analysis and statistical tabulation. A standard scheme for coding cause of death along with rules for choosing the underlying cause of death are published in the *International Statistical Classification of Diseases and Related Health Problems, 10th Revision*[4-4] also called **ICD-10**. The International Classification of Diseases has been used as the standard for classifying mortality data since the late nineteenth century and is now in its tenth revision.

The ICD-10, which is currently used, consists of three published volumes:

- **Volume 1 Tabular List** contains the list of conditions with their codes. The diseases, injuries, external causes of injury, and factors related to heath status are grouped into 22 chapters.
- **Volume 2 Instruction Manual** gives instructions on coding causes of death and selecting the underlying cause of death. It also contains background on the ICD and includes information on presentation of coded statistical data and calculation of statistical indicators.
- **Volume 3 Alphabetical Index** contains an alphabetical index to the classifications and their codes listed in Volume 1.

The ICD coding structure is hierarchical with codes for specific diseases that can be combined into larger groups for research studies and statistical analysis. The ICD-10 codes consist of three-character alphanumeric categories (a letter and two numbers such as E14). The three-character categories can be further divided into up to 10 four-character subcategories (the three characters followed by a decimal point and one number such as E14.2). Possible codes are A00.0 to Z99.9 although not all countries use the four-digit subcategories. WHO requires countries to use at least the three character level for reporting to their mortality data base for international comparisons.

In applying the ICD codes to the cause of death, a coder needs to know and understand the rules and classification scheme used in the ICD. In theory, the cause of death entered in the lowest line used in Part I of the medical certificate should be the underlying cause of death for statistical tabulations. However, the medical certifier may not have entered the information in the correct sequence or may have entered more than one cause on a line. Following the rules given in the ICD, Volume 2 may result in another cause being selected as the underlying cause of death.

To have accurate and consistent underlying cause of death data, it is very important that the codes and rules be applied correctly. Correctly application of the rules for choosing underlying cause requires a coder to have extensive training in ICD coding that includes practical exercises. Only well trained coders should select the underlying cause of death. Physicians and others who have not been trained should not code of cause of death information.

Because of the difficulty in coding cause of death information and the extensive training needed for coders, some countries have started to use computer programs based on

the ICD-10 classification rules to select the underlying cause of death. The automated system assigns an ICD code to each entry in the medical certification of death and then applies the rules from ICD-10, Volume 2 to choose the underlying cause of death. The computer program should select the same underlying cause as a trained ICD coder. While the computer program can select an underlying cause for most deaths, some complicated cases are rejected for coding by an expert ICD coder.

Although most countries just use the underlying cause of death in their vital statistics publications, some countries have started to use information on all of the causes, or **multiple causes**, listed in the medical certification. Using all of the detail on the medical death certificate allows studies of the interrelationship of the diseases and factors involved in death and their connection to the underlying cause of death. Studies can also be conducted on all deaths with a certain condition, such as diabetes or hypertension, whether or not it is the underlying cause of death.

The ICD-10 contains thousands of codes if all four digits are used to code underlying cause of death. To facilitate preparation of tabulations and distribution of data using ICD codes, WHO has developed standard groupings of underlying causes of death called **tabulation lists**. Tabulation lists were developed for both General Mortality and Infant and Child Mortality. The tabulation lists are grouped using ICD codes to the three digit level (e.g., Diabetes Mellitus E10-E14, Hypertensive Disease I10-I14, Ischemic Heart Disease I20-I25, Transport Accidents V01-V99, etc.). Some larger groups, such as Neoplasms C00-D48, contain subgroups that show the site of the neoplasm. Most countries determine their **leading causes of death** from the standard groups in the tabulation list making comparison of leading causes of death consistent from country to country.

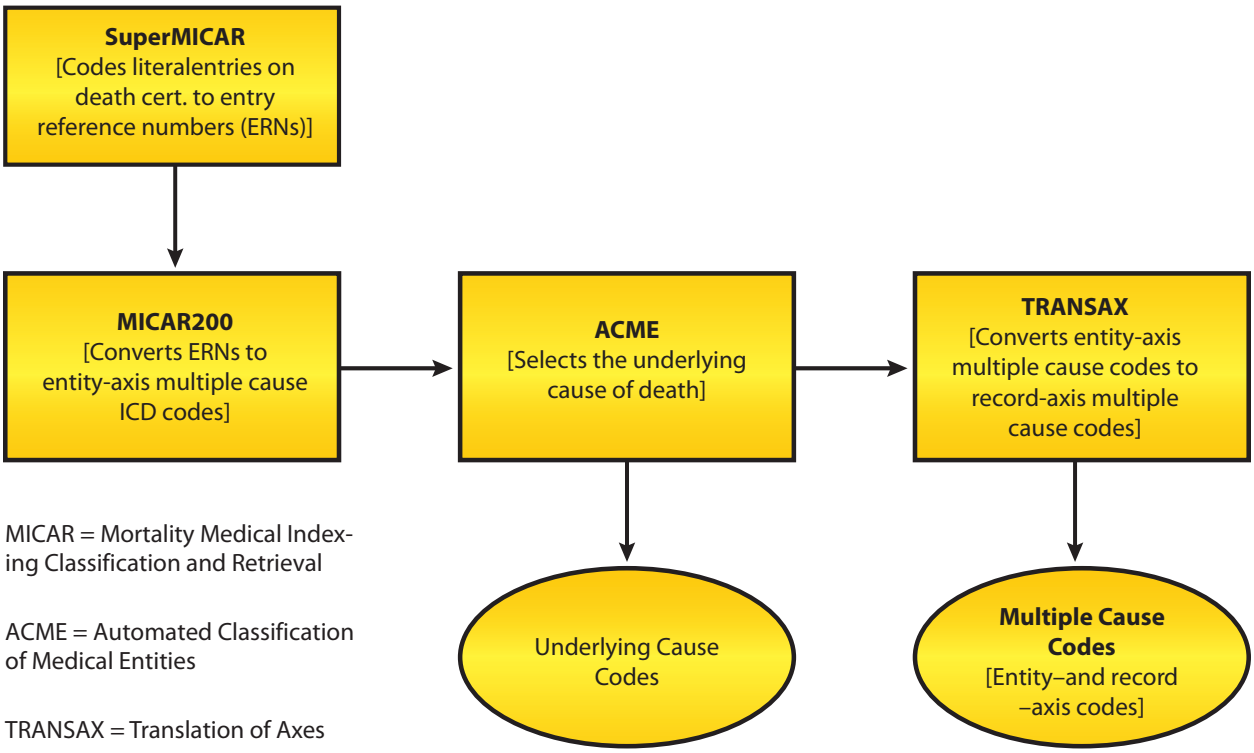
Supplemental Information in Medical Certification: Some countries add additional items to the standard format for the medical certificate of death. Generally the items added are for studies of specific interest in the country or to obtain more detail about the causes of death entered on the medical certificate, particularly on deaths from injuries. Examples of items added include the following:

- Manner of death (natural, accident, suicide, homicide, unknown)
- Autopsy questions
- Detailed information on injuries
  - How injury occurred (literal description)
  - Time of injury
  - Place of injury
- Pregnancy question for females
- Smoking and other risk factors

Some of the supplemental information can be used for more detailed coding of cause of death. Additional statistical tabulations of details related to the cause of death can also be done.

Automated Coding Systems: Development of a system to automate the entry, classification, and retrieval of cause of death information reported on death certificates began in 1967. An automated coding system provides standardization in mortality coding, improves the quality of coding, and facilitates international comparability of mortality data. For automated coding, the U.S. CDC's National Center for Health Statistics has developed the Mortality Medical Data System (MMDS). The MMDS is compatible for use in the English language, and has been used by the U.S., Canada, Australia, South Africa, and the United Kingdom. The MMDS is composed of four different components, as shown in the figure below[4–5]:

Because the MICAR component of the MMDS is only suitable for coding death certificate data that has been certified in English, a consortium of European countries (France, Hungary, Italy, Sweden and Germany) have developed IRIS, an alternative



automated coding system which can function in multiple languages. In IRIS, the language-dependent components are stored in database tables that can be easily modified. Since IRIS still uses components of the MMDS, international comparability of mortality data remains possible. As well, IRIS incorporates updates to the ICD-10 knowledge base according to WHO timelines[4–6].

Verbal Autopsy: In some countries there is a problem obtaining cause of death information. Not all countries use the medical certificate of cause of death recommended by WHO. Other countries may not have good reporting of deaths through the civil registration system. In some areas, deaths not occurring in medical facilities or under the care of a physician may not have the medical certification of death completed as part of civil registration. However, since the need for information on cause

of death for monitoring health still exists so other methods, such as the **verbal autopsy**, have been developed to obtain cause of death. While medical certification of cause of death is the preferred method for eliciting cause of death information, verbal autopsy provides a suitable alternative in the absence of medical certification.

A verbal autopsy is an interview with family members or caregivers of the deceased to obtain information that can be used to assign a probable cause of death. A questionnaire is used to obtain details on signs, symptoms, complaints, and medical history or events of the deceased in the period before death. The cause of death is then assigned, usually by a panel of physicians, based on the data collected.

Verbal autopsy is the primary source of information on causes of death in areas lacking civil registration systems or medical certification of cause of death. Verbal autopsy may be used as a source to describe causes of death at the community or population level, and it may also be used as a research tool to conduct epidemiological studies into the causes of death for specific groups such as children or pregnant women.

In the past, verbal autopsy data were collected through the use of questionnaires developed by researchers for use in a particular study. There were no standards, and data collected were not comparable from country to country or study to study. As the use of verbal autopsy increased over time, and with the requirement for more data to evaluate disease control programs and the global health initiative, the need for standards became apparent.

In 2007, WHO published Verbal Autopsy Standards, Ascertaining and Attributing Cause of Death[4–7]. Included are standard questionnaires for three age groups: under four weeks, four weeks to 14 years, and 15 years and above. The publication also contains coding guidelines for applying ICD-10 to verbal autopsy and a cause of death list for verbal autopsy with corresponding ICD-10 codes. WHO is continuing to refine and enhance verbal autopsy, and in July 2012, WHO published a first release candidate of a simplified VA instrument[4-8]. A subsequent version has now been developed and released (2014 WHO VA instrument)[4-9]. The aim of the simplification process was to develop an abbreviated VA instrument that could be used on a routine basis, including in the context of a national civil registration and vital statistics system. The instrument is compatible for data collection, transmission, and analysis using mobile devices, greatly improving the capacity for reaching remote areas. Furthermore, the instrument is compatible with automated analysis methods that can be developed with basic IT support, including InterVA-4 (www.interva.net) and SmartVA (http://www.healthdata.org/verbal-autopsy/tools).

Cause of death information collected through verbal autopsy and the way underlying cause of death is assigned is different from the method used for medical certification in civil registration systems. In verbal autopsy, the certainty of assignment of underlying cause is lower, and some diseases cannot be diagnosed at all. Verbal autopsy works best for causes with distinctive features. Childhood causes of death with generally acceptable levels of sensitivity and specificity include: neonatal tetanus, measles, malnutrition, and accidents; childhood causes with generally unacceptable levels

of sensitivity and specificity include: diarrhea, malaria, and acute lower respiratory infections (ALRI). The quality of information from verbal autopsy depends on the expertise of the panel of reviewers (generally physicians) who assign the underlying cause of death. Computer algorithms are being developed to select the underlying cause in place of the panel of physicians. While the computer programs may generate a smaller number of underlying causes of death, the information is still useful for public health planning purposes. Computer programs also are more consistent in selecting the underlying cause of death, and are faster and cheaper than a panel of physicians.

Data obtained from verbal autopsy should never be merged with data obtained from medical certification in civil registration systems. WHO cautions:

> *"The purpose of verbal autopsy is to describe the causes of death at the community level or population level in instances where no better alternative sources exist. Therefore, it is a limited substitute for proper medical certification. The quality of information and of the diagnoses varies depending on the skills of the interviewer and the memory of the respondents."*[4–7, Section 3.59]

Problems with Data

Information on death records can have numerous sources of error. Data problems can be caused during the civil registration process when the information is obtained from the informant, during the processing of the death record after it has been registered, and in computer software used for tabulation of data. Errors can also arise in the collection of cause of death information, in coding the cause of death for tabulation, and in selection of the underlying cause of death. Common types of problems with death data are as follows:

- **Source and accuracy of information**
  - Items on the death record are generally reported by the next of kin or a family member who may not know all the correct information for an item or may provide the wrong information.
  - Information that may be considered sensitive may not be accurately reported by the informant.
  - If a funeral director obtains the information from the next of kin, the funeral director may record the information on the death record incorrectly.
  - The medical certifier may not have attended the deceased recently and may not accurately report the cause of death.
  - If cause of death information appears on the death record, the medical certifier may not want to embarrass the family by entering certain causes such as AIDs, cancer or suicide.
  - The medical certifier may not enter the cause of death information in the correct order causing the wrong underlying cause to be selected.

- **Missing records**
  - ▶ Death records may not be registered in certain areas of the country or by some population groups.
  - ▶ Death records that are registered late may not be included in the statistical files.
  - ▶ Death records for infants or other children may not be registered. Deaths of infants, particularly those who die close to birth, are known to be poorly reported even in developed countries.
  - ▶ Deaths occurring at home may not be registered.
- **Missing information**
  - ▶ Certain population groups may be more likely to have missing information which could skew the data.
  - ▶ The medical certifier may not enter all causes of death or may not enter the complete chain of events leading to death. Sometimes just the immediate cause (not the underlying cause) is entered and sometimes just the mode of dying (natural causes, accident, suicide, homicide) is entered with no information on the disease or condition that caused death.
- **Errors in preparation and processing**
  - ▶ If the next of kin reports the death to the local registrar, transcription or other clerical errors may be made when information is entered into the death record.
  - ▶ If the medical certification of death is collected separately from the death record for civil registration, the medical certification could be linked to the wrong death record.
  - ▶ Both demographic and cause of death information could be coded incorrectly.
  - ▶ The ICD rules for choosing underlying cause of death may not be applied correctly.
  - ▶ Keying errors may occur when information is entered into the computer.
  - ▶ Errors may occur in computer software programs used for entering or keying data, extracting data for vital statistics files, creating derived variables, or tabulating data.

In any data collection system there can be problems with the data collected. All efforts should be made to identify and prevent as many problems as possible as early in the registration process as possible. Procedures should also be in place to identify and correct problems and errors throughout all death processing steps including by the statisticians who tabulate the data. Statisticians should be aware of the types of errors that can be caused, particularly in cause of death information, and they should review the data for unusual, unlikely, or rare causes that could be due to errors in coding or in choosing the underlying cause of death.

Review

- Death is the disappearance of life after birth has taken place.
- Information on death records is collected for legal, administrative and statistical purposes.
- Items can be added to computer files for tabulation and analysis of data.
- Cause of death may be collected separately from the death information for civil registration in some countries.
- The best person to provide the cause of death is the physician in attendance at death or the coroner or medical examiner required to determine the circumstances of death.
- WHO developed a standard form for collection of the medical certification of death.
- The underlying cause of death is the disease or injury that started the chain of events leading directly to death or the event causing the fatal injury.
- The International Classification of Diseases (ICD-10) is a classification scheme adopted by WHO for coding cause of death data.
- ICD-10 contains rules for applying the codes to cause of death data and standard groupings of codes called Tabulation Lists from which leading causes of death are chosen.
- Coders selecting underlying cause of death need to understand the structure of the classification scheme and have extensive training in the application of ICD-10 rules.
- Verbal autopsy is used when collection of cause of death is not part of civil registration.
- Verbal autopsy is an interview with family members or caregivers about symptoms, complaints, circumstances, and medical history of the deceased.
- WHO developed standards for verbal autopsy questionnaires and for determining underlying cause of death.
- Cause of death from verbal autopsy is not the same as cause of death collected through civil registration, and data from the two different methods should not be combined.
- Problems with death data include:
  - Source and accuracy of information
  - Missing records
  - Missing information
  - Errors in preparation and processing

Section 4 References

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Volume 1. Tabular List

Volume 2. Instruction Manual

Volume 3. Alphabetical Index

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Section 5

Analysis Of Vital Statistics Data

Civil Registration And Vital Statistics Systems

Uses, General Princliples, and Standardization of Vital Statistics Data

Vital events filed through the civil registration system have long been recognized as a source of valuable data for monitoring changes in social and economic development. Today, most countries tabulate data from vital records for a variety of uses. Data from civil registrations systems that have good reporting of vital events at the national level also allow for comparisons at regional levels and for small areas where vital statistics are often the only source of reliable data.

Uses: Vital statistics, particularly births and deaths, are the basis for public health and epidemiologic monitoring, evaluation, and planning. Vital statistics are used to study trends in mortality and natality, investigate the prevalence and distribution of diseases, identify populations at risk for certain medical problems and diseases, examine differences among population groups, construct life tables, establish baseline levels, and evaluate the effectiveness of public health programs. Information can be examined by age, sex and other demographic characteristics of the persons involved in the vital events as well as by geographic location.

Vital statistics provide data for studies on maternal and child health, infant mortality, and family planning. A well-established civil registration system can provide information on trends and changes in vulnerable groups, such as single mothers and their children, so that adequate services can be provided. Vital statistics from civil registration provide the only nationally representative source of mortality data by cause of death. Timely registration of deaths with cause of death information can provide early indications of disease prevalence and allow for better implementation of prevention or intervention strategies. Small area vital statistics data can also help identify local health problems and issues.

Vital statistics are also used in other areas, particularly in demographic studies and to prepare population estimates and projections. Various government agencies use vital statistics for planning purposes and allocation of resources such as education departments for school enrollment and social service agencies for location of service providers. Businesses and economists use the data for consumer market research, determining retail and service locations, forecasting future trends, planning business growth, and studying various demographic, economic, and social conditions.

General Principles: Vital statistics data from the civil registration system provide an abundance of information for analyzing different aspects of births and deaths and the population involved in those events. However, production of vital statistics tabulations must meet the needs of the statistical user. For example, to analyze mortality differences between urban and rural areas in a country or various geographic regions, vital statistics data should be tabulated by usual place of residence of the deceased. The goal of collecting and compiling vital statistics is to generate **usable statistics**.

To be usable, vital statistics must meet certain criteria. Each data item collected through the civil registration system must have a clear, explicit and simple definition so

the information can be obtained from the informant as completely and accurately as possible. The definitions used should have universal acceptance, follow international standards, and be comparable over time and to other data systems used in the country.

Tabulations produced from vital event data should have continuity so users can be assured that needed information will be consistently available for analysis and evaluation of public health programs and interventions, for monitoring health outcomes, and for assessing important indicators of quality of life such as life expectancy and the infant mortality rate.

The vital statistics system must also be flexible enough to adapt to new and rapidly changing technology. The widespread availability of computer equipment and other technology has allowed electronic methods to be used for civil registration and provided additional tools for data transmission, editing and quality control, linking of data files, and data analysis. New ways for publication and dissemination of vital statistics tabulations, particularly over the Internet, have made vital statistics information more accessible to users.

Standardization of Vital Statistics Data: To have internationally comparable data, the World Health Organization adopted the International Classification of Diseases (ICD) as mentioned in the previous section. The ICD, consisting of an extensive list of alpha-numeric codes, is used to classify diseases, conditions, findings, and causes of injury or disease. In fact, the ICD has become the international standard diagnostic classification for all general epidemiological and health management purposes.

The ICD has been has been used since 1900 although the classification scheme it is based on was developed in the mid-1800s. Currently the ICD is in its tenth revision (ICD-10), and in the past, revisions have occurred approximately every ten years. However, the tenth revision was published in 1993, and the next revision is likely to be at least 25 years after ICD-10. Due to the complexity of ICD and the difficulty of revising computer software for processing and tabulation of ICD codes, countries have been slower to adopt new revisions. For example, in the United States, the ninth revision was used from 1979-1998, and the tenth revision has been used since 1999.

In addition to standard definitions for causes of death and underlying cause of death, WHO also included in the ICD standard definitions for live birth and fetal death and the following other terms related to maternal and infant health (See Appendix A):

- birth weight
- low birth weight
- very low birth weight
- extremely low birth weight
- gestational age
- pre-term, term, post-term
- perinatal period
- neonatal period
- maternal death
- late maternal death
- pregnancy-related maternal death
- direct obstetric deaths, indirect obstetric deaths

While it is important that countries follow international standards as closely as possible to make data comparisons and monitor progress in improving the health of their citizens, some countries do adjust definitions and groupings of data to meet their own needs. Statisticians and epidemiologists should be aware of the definitions used by various countries when making data comparisons, and they should take any differences in definitions into consideration when conducting analyses and making conclusions about the results.

Types of Vital Statistics Measures

Absolute versus Relative: Although **absolute counts** provide some useful data for planning facilities (schools, hospitals), the need for service providers (doctors, funeral directors), or comparing burden, just counting the number of births and deaths does not provide much useful information for assessing health status. Because of population differences, absolute counts are not comparable for measuring risk over time or geography. To account for differences in population size, age and sex distribution, and racial or ethnic composition, the absolute counts are converted to a **relative number** by relating the counts to the population at risk at a particular place and time. That is, one absolute number is related to another absolute number to obtain a relative number (e.g., the count of deaths is related to the count of population) for analysis and comparison. The most commonly used relative numbers in vital statistics are percentages, rates, and ratios.

In order to calculate relative numbers for births and deaths, the population at risk is needed for the denominator information. Census counts are used as the denominator for many vital statistics measures since they generally provide population data in detail by age, sex, race or ethnicity, and geographic location. Relative numbers can be calculated for small groups for comparison as long as denominator data are available. However, caution must be used with small absolute numbers since the uncertainty of the estimates will increase.

Percentages: A percentage is a proportion of events out of the total events multiplied by 100. In a percentage, the numerator is part of the denominator. For example, to show what percentage of total births are premature, the number of premature births is divided by the total number of births and multiplied by 100.

Data can also be presented as a percentage distribution where percentages are computed for an array of mutually exclusive subcategories using the total number as the base denominator. In this case, all the percentages should add up to 100. For example, to show the percentage distribution of births by age of mother, the number of births in each subcategory is divided by the total number of births and multiplied by 100.

Ratios: A ratio indicates the size of one number relative to another number. The numerator does not have to be part of the denominator (although it can be as in a

percentage which is a type of ratio). For example, the sex ratio at birth is calculated by dividing the number of male births by the number of female births and multiplying by 1,000 to obtain the number of male births per 1,000 female births.

Rates: A rate is the number of events relative to the population at risk for the event. While a percentage or ratio is generally used to describe a static quantity, a rate describes a dynamic quantity or the speed with which something is happening during a specific period of time. All rates must have a period of time specified. For example, a death rate describes how fast deaths are occurring within a country in a given calendar year. Note all rates are ratios calculated by dividing a numerator by a denominator, but not all ratios are rates.

There are two types of rates that are used in vital statistics analyses:

1. Rates computed using only vital statistics
2. Rates computed using both vital statistics and population statistics

In the first type of rate, data from vital statistics are used in both the numerator and the denominator. For example, the infant mortality rate is calculated by dividing the number of deaths under 1 year of age (infants) in a calendar year by the number of live births in that calendar year.

In the second type of rate, data from vital statistics are used in the numerator and population statistics are used in the denominator. For example, the age-specific death rate for children under 1-year of age is calculated by dividing deaths to children under 1-year of age by the mid-year population of children under 1 year of age. Since population statistics are needed for these calculations, statisticians and epidemiologists should be familiar with the availability and quality of census data in their country. In many countries the census is not taken annually, so current population estimates should be used. In some cases, those wishing to analyze vital statistics data have to prepare their own population estimates to have appropriate mid-year populations for calculating vital statistics rates.

Natality Statistics

Rates/Ratios/Percentages

Note: For interpreting natality measures, it is customary to use rates per 1,000 population. However, when the measure is for a relatively rare event (e.g. low birth weight), rates per 100 are often used.

- **Crude Birth Rate (CBR)**: The crude birth rate is the number of resident live births for a specific area during a specified time period divided by the total population for that area multiplied by 1,000. Generally the mid-year population is used in the denominator.

$$\frac{\text{Total resident live births}}{\text{Total population}} \text{ X 1,000}$$

  The crude birth rate is usually calculated for a calendar year. While the crude birth rate is a basic measure of fertility, there are other fertility measures (general fertility rate and total fertility rate) that are more population-at-risk specific and more comparable across time and geography. Note that the birth rate is NOT the same as pregnancy rate, which is the total number of resident pregnancies including live births, induced abortions, and fetal deaths per 1,000 women aged 15-44 years for a specified geographical area (country, state, county etc.) during a specified time period.

- **Sex Ratio at Birth**: The sex ratio at birth is the number of resident male live births for a specific area during a specific time period divided by the number of resident female live births for the same area and time period multiplied by 100 or 1,000.

$$\frac{\text{Number of resident male live births}}{\text{Number of resident female live births}} \text{ X 100 (or 1,000)}$$

  The sex ratio at birth is an important demographic indicator used for determining the sex composition of a population. It also affects some critical demographic measures such as the number of years required for a population to double in size given a rate of population growth which rises as the ratio of males to females at birth increases.

- **Percent of Low (or Very Low) Birth Weight**: The percent of births with low (or very low) birth weight is the number of resident live births for a specific area during a specified time period with a birth weight of less than 2,500 (or 1,500) grams divided by the number of resident live births for that area and time period multiplied by 100.

$$\frac{\text{Number of resident live births < 2,500 (or 1,500) grams}}{\text{Number of resident live births}} \text{ X 100}$$

  Low and very low birth weight births have been associated with negative birth

outcomes, and may be an indicator of problems in access to quality health services and/or the need for prenatal care services.

- **Percent of Preterm Live Births**: The percent of preterm live births is the number of resident live births for a specific area during a specified time period with a gestational age less than 37 completed weeks divided by the number of resident live births for that area and time period multiplied by 100.

$$\frac{\textbf{Number of resident preterm (< 37 weeks gestation) live births}}{\textbf{Number of resident live births}} \textbf{ X 100}$$

In less densely populated areas, annual numbers of preterm births may be small (<10 or 20) which would result in a percent preterm considered to be too unstable or unreliable for analysis. Adding additional years (three or five-year average annual rates) and/or expanding the area to be studied should result in a larger number of preterm births and more reliable rates for analysis.

- **Age-Specific Birth Rate**: The age-specific birth rate is the number of resident live births to women in a specific age group for a specific area during a specified time period divided by the total population of women in that same age group for that area and time period multiplied by 1,000. Generally the mid-year population is used in the denominator.

$$\frac{\textbf{Number of resident live births to women in a specific age group}}{\textbf{Number of women in the same age group}} \textbf{ X 1,000}$$

Age groupings used are generally 5 or 10-year intervals but should be chosen to have sufficient numbers of births to have reliable rates for analysis.

- **General Fertility Rate (GFR)**: The general fertility rate is the number of resident live births for a specific area during a specified time period divided by the female population aged 15-44 years (usually estimated for mid-year) for the same area and time period multiplied by 1,000.

$$\frac{\textbf{Number of resident live births}}{\textbf{Number of females aged 15–44 years}} \textbf{ X 1,000}$$

The general fertility rate is the most commonly used overall fertility measure because of the readily available numerator and denominator data. It attributes births to women of reproductive age (15-44) and thus represents the population at greater likelihood of giving birth.

- **Total Fertility Rate (TFR)**: The total fertility rate is the sum of the age-specific birth rates (calculated in 5–year age groups for females 10–49) for female residents of a specific area during a specified time period multiplied by 5.

$$(\sum \text{Five-Year Age-Specific Birth Rates}) \times 5$$

where the five year age-specific birth rate is

$$\frac{\text{Number of live births to women in age group Y}}{\text{Number of women in age group Y}} \times 1{,}000$$

Age groups are 10-14, 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, and 45-49. The sum of the age-specific birth rates is multiplied by 5 because each rate represents a five-year cohort of women.

The total fertility rate is one of the most commonly used standard fertility measures because it provides a single number that can readily be used for comparative purposes. The total fertility rate estimates the number of children a hypothetical cohort of 1,000 females in the specified population would bear if they all went through their childbearing years experiencing the same age-specific birth rates for a specified time period. Sometimes the total fertility rate is expressed per woman instead of per 1,000 women to indicate the average number of children that would be born to woman during her lifetime.

Mortality Statistics

Note: For interpreting mortality measures, it is customary to use rates per 100,000 population. One exception is infant mortality rate, which is customarily reported per 1,000 live births.

Rates and Other Mortality Calculations:

- **Crude Death Rate (CDR)**: The crude death rate is the number of resident deaths for a specific area during a specified time period divided by the total population for that area multiplied by 1,000. Generally the mid-year population is used in the denominator.

$$\frac{\text{Total resident deaths}}{\text{Total population}} \times 1{,}000$$

The crude death rate is a very general indicator or index of the health status of a geographic area or population. This type of crude rate is not appropriate for comparison of different populations or areas due to the substantial impact of age in mortality data and the different age-distributions in different populations. It is generally better to use age-adjusted mortality rates (described later in this section) for comparative analysis.

- **Age-Specific Death Rate**: The age-specific death rate is the number of resident

deaths for a specific age group (or age) for a specific area during a specified time period divided by the total population in that same age group (or age) for that area and time period multiplied by 1,000. Generally the mid-year population is used in the denominator.

$$\frac{\text{Number of resident deaths in a specific age group}}{\text{Total population in the same age group}} \times 1{,}000$$

Age groupings used are generally in 5 or 10-year intervals but any grouping of interest could be used, for example young adults (18-24) or middle age (45-65).

- **Cause-Specific Death Rate**: The cause-specific death rate is the number of resident deaths from a specified cause of death for a specific area during a specified time period divided by the total population at risk in that area and time period multiplied by 100,000. Generally the mid-year population is used in the denominator.

$$\frac{\text{Number of resident deaths from a specific cause of death}}{\text{Total population at risk}} \times 1{,}000$$

Cause-specific death rates provide more detail to help identify health problems in an area. Since there are relatively few deaths from many distinct causes, the multiplier of 100,000 is used to have a number greater than one for ease of comprehension.

- **Infant Mortality Rate (IMR)**: The infant mortality rate is the number of resident infant deaths (newborns dying under 1 year of age) for a specific area during a specified time period divided by the total number of resident live births for that area and time period multiplied by 1,000.

$$\frac{\text{Number of resident infant deaths X 1,000}}{\text{Number of resident live births}} \times 1{,}000$$

The infant mortality rate (IMR) is considered a primary and important indicator of an area's overall health status or quality of life.

Fetal / Neonatal / Postneonatal / Perinatal mortality rates are calculated in a similar way using the specific populations at risk (see WHO definitions in Appendix A).

- **Maternal Mortality Rate**: The maternal mortality rate is the number of resident maternal deaths (deaths of women while pregnant or within 42 days of termination of pregnancy due to complications of pregnancy, childbirth, and the puerperium) for a specific area during a specified time period divided by the total number of resident live births for that area and time period multiplied by 100,000.

$$\frac{\textbf{Number of resident maternal deaths}}{\textbf{Number of resident live births}} \textbf{ X 1,000}$$

The maternal mortality rate is considered a primary and important indicator of an area's overall health status or quality of life. It can be used as an indicator of access to prenatal and obstetric care and may suggest the need for additional resources in an area.

- **Pregnancy-Related Mortality Rate**: The pregnancy-related mortality rate is the number of resident pregnancy-related deaths (deaths of women while pregnant or within 42 days of termination of pregnancy from any cause of death) for a specific area during a specified time period divided by the total number of resident live births for that area and time period multiplied by 100,000.

$$\frac{\textbf{Number of resident pregnancy-related deaths}}{\textbf{Number of resident live births}} \textbf{ X 1,000}$$

Pregnancy-related mortality rates are different from maternal mortality rates. The World Health Organization defines a pregnancy-related death as "the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the cause of death." [5-1] In contrast, a maternal death is restricted to deaths "from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes." [5-1] (See Appendix A) In addition to deaths from causes commonly associated with pregnancy, pregnancy-related deaths include deaths from causes not related to pregnancy such as accidents and homicide.

Life Expectancy at Birth: Life expectancy at birth is one of the indicators frequently used as an assessment of health to determine if a country is achieving the goal of a long life for all of its citizens. It is derived through **life table** calculations that measure mortality, survivorship, and life expectancy. Life expectancy at birth is a theoretical number of years a newborn would live, on average, if he or she experienced the current levels of mortality within each age group as he or she aged.

Life tables are classified into two types according to the reference year of the table: period or cohort. A period (also called static) life table is based on a period of time such as three years or a short period of time in which mortality has remained essentially the same, and it shows the probability that a person of a particular age will die before his or her next birthday. A cohort life table is based on the mortality rates of a particular birth cohort, and it shows the probability of death for people in the cohort over their lifetimes.

Life tables are also classified into two types according to the length of the age interval used: unabridged and abridged. An unabridged (also called complete) life table contains data for every single year of age from birth to the last applicable age. An abridged life table contains data by intervals of age such as 5 or 10 years.

Life tables are frequently calculated separately for men and women since they have substantially different mortality rates. Life tables can also be calculated for other subgroups of the population such as race or ethnicity or for different geographic areas. Additional information on life expectancy and an example of a life table are shown in Appendix B.

Years of Potential Life Lost (YPLL): Years of potential life lost is an estimate of premature mortality since it is calculated by subtracting the age at death of a person who died before a predetermined end point age (such as 75 years) from that predetermined age. Or, it is the average number of years a person would have lived if he or she had not died at an early age (prior to the predetermined age).

YPLL = predetermined end point age–age at death of decedent who died prior to end point age

The YPLLs for each death, usually to residents of a geographic area for a specific time period, are then summed to calculate the total years of potential life lost for the area for a specific time period.

To calculate YPLL, the statistician or epidemiologist has to determine an upper end point age for use in the calculations. Generally, this age is set around life expectancy, or 65 or 75 years are frequently used. However, this is arbitrary and the end point age can be set at any age that is appropriate for the particular analysis. Only those who die before the end point age are included in the calculation.

In most mortality indicators, deaths at older ages are emphasized because risk of death increases with age. Years of potential life lost gives more weight to deaths at younger ages, and it is used to point out causes of death that are more likely for younger age groups. Commonly, years of life lost are calculated for the leading causes of death in a geographic area or for a demographic group. The results are then ranked to compare the potential years of life lost for each cause of death. For example, the ranking of years of potential life lost for deaths from cancer and accidents generally moves higher on the scale than years of life lost from heart disease (depending on the end point chosen). Because years of potential life lost provides a better indication of premature mortality than some other mortality measures, it is becoming more widely used to establish public health priorities.

Age Adjusting: Age adjusting is used to control for differences in population age distributions when mortality rates are compared across different geographic areas. For example, if country A has a crude mortality rate of 10 per thousand and country B has a crude mortality rate of 7, it does not necessarily mean that the population of country B is healthier than that of country A. Country A may have a much older population and would be expected to have a many more deaths. To compare the mortality rates of the two countries, the effect of the differences in age distribution must be removed through age adjusting.

There are two basic methods for age adjusting: direct and indirect. In direct age adjusting, a *standard population* is used for weighting each age group (like a weighted average), while in indirect age adjusting a set of *standard age-specific death rates* is used.

In **direct age adjusting**, the age-specific rates are calculated for the population of interest and then are multiplied (weighted) by the proportion of each age group in the standard population. The age adjusted rates for each age group are then added to obtain the total age-adjusted death rate. An example of direct age adjusting is shown in Appendix C.

Different countries use different standard populations for direct age adjusting. When comparing rates within a country, the national level age distribution can be used if it is accurate and reliable. If a country's age distribution is not accurate and reliable, or if international comparisons are to be made, the WHO World Standard Population should be used. The WHO World Standard Population is designed to reflect the average age structure of the world population over the period of time (25-30 years) the Standard will be used. From the latest (1998 at the time) United Nations population assessment, an average world population age structure was constructed for the next generation, from the year 2000 to 2025. The use of an average world population, as well as a time series of observations, removes the effects of historical events such as wars and famine on population age composition. Appendix D contains a table with the WHO World Standard Population distribution.

Direct age adjusting facilitates the comparison of mortality in different areas by removing the effects of differences in population age distributions. The age adjusted rate is hypothetical and acts as an indicator that is only useful for comparing mortality in areas adjusted to the same standard population. Since age adjusted rates will vary depending upon the standard population used, the standard used should always be documented when direct age adjusted mortality rates are presented.

Indirect age adjusting is not used as frequently as direct age adjusting. However, it may be useful when age-specific numbers of deaths in the study population are either unavailable or small in number (less than 25 events across all age groups).

Indirect age adjusting, a standard set of age-specific rates for a given area (Area A) are applied to the age distribution of the study population (Country B) to calculate the number of deaths that would be expected in the study population (Country B) in each age group. The expected deaths by age group are then added together to get the total expected deaths for the study population (Country B).

∑ [(standard age-specific death rate for age group) X (number in study population for same age group)] = total expected deaths in study population

The number of expected deaths for the study area (Country B) is then compared to the actual number of deaths in the study area by calculating a standard mortality ratio (SMR) as the number of actual or observed deaths in the study population divided by

the number of expected deaths multiplied by 100.

$$\frac{\textbf{Number of observed deaths in study population}}{\textbf{Number of expected deaths}} \textbf{ X 100}$$

Example: ∑ [(standard age-specific death rate for age group from Area A) X (number of people in same age group in population for Country B)] = total expected deaths in Country B

$$\textbf{SMR for Country B} = \frac{\textbf{Number of observed deaths in Country B}}{\textbf{Number of expected deaths for Country B}} \textbf{ X 100}$$

The standard mortality ratio is the most common way of presenting the results of indirect age-adjustment of a death rate. A standard mortality ratio above 100 means the number of observed deaths is greater than what would be expected if the study population had the same probability of dying as the standard population. A standard mortality ratio below 100 means the number of observed deaths is less than expected.

The standard age-specific death rate used in indirect age adjusting may be from a national level to apply to a regional level or from one country to apply to another country. It is a useful technique to compare mortality for two countries when the age-specific death rates can be calculated for one country (deaths by age are known) but only the total number of deaths is known for the second country (assuming the population distribution by age is known for both countries).

Visualizing Data

Tabulations: Nearly all vital statistics offices prepare numerous compilations of vital statistics data for their users and present them in table format. Statistical tables are excellent for displaying numerical data and assist users in making comparisons and noting relationships between various data sets. The degree of detail presented in statistical tables depends on the purpose of the table and the limitations of the vital statistics data. Most countries present data by age, sex, race or ethnicity, geographic area and cause of death. Although countries can create their own special groupings of vital statistics data, WHO has made recommendations for standard groupings of data to improve comparability and has provided certain conventions for data summarization and computation of basic vital statistics rates (see section on “Mortality, Tabulations, Graphs, and Figures”).

Tabulations of vital statistics data should be compiled for a specified period of time. Time periods used should be specific calendar periods such as months, quarters, or years. In preparing tabulations, a decision must be made on whether to use the date of occurrence of the vital event or the date of registration of the event. Generally, the

recommendation is to present final vital statistics tabulations for events that occurred during the time period specified based on the assumption that the events have been registered within the time period required in the civil registration laws. Often, current weekly, monthly, or quarterly summaries may be produced more quickly by using date of registration. If provisional tabulations are done using the date of registration, an evaluation should be made of the degree of difference in the two types of tabulations.

The recommendation to do final tabulations by date of occurrence necessitates the need for a "cut-off" date for inclusion of vital events in the annual (or other time period) vital statistics tabulations. Since any vital events registered after the "cut-off" date would not be included in annual tabulations, consideration must be given to the civil registration structure and process in the country as well as the requirements of the civil registration law. The "cut-off" date must be established such that a high percentage of vital events are included in the tabulations and such that events for smaller subgroups, such as infant deaths, are not missed. Use of electronic technology for registering and processing vital event records should help countries lower their "cut-off" dates.

Geography must also be considered in preparing tabulations of vital statistics data. Assuming that every vital event occurring in the country is registered and included in the vital statistics data, tabulations can be prepared at the national level and for subdivisions of the country, such as civil divisions, cities, and towns, and for sub-population groups. However, registration may not be complete in certain geographic areas or cover the entire country, so a country may decide to just do detailed tabulations on geographic areas of known coverage completeness. This should be just a temporary measure, and attempts should be made to improve the registration of vital events since the goal of a civil registration system is to have complete coverage of the entire population.

In preparing tabulations for geographic areas, a decision must be made on whether to use place of occurrence of the event or usual place of residence of the person involved in the event. The assumption is generally made that there is relatively little difference between a country's resident population and the population present in the country at any particular time. Presumably, people involved in international travel or those not at their usual place of residence (tourists, military, diplomats, etc.) are a very small portion of the total population and add very few births or deaths. Therefore, it is customary to consider that the vital events occurring in a country are approximately the same as the events occurring to the residents of the country for national tabulations.

For final tabulations other than those at the national level, the usual place of residence should be used since most health analyses and demographic studies are based on residence data. Therefore, vital events that occur in medical facilities outside of the residence area would be reallocated back to the usual residence area for tabulation. However, if provisional tabulations are needed quickly, it may not be practical to reallocate data back to usual residence, so place of occurrence would provide a useful alternative. The occurrence data could also be presented for those events occurring to residents of the geographic area and events occurring to non-residents of the geographic area.

Charts, Graphs, and Figures: Charts, graphs, and figures are useful for presenting vital statistics data in a format that allows users to more easily and rapidly determine the meaning of the numbers. Large amounts of information can be effectively presented and patterns of data stand out more quickly than in tabular form. Charts can be used to show how things are distributed, or patterns or relationships of data at a point in time or over time.

The users must be considered as well as the data in deciding which kind of chart, graph, map, diagram or figure to use to present vital statistics data. The method used should be the one that is best to illustrate the issue of interest. The education and knowledge of the audience should be considered in determining the complexity of the particular chart, graph or figure. A graph for a scientific or professional meeting might be very different from one used to explain or present data to stakeholders or legislators.

Natality Tabulations, Graphs, and Figures: Natality data can be presented in at various levels of detail in numerous tabulations and graphical formats. Often numbers and/or rates are presented as tables of information accompanied by graphs or figures using the same data to illustrate the point or topic of interest. Natality data can be cross tabulated for multiple items on the birth certificate such as age of mother, race or ethnicity of mother, geographic area of mother's residence, and factors such as infant's birth weight, number of children born to the mother (birth order), pregnancy care information, and other topics of importance for public health and demographic analysis. Natality rates, ratios, and percentages such as crude birth rates by geographic region, percent of births by age of mother, age specific birth rates, percent of births by birth weight, percent of births receiving prenatal care in the first trimester, fertility rates, etc., can be presented in tabular format as well as in graphs or figures to show distributions of data or changes over time. Examples of different types of tables and graphs of natality data are shown in the slides for this course.

Mortality Tabulations, Graphs, and Figures: Tabulations of mortality data can be done for various items on the death record at multiple levels of detail. One of the most common and useful ways to present mortality data is by cause of death. Generally cross tabulations are presented for specific causes of death by various demographic items such as age, sex, and race or ethnicity, by geographic area, and as distributions over time.

Below are the recommendations WHO makes for statistical tabulations of mortality data (ICD-10, Volume 2, Section 5.6.1):

> *"The degree of detail in cross-classification by cause, sex, age and geographical area will depend both on the purpose and range of the statistics and on the practical limits to their tabulation. The following patterns, which are designed to promote international compatibility, present standard ways of expressing various characteristics. Where a different classification is used in published tables (e.g., in age-grouping), it should be reducible to one of the recommended groupings.*

a. *Analysis by the International Classification of Diseases should, as appropriate, be in accordance with:*
   i. *the detailed list of three-character categories, with or without four character subcategories;*
   ii. *one of the special tabulation lists for mortality;*
   iii. *the special tabulation list for morbidity.*

b. *Age classification for general purposes:*
   i. *under 1 year, single years to 4 years, 5-year groups from 5 to 84 years, 85 years and over;*
   ii. *under 1 year, 1–4 years, 5–14 years, 15–24 years, 25–34 years, 35–44 years, 45–54 years, 55–64 years, 65–74 years, 75 years and over;*
   iii. *under 1 year, 1–14 years, 15–44 years, 45–64 years, 65 years and over.*

c. *Classification by area should, as appropriate, be in accordance with:*
   i. *each major civil division;*
   ii. *each town or conurbation of 1 000 000 population and over, otherwise the largest town with a population of at least 100 000;*
   iii. *a national aggregate of urban areas of 100 000 population and over;*
   iv. *a national aggregate of urban areas of less than 100 000 population;*
   v. *a national aggregate of rural areas.*

Note 1. Statistics relating to (c) should include the definitions of urban and rural used.
Note 2. In countries where medical certification of the cause of death is incomplete or limited to certain areas, figures for deaths not medically certified should be published separately."[5-2]

Because there are thousands of codes in the International Classification of Diseases (ICD) used to code cause of death data, WHO has developed standard groupings of codes, called **Tabulation Lists**, to use for presentation of cause of death data as mentioned in an the previous section on death records. There are four WHO Tabulation Lists: two for general mortality and two for infant and child mortality.

- **General Mortality, Condensed List** (103 groups of causes)
- **General Mortality, Selected List** (80 groups of causes)
- **Infant and Child Mortality, Condensed List** (67 groups of causes)
- **Infant and Child Mortality, Selected List** (51 groups of causes)

The two condensed lists contain the full range of three-character ICD codes condensed into groups for tabulation and publication purposes. The two selected lists contain items "for conditions and external causes significant for the monitoring and analysis

of population health status and mortality-related health concerns at both national and international levels."[5-3]

The standard groupings in the cause of death tabulation lists are used by most countries for tabulating cause of death data and as the basis for selecting the **leading causes of death**. For most countries, the WHO tabulation lists provide sufficient information about their most important diseases and external causes of death. The standard lists also allow for international comparisons of cause of death. However, countries can also develop their own cause of death tabulation lists to meet their specific needs. For example, the ICD codes can be grouped in whatever way is most appropriate and useful for the specific analysis or is needed to monitor local health programs. Some guiding principles to consider for national cause of death tabulations include: excluding vague or ill-defined causes (including "other" or "unspecified" causes); including causes that reflect issues facing a country (e.g. if schistosomiasis is not present in a given country, deaths from schistosomiasis should not be included in the cause of death tabulation); and including EITHER an overall cause category (e.g. cancer) OR cause subcategories (e.g types of cancers), but not both (note: it is acceptable to list an overall cause category in one tabulation and then include a second tabulation with subcategories of the overall category). Other criteria that should be considered for national cause of death tabulations include quality of reporting (e.g. if the majority of deaths related to heart disease are unspecified, it would be advisable to include an overall category for heart disease rather than to use subcategories of heart disease) and the ability to compare tabulations over time.

It is also important to note that due to the somewhat arbitrary procedure used to rank causes of death, interpretations of cause of death rankings should be done with attention to the inherent limitations of ranking. The rank order of a given cause depends on the causes included in the list from which ranks are determined. Also, rankings do not imply burden. While the rank of a given cause (i.e. its burden of mortality relative to other causes) may decline over time, the mortality rate for the same cause may not change (and vice versa). Lastly, rankings do not necessarily indicate causes of death of greatest public health concern. For more information about the use of national rankings of causes of death, see: CDC/NCHS National Vital Statistics System, National Vital Statistics Reports, Deaths: Leading Causes for 2005, Vol 58, No 8 (http://www.cdc.gov/nchs/products/nvsr.htm).[5-4]

Mortality data can be presented in various levels of detail in numerous tabulations and graphical formats. The method used for presentation of the data depends on the particular point or issue that is to be communicated or illuminated. Examples of many different types of tables and graphs of mortality data are shown in the slides for this course. Mortality data for a number of countries is shown on the WHO Web Site.[5-5]

In analyzing mortality data, the population size of the country or subnational area needs to be considered. In countries or areas with small populations, the annual number of deaths in many categories will be very small and will fluctuate randomly from year to year. To eliminate some of the problems with small numbers, causes of death can be grouped into broader categories or several years of data can be combined to have

sufficient numbers to analyze. For analysis by age categories, it may be necessary to combine data into larger age groups or combine several years of data.

While the goal of civil registration is to record all vital events in a country as they occur, this goal is not met in all countries. Other countries that have good registration of vital events may not collect cause of death data through civil registration in all parts of the country. Where good registration of vital events is not possible for the entire country, countries should begin to produce and use vital statistics for those areas that do have good registration coverage. These data are likely to be more accurate than data collected from sample surveys. Good vital statistics information for smaller areas that can be used for public health monitoring and analysis will help to gain support from government officials for expanding and improving civil registration and vital statistics systems.

Linking Data

Linking of vital event records is done for administrative as well as research purposes. Vital records can be linked to other records in the civil registration system, such as deaths to births, or to records with person-specific information in other administrative systems or in research studies.

One of the primary linkages in many civil registration offices is matching an infant death record to its live birth record to create a birth-infant death data set for analyzing detail about infant mortality. Linking individual birth and infant death records yields a rich data set with information from both the birth record (birth weight, gestational age, characteristics of mother and infant at birth, etc.) and death record (cause of death information). Another research data set can be created for maternal death surveillance by matching a maternal death record to the birth record of the infant delivered from that pregnancy.

Linking death records to birth records can also be used as a means of preventing fraudulent use of birth records. A person wishing to obtain a false identity might apply for a copy of the birth certificate of a person who died (often an infant or young child) but who was born in about the same year and was the same sex as the fraudulent applicant. To protect against this deception, vital record offices link death records with corresponding birth records and mark the birth record as “deceased.”

Since linking birth and death records is an important function of the civil registration process, it should be a routine practice in local civil registration offices where the initial matching should occur. While it is desirable to try to find a matching birth record for all death records, resource constraints often limit the matching process to births and infant deaths. The birth-infant death match is also important for quality control to identify unregistered births. Inconsistencies in reporting of items that appear on both birth and infant death records can also be identified and resolved.

Many other types of research data sets can be created by linking birth and death records to other types of person-specific records. Death records can be linked to census records to study additional demographic information about those who died. Census records can also be linked to birth and/or death records to monitor the completeness of civil registration. Death records can be linked to records of individuals in different types of benefit programs to study causes of death in specific population groups. Birth records of infants whose mothers receive benefits for medical or social services can be linked to the mother's benefit record to monitor pregnancy problems and outcomes. Researchers studying individuals employed in certain occupations, participants in drug trials or other medical studies, or persons in cancer or other disease registries can link records of their study participants to death certificates to obtain cause of death information. Essentially, as long as a researcher has person-specific records, he or she can link them to birth or death records if it is appropriate for the study and allowed by the civil registration laws and regulations.

Researchers, epidemiologists and statisticians involved in using linked data from vital records should be aware of confidentiality and privacy issues with the linked data. If civil registration laws and regulations specify that information from vital records is confidential, then under most civil registration laws, that information must remain confidential if it is used in a research study and linked to another data set. Procedures should be in place to ensure that anyone using vital record information in a research study, particularly when linked to another data set, will keep the vital record information confidential.

Review

- Vital statistics are the basis for public health and epidemiologic monitoring, evaluation, and planning.
- Vital statistics data systems should have clear, explicit and simple definitions; continuity; and flexibility to adapt.
- For international comparison, WHO standards for classification of diseases and definitions for a variety of terms used in tabulating vital statistics data should be followed.
- Types of vital statistics measures include percentages, ratios, and rates.
- A time reference (date of occurrence or date of registration) and a geographic reference (place of occurrence or place of residence) must be considered in preparing vital statistics tabulations.
- Some common measures used to analyze natality data are crude birth rate, sex ratio at birth, percent low birth weight, percent preterm births, age-specific birth rate, general fertility rate, and total fertility rate.

- Some common measures used to analyze mortality data are crude death rate, age-specific death rate, cause-specific death rate, infant mortality rate, maternal mortality rate, pregnancy-related mortality rate, life expectancy at birth, and years of potential life lost.
- Age adjusting is used to control for differences in age distribution of the population when comparing mortality rates across different geographic areas.
- In direct age adjustment a standard population age distribution is used while in indirect age adjustment a set of standard age-specific death rates is used.
- WHO has developed standard Tabulation Lists consisting of groups of ICD codes to be used in presentation of cause of death data.
- WHO has also made recommendations for age categories and size of geographic area to use for mortality tabulations.
- Linking of birth and/or death records is done for both administrative and research purposes.

Section 5 References

5-1. *International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Volume 2, Instruction Manual*, World Health Organization, Geneva, Switzerland , 1993 (Section 5.8.1) http://www.who.int/classifications/icd/en/

5-2. *International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Volume 2, Instruction Manual*, World Health Organization, Geneva, Switzerland , 1993 (Section 5.6.1) http://www.who.int/classifications/icd/en/

5-3. *International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Volume 2, Instruction Manual*, World Health Organization, Geneva, Switzerland , 1993 (Section 5.4.2) http://www.who.int/classifications/icd/en/

5-4. CDC/NCHS, National Vital Statistics System, National Vital Statistics Reports, Deaths: Leading Causes for 2005, Vol 58, No 8, http://www.cdc.gov/nchs/products/nvsr.htm

5-5. World Health Organization Mortality Data available on their Web Site at http://www.who.int/healthinfo/mortality_data/en/

Section 6

Data Uses And Dissemination

Civil Registration And Vital Statistics Systems

Producing Vital Statistics

The importance of vital event data for statistical use has been widely recognized. Most countries have a central agency responsible for generating statistical tabulations from vital event data obtained through the civil registration system, and in some countries the civil registration law contains a requirement for tabulation and/or publication of vital statistics. Birth and death records are the main source of vital statistics data for public health monitoring and analysis and are widely used for demographic and social research studies.

The statistical agency should produce and disseminate vital statistics on a timely schedule and in multiple formats that meet the needs of their data users at both national and local levels. Users should be consulted to determine the relevance and utility of tabulations, graphics, publications, and dissemination methods of vital statistics data, and a periodic review should ensure that user needs continue to be met. The United Nations makes the following recommendation for the minimum compilation of vital statistics:

1. provision of monthly or quarterly summary counts of vital events "*on a time schedule prompt enough to provide information for health interventions and population estimation programmes, administrative uses or other needs, and*
2. *the production of detailed annual tabulations of each type of vital event cross classified by its demographic and socio-economic characteristics*."[6–1]

Statistics produced should be based on standard definitions, classifications, and statistical methods that are documented and made available to users. Technical information about the production of vital statistics should include methods of data collection, processing procedures, quality assessments, and limitations on data usage. Methods should be in place to ensure that information on individuals remains confidential, and data are not released in small aggregates such that individuals could be inadvertently identified.

To improve timeliness and quality of vital statistics data, local registrars, funeral directors, medical personnel, and others involved in the civil registration process should be provided with training and resource materials so they recognize and appreciate the significance of vital statistics information and its value to their local communities. Wide dissemination of vital statistics data, particularly local level detail, helps the statistical agency become known to government officials and others who can provide support in improving the civil registration and vital statistics systems.

Statistical agencies need to be flexible and keep up to date to meet the constantly changing uses of technology, particularly the use of the Internet for dissemination of vital statistics information. They must also recognize the changing information requirements of their users and the need for more detail in analysis and public health monitoring. Alternative ways to make detailed vital statistics data available to users need to be considered, such as micro-data files or Web-based query software.

Statistical agencies also need to develop ways to make the vital statistics data more useful by integrating it with data from other sources such as the census or other types of official statistics.

In 2005, the Committee for the Coordination of Statistical Activities of the United Nations, recognizing the essential need for official government statistics, and that *"public trust in official statistics is anchored in professional independence and impartiality of statisticians, their use of scientific and transparent methods and equal access for all to official statistical information,"*[6–2] endorsed a series of *Principles Governing International Statistical Activities* that are provided in Appendix E.

Using Vital Statistics In International Comparisons

Countries are often interested in seeing how their health status compares on an international scale. Knowing about the successes and setbacks of other countries also might affect how health policies or interventions are established in their own country. However, making valid international comparisons can be complicated. The Australian Institute of Health and Welfare has developed *A Working Guide to International Comparisons of Health* to *"encourage users of international health-related data to consider the complexities before comparing countries, and to assist them in interpreting the results of these comparisons. It presents examples to highlight the types of questions to ask when using health data in an international context."*[6-3]

The Australian Guide covers three areas for consideration in comparing international data, and a summary checklist for international comparisons from the publication is available in Appendix F.

1. **Data Quality**
   - **Consistency**–Are the data consistent across countries? The information being compared should be based on the same definitions. If different definitions are used, countries may appear better or worse for reasons related to the data rather than to the health system. If comparable source data are not available, an explanation emphasizing the differences should be included.
   - **Methodology**–Do all countries use the same method to collect the data? Collection methods and availability of health data vary from country to country depending on the country's infrastructure. In some countries health data come from administrative systems, health care providers, or population surveys. Other sources are disease registries, surveillance data, mortality data, hospital utilization data, etc. If data are not based on the same methods for collection, comparison of the data may give misleading results. Using data based on the same collection methods will increase comparability.
   - **Coverage**–Do the data cover similar parts of the population? In some countries data do not cover the entire population or health system. Coverage is affected by national legislation, geography, and data collection systems.

Civil registration requirements for non-citizens, including refugees and guest workers, vary across countries. Some countries may only report data from government-funded health centers. Data collected from population surveys designed to represent the entire population of a country may lack information on important subsets of the population, including minors, indigenous populations, institutionalized people, or nomadic populations. It is important to be aware of the level of data coverage when making international comparisons.

- **Time Period**–Do the data refer to the same time period? International comparisons should cover approximately the same year or range of years so that data properly account for global trends (such as technological advancements). When the same data years are not available, the years covered for each country should be clearly labeled. If similar data years are not available, the latest available data may be used for each country, or data presented can be restricted to countries whose data meet a particular range of years (e.g., the last 5 years).

2. **Choice of Countries**

- **Comparability**–Countries chosen for comparison should include those for which a comparison is practical and useful. Selection of appropriate countries should take into account the purpose of the comparison, how interpretations are made, data availability, and comparability. Comparability may be judged on a country's economic status and/or income per capita, population size, geographical land mass, or geographic proximity. The method for selecting countries for comparison should be fully evident. (Note: The limitations of using income per capita to compare across countries that publically fund health care and other social services to varying degrees should be considered.)

3. **Presentation and Interpretation**

- **Presentation**–Are the data presented appropriately? Presentation methods can affect the interpretation of the data. Since a variety of methods can be used for presenting data comparisons, including tables, graphs, rankings, and interactive databases, the method used should be selected based on the purpose and topic of the comparison, the audience, and the number of countries included in the comparison. When making comparisons, the following issues should be considered:

  - Can (and should) the data be ranked from best to worst?
  - Is there agreement on which indicator best represents the underlying concept?
  - What size are the differences separating countries of different ranks?
  - Has the country's performance been considered independently of the international context? Note that a country's ranking may improve (or worsen) while a country's absolute performance may have declined (or improved).

- **Explanation**–Is the variation between countries adequately explained? Understanding the different genetic, cultural, economic, political, and environmental factors (e.g., age distribution, population composition, and availability of preventive and primary health care services) can help explain some variation between countries. But, some factors (e.g., variations in coding and registration practices) may limit the usefulness of international comparisons and conceal meaningful differences in the data. Comparison of international data is limited to what differences are present in the data rather than why the differences are present.
- **Underlying Differentials**–Are differences within countries considered? National level data may not fully represent a country's population, due to differences in cultural groups, socioeconomic status, rural-urban divides, literacy levels, income, and governmental administrative areas. Thus, international comparisons can hide inequalities and poorer outcomes among some subgroups within a country. Though it is beyond the scope of international comparisons to explore differences among population subgroups, it is important to consider to what extent different health outcomes among population subgroups may affect national data.
- **Context**–Can the data be used outside of the international comparison? Some international data are meaningful only within the context of international comparisons. Often data used for comparisons are adjusted to account for population differences between countries (e.g., age-adjusting). When data are adjusted, countries can be compared on the same basis, but the resulting figures are valid only for the comparison; they do not represent true national estimates. Also, methods for defining and calculating a country's official estimates may differ from methods used to prepare data for international comparisons. For example, mortality statistics from the WHO mortality database are recorded by the year the death occurred, while some countries report deaths by year of registration. Each method yields different mortality numbers and rates.

A table from the European Perinatal Health Report that presents comparison data for maternal mortality for 2003-2004 for European countries is shown in Appendix G. Data comparison issues are highlighted in the footnotes of the table. A number of the issues mentioned on the Australian Guide's checklist in Appendix F are covered in the footnotes of the table.

Publications

Publication of vital statistics is one of the main functions of the vital statistics agency. Distribution of tabulated vital statistics data in various types of publications and media to various types of users involves publishing vital statistics data at many levels of detail and in many formats. Publications should range from short interpretative pieces with lots of graphics for the public to detailed tabulations for reference in a library. While in the past, most publications were available only on paper, today they can be released in multiple formats, but as many as possible should be made available on the Internet.

Annual Reports: For reference and historical purposes, most countries prepare an official annual report of vital statistics data. These reports are intended to provide a consistent and reliable source of vital statistics data that will be available for access in the future. While most countries use a calendar year for their data compilations, the size and content of official annual reports ranges from a few pages of basic tables to several volumes of tabulations and analysis. Some typical kinds of material contained in annual reports include the following:

- **Natality Statistics Tabulations**
  - Live birth numbers and rates with time trends
  - Detail about mother–age, race or ethnicity, marital status
  - Detail about infant–sex, birth weight, congenital malformations
  - Pregnancy information –prenatal care, birth order, type of place of delivery, attendant at birth, period of gestation, medical problems of mother
  - Geographic information–appropriate small area information by place of residence of mother
  - Some countries include fetal death tabulations
- **Mortality Statistics Tabulations**
  - Death numbers and rates with time trends
  - Demographic information about deceased–age, sex, race or ethnicity, marital status
  - Geographic information–appropriate small area information by place of residence of deceased
  - Cause of death information–detail on leading causes of death by age, sex, and place of residence of deceased
  - Special sections on infant mortality, perinatal mortality, and maternal mortality
- **Other Types of Vital Statistics Data if appropriate for country such as marriage and divorce tabulations**

- **Other Sections**
  - Summary highlights
  - Various types of graphs and figures
  - Preface, introduction, and/or transmittal letter
  - Table of contents
  - Lists of tables and/or figures
  - Appendix
    - Population data for denominators
    - Any special ICD code groupings used
    - Other detailed information needed for calculations
  - Technical or explanatory notes
    - Definitions
    - Sources of data
    - Formulas used in calculations
    - Processing methods
    - Imputation methods
    - Limitations of the data
    - Information on data variability
    - Calculation of confidence intervals
  - Any other information that would be of benefit to their users

Ideally the content of an annual report should be designed to provide useful information, not just tabulations of data. Summary highlights of annual findings can assist users in quickly discovering the important changes and developments that occurred during the past year. Graphic presentations showing trends, percentage distributions, comparisons of rates, etc., help users understand and interpret the data. Information for sub-national geographic areas is also provided in annual reports for some countries to show differences in various health indicators at local levels.

It is important that tables, graphs, figures, etc., included in publications contain clear explanatory notes or text that explain any data limitations or qualifications. If data are of questionable or unknown quality, tabulations can be made available, but they should include appropriate warnings and notations to alert users about possible misinterpretations. Calculations of rates, ratios, or percentages based on small numbers should be noted. Some countries do not show calculations if the numerator or denominator is less than a set small number (e.g., 10 or 20) because of the unreliability of the rates.

Most annual reports contain appendices and/or technical notes or explanations that provide users with information about the data and methods used in preparing the vital statistics contained in the report. These sections should contain any special data used

in calculations such as populations used for denominators and identify the source of the data. An explanation about the ICD should be included and groupings of ICD codes used in the tabulations should be shown. Technical or explanatory notes should include definitions and sources of data, methods used for data collection and processing, and formulas used for calculations. Detailed procedures about any other statistical techniques such as methods for imputation of data or calculation of confidence intervals may also be included in the technical section.

Data Variability and Confidence Intervals: In annual reports for some countries, detailed methods are provided for calculating confidence intervals for the numbers, percentages, and rates of vital events. Although vital events are not subject to sampling error, they are affected by non-sampling errors that occur in the registration process (e.g., mistakes in recording of place of residence, age, or other items).

Generally countries with good civil registration systems, in which nearly all births and deaths are registered in a timely manner, are considered to have a complete count of their vital events. However, when the number of births, for example, is used for comparison of numbers, rates, or percentages over time (or for different areas or groups), the number of births that *actually* occurred can be thought of as one outcome in a large series of possible results that *could have* occurred under the same or similar circumstances. When considered this way, the number of births is subject to *random variation* and statistical methods can be used to estimate a probable range of values or a *confidence interval* from the actual figures.

A confidence interval is composed of a lower limit and an upper limit, called *confidence limits*, calculated specifically for the number (or percentage or rate). The interval that would be expected in 95 out of 100 cases for the number (or percentage or rate) of vital events is called the 95 percent *confidence interval*. For example, if the crude birth rate is 15.5 per 1,000 population (388 births, 24,979 population) for Area A, and the 95 percent confidence interval for that rate is calculated as 14.0 to 17.1 births per 1,000 population, it can then be said that the chances are 95 out of 100 that the actual birth rate for Area A lies between 14.0 and 17.1 births per 1,000 population. The larger the number of events, the more likely it is that the computed rate is closer to the true rate, or the smaller the confidence interval.

Statistical formulae and a more detailed description on calculating confidence intervals are included in Appendix H for those who are interested.

Including confidence intervals (or the statistical methods for calculating those intervals) for the numbers, percentages and rates of vital events can help users make better interpretations of the data.

Other Annual Publications: In addition to the annual report that generally covers all vital events some countries publish reports on specific topics on an annual basis depending on the needs of their users. For example, officials in the health agency may want a report with additional detailed data on maternal and child health issues that are not included in the annual report. A special report comparing vital statistics data for

local areas may be of interest to local officials (this could be a publication containing all sorts of graphs and charts for easy interpretation of the data). A brochure with summary highlights could be published for the general public or for use in schools. These special publications can contain complex analyses or very brief summaries, but should be prepared to have vital statistics data available to meet the most common and/or recurring statistical requests from data users.

To supplement the vital statistics data released through publications, many vital statistics offices prepare additional tabulations for internal use or that are released to the public on request. Examples of these might include a listing of causes of death for each 3-digit (or 4-digit) ICD code cross tabulated by age group and sex. Since a table this detailed would have many blank cells and be very large, it would not be practical to publish it. However, it would be very useful for reference to answer a request from someone who wanted detailed information for a specific cause of death. Users should be made aware of the availability of unpublished data tabulations, and given guidance on how to obtain information from them.

Release of Vital Statistics Information: Timely release of annual vital statistics information on a regular schedule is important to retain the support of data users. The schedule for completion of annual files should be set so that nearly all vital events are included in the final tabulations, and sufficient time should be allowed to review and edit the data to eliminate as many errors as possible. However, to be useful, annual vital statistics data should be released within a reasonable time after the end of a calendar year, and not several years later. Timely release of annual vital statistics data is extremely important for monitoring public health, particularly assessing trends and issues in maternal and child health and evaluating changes in causes of death over time.

Since compilation of the annual report may take a while after the final annual vital statistics data are complete, annual data can be released in other formats for users who need the information more quickly. Various formats, such as data files, special summaries, news releases, or ad hoc tabulations, can be used for fast release depending on the needs and technical skills of the users. The main goal is to make annual data available to users as quickly as possible and not wait until the printed annual report is distributed.

Monthly/Quarterly/Preliminary Publications: To make vital statistics data available on a timely basis, some countries publish monthly or quarterly tabulations of vital statistics data. The amount of detail contained in these reports varies, but generally they do not contain many cross tabulations or much detail. These reports vary in the way data are compiled. Some countries just show data for the month or quarter, possibly compared to the same period the previous year, while others show data for the past 12 months as a moving average (drop the oldest month or quarter and add the current month or quarter).

To keep these reports timely, the tabulations are often done by place of occurrence of the event and date of registration rather than place of residence and date of occurrence

as in the annual tabulations. These reports are useful for monitoring unusual changes in vital events, particularly causes of death. Preparing monthly or quarterly tabulations can also help identify problems with the vital event data such as missing items or coding and keying errors that can then be corrected prior to preparation of annual tabulations.

Using a small sample of the vital events to prepare preliminary tabulations is another method for early release of basic data. For example, a 10 percent systematic sample could be taken by choosing every 10th record for processing first when there are large numbers of records to be manually coded and keyed. Tabulations based on this sample would be provisional and would not provide accurate estimates for small areas or small subgroups. Use of sampling should be considered carefully to determine if its use is justified based on the volume of records, data requirements, and administrative constraints.

With the increased use of computers, particularly for initial registration of vital event data, there is less need for sampling to produce preliminary data. Preliminary tabulations or reports can be produced from data files at any point and replaced by final results later. As soon as vital event data are computerized, they are available for surveillance purposes. Ad hoc computer programs can be written to locate deaths from certain diseases or other causes of interest using ICD codes or any other data items of interest for preliminary analyses. However, users of these preliminary tabulations or reports need to be made aware of their limitations.

Directory of Users: Tracking users and which publications or data they access can help make the distribution of vital statistics information more efficient. To determine who is using vital statistics data and for what purposes, some vital statistics offices keep a list or data base with information about their users such as name, address, electronic contact information, type of user (library, government official, business, etc.), categories of interest and publications requested. Special correspondence or electronic notifications can be sent to users alerting them about release of a particular publication or data tabulation of interest to them. A directory can help to locate users with specific interests to obtain their input and comments about current publications or suggestions for new ones. The directory can also be used a source for announcing meetings, training programs or technical seminars.

Electronic Media/Internet

More and more statistical agencies are disseminating vital statistics data through electronic media and the Internet. Annual reports and other published reports can be made available for access on the Internet in a form that can be downloaded to save or print as the user wishes. In addition to these reports, it is helpful to have short summaries of information with links to other pages on Web sites to assist users in quickly locating data to meet their needs. An attractive, well-designed, user-friendly Web site that makes nearly all vital statistics publications available on-line can eliminate the need for users to contact the statistical agency for assistance. The Internet provides

an effective and efficient way to distribute large amounts of data and information to numerous users.

To further assist users who want specific tabulations, some countries are creating public use data files on computer disks with de-identified data to protect privacy. Users can then do their own research and analyses using these files. Some places are also making data available through down-loadable files that can easily be obtained from the Internet, again with privacy protections. Other places provide interactive software on the Internet that allows users to create their own ad hoc tables and graphs. The software generally limits tabulations to specific age groups or cause of death categories, but often allows tabulations to be created for major geographic areas. All of these types of data releases should contain instructions for their use and easily accessible help screens. In addition, adequate information about the data files and their limitations and cautions on using small numbers for analysis should be prominently displayed.

Special Uses Of Data

No matter how many vital statistics tabulations and reports are prepared and disseminated there will still be requests for additional information from researchers and users for specific analyses or projects. There are a various ways to assist these individuals depending on the amount of data they want, the level of detail requested, and the technical skills of the users and of the staff in the statistical agency.

Many users and researchers will be able to obtain the level of detailed information they need from public use data files that contain a unit record for each vital event with some variables collapsed into groups or some variables suppressed to maintain confidentiality (e.g., age may be shown in 5 or 10 year groups). In some cases, unit record files may still contain too much detail to maintain confidentiality, so summary files are made available. These files can be distributed over the Internet or on magnetic media and are very useful for program planning, demographic and epidemiologic research, economic and business analyses, etc. Commercial software designed for non-programmers allows statisticians, epidemiologists, and researchers to write their own programs to prepare tabulations and conduct statistical analyses from these files.

If the vital statistics agency does not have a public use file or the public use file does not meet the needs of the user, it is helpful for agency staff to be able to offer assistance in the form of special tabulations, preparation of special data files, and/or analytic consultation. Clear instructions should be provided to users on the procedures for special data requests and if there are any charges for providing the requested information.

In many cases data files for special studies are requested at a level of detail that could identify individuals, and some requests specifically request identifiable information to use as a sample for statistical or epidemiologic research. The statistical agency must have methods in place to require users to guarantee they will maintain data

confidentiality as specified in their civil registration laws and regulations. The statistical agency should have a terms-of-use agreement that all users must sign prior to data release. The agreement should state all restrictions on data use and include a statement that users will not share any data files or data at a level in which individuals could be identified. In some places, users must receive approval from a review panel prior to obtaining identifiable data, and in other cases where files cannot be released due to confidentiality restrictions, users may be accommodated by allowing them to have access to files on agency premises under the supervision of agency staff.

If the civil registration law allows use of identifiable vital statistics information for government administrative purposes, some civil registration offices or vital statistics agencies will prepare special listings or files for government agency use. Listings or files of births with names, birth dates and addresses of parents can be prepared for school enrollment or agencies with social programs. Death files or listings with appropriate information can be provided to population or election registries, motor vehicle licensing agencies, and social benefit programs to purge their files. Identifiable information from birth and death files is useful for many programs in public health such as locating children for immunization programs, or removing deceased individuals from cancer or other disease registries. Generally these types of files or listings are relatively easy to prepare and take little staff time, and with appropriate computer software, can often be created and transmitted to the requesting agency automatically on a set schedule. Officials of all government agencies receiving any identifiable information from vital statistics files should agree to use the information only as allowed in the civil registration law.

Professional/Technical Meetings

To promote the use of vital statistics data, some vital statistics agencies hold various types of meetings to assist their users and answer questions about the data. These meetings can range from brief presentations or seminars for government officials on a specific topic of interest, such as infant mortality, to technical training sessions on public use data files. Periodic seminars can be held to describe the types of vital statistics available and how to access them or on particular topics such as cause of death data to inform users about collection and processing procedures, ICD codes and tabulation lists, and appropriate use of the data. Meetings with or presentations to government officials are particularly good for showing the importance of vital statistics data and promoting its use. Input can also be obtained from users on problems they may have with tabulations, publications, Web site, etc., and their suggestions for enhancements and improvements. Communication with users is essential to ensure that they receive answers to their questions, are aware of the appropriate use of vital statistics data, and that the statistical agency is meeting their needs.

Review

- Statistical agencies should produce and disseminate vital statistics on a timely schedule and in multiple formats.
- Statistics produced should be based on standard definitions, classifications, and statistical methods that are documented and made available to users.
- Statistical agencies need to be flexible and use technology, particularly the Internet, for dissemination of vital statistics information.
- When comparing international health-related data, users should consider the data quality, the choice of countries, and the presentation and interpretation before comparing countries.
- Most countries prepare an official annual report of vital statistics data.
- Some countries publish special reports on topics of interest to particular users.
- To make vital statistics data available on a timely basis, some countries publish monthly, quarterly, and/or preliminary tabulations of vital statistics data.
- The Internet is a highly effective and efficient way to disseminate vital statistics information.
- Data users requesting special files or tabulations with potentially identifiable data should be required to sign terms-of-use agreements prior to release of any data.

Section 6 References

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Section 7

Assessing Vital Statistics

Civil Registration And Vital Statistics Systems

Adequacy Of Vital Statistics

As stated previously, the goal of the vital statistics system is to have complete, accurate, and timely data for all vital events in a country. To meet the goal of the vital statistics system, the goal of civil registration, which is to record all vital events in a country as they occur, must also be met. To determine if these goals are being achieved, a country's civil registration and vital statistics system should be evaluated periodically.

In addition to reaching these goals, for statistical data to be adequate, statistical agencies must meet the expectations of their users by producing objective, high-quality statistics that provide the information their users need. Vital statistics data are the basis for monitoring and evaluating public health as well as providing data for demographic, social and economic needs. Vital statistics data produced in a country should be appropriate to meet all of these applications.

To be usable, vital statistics data must be accurate, timely, relevant, and readily accessible. Data content and tabulations should include items in sufficient detail to meet the needs of the majority of users. Population data must be available for calculation of appropriate rates for data comparisons, or the statistical agency may need to prepare its own estimates. Compilations of data should be provided in a variety of formats such as tables, graphs, charts, data files, etc., and released in multiple ways such as paper, computer disk, and over the Internet, as described in the section on dissemination of data.

For vital statistics data to be adequate and usable, users must also have confidence that the data produced are of sufficient quality to make appropriate evaluations, analyses, and conclusions. To assess the quality of a country's vital statistics data, a variety of methods may be used but this course will cover dimensions of quality that are consistent with requirements for official statistics.

Quality Of Vital Statistics

One method for assessing the quality of vital statistics data, described in a paper published in the Lancet (Mahapatra, et. al.[7–1]), provides an assessment framework based on five evaluation criteria:

1. Accuracy
2. Timeliness
3. Comparability
4. Relevance
5. Accessibility

A table reproduced from this paper, showing the components included in each of these evaluation criteria, is included in Appendix I. This course provides some methods for assessing each of these five criteria as guidelines for evaluating the quality of vital statistics.

Accuracy: Correctness or accuracy of vital statistics data is perhaps the most important factor in assessing the quality of the data. Accuracy means that all vital events occurring in the country have been registered and all items on the vital record have been completed without error; that is, all responses are correct and there are no missing items. Thus, accuracy can be assessed by looking at the following components:

- **Completeness/Coverage error**
  - Completeness–Extent at which vital events are recorded
  - Coverage–Extent to which population is covered by a civil registration system
- **Content error**
  - Missing or erroneous data
  - Use of ill-defined categories
  - Improbable classifications

(Note that the terms completeness and coverage are often used interchangeably. Different reference documents may use either of these terms to mean the same thing. There are several different ways to evaluate completeness/coverage, and in the slides and in these Student Notes, the terms completeness and coverage are used according to the reference from which a particular assessment method or measurement comes. The important point in evaluating completeness/coverage of civil registration is determining if all births and deaths have been registered for all geographic areas of the country and all population groups.)

To evaluate the coverage and completeness of vital statistics data, both the civil registration and vital statistics systems need to be considered:

1. **Civil registration**–Has every vital event that occurred been registered in the civil registration system?
2. **Vital statistics**–Has a record of every registered vital event been forwarded to the agency responsible for vital statistics and been included in the compilation and production of data?

A civil registration system is complete when every vital event that has occurred in a country (or area) within a specified time period has been registered in the civil registration system. While civil registration should try for the goal of 100 percent completeness, such a level of completeness is not possible from a practical standpoint, and every country is lacking in registration to some degree. Generally at least 90 percent completeness is considered necessary to produce adequate vital statistics. In some places, only a portion of the country or certain geographic areas can meet the

goal of complete civil registration to produce adequate vital statistics. If this is the case, the country should strive to expand the system to have sufficient civil registration to produce national vital statistics.

Vital statistics produced from vital events are complete when, in addition to the requirement for complete registration of each vital event, a record of each of those vital events is forwarded to the agency responsible for the compilation and production of vital statistics and been included in those statistics.

Accuracy–Coverage error: Since a vital statistics system will never be able to attain 100 percent completeness, the deviation from complete coverage is measured by coverage error. Coverage error may be due to a variety of factors, and it can be measured in different ways.

One way to look at coverage is the extent to which geographical or political units in the country have established civil registration systems. This can be measured by the percent of the population with access to a functional civil registration system. The World Health Organization (WHO) notes that access *"covers a range of issues, including availability of registration points, distance, affordability, and cultural and social acceptability."*[7–2] WHO measures access level by dividing the number of people in areas or districts of the country with at least one registration office by the total number of people and multiplying by 100 to get a percent.

$$\textbf{Percent access level} = \frac{\textbf{Number of people in districts with registration points}}{\textbf{Total population of country}} \textbf{ X 100}$$

In the WHO Indicator and Measurement Registry[7-3] the percent coverage of deaths is defined as the total deaths reported for a country in a year from the civil registration system divided by the total estimated deaths (by WHO) for that year times 100.

$$\textbf{Percent access level} = \frac{\textbf{Total deaths reported by civil registration in year}}{\textbf{Total deaths in year estimated by WHO}} \textbf{ X 100}$$

Using this method could yield a percent for death coverage that is over 100 if all deaths occurring in the country are included, not just those to residents; or, deaths to nationals dying abroad are included; or, the population used in estimating deaths is lower than the actual population. This same method is used in the WHO Indicator and Measurement Registry to calculate the **percent birth coverage**, but the estimates used in the denominator come from the United Nations demographic year book and UNICEF's State of the World's Children survey.

Coverage for cause of death refers to the percent of the population living in areas where medical certification of cause of death has been legally mandated. Percent cause of death coverage is the population living in areas with mandatory medical certification of cause of death divided by the total population of the country multiplied by 100 to get a percent.

$$\textbf{Percent covered by COD certification} = \frac{\textbf{Number of people in districts with COD certification}}{\textbf{Total population of country}} \textbf{ X 100}$$

COD = cause of death

Estimations of completeness of birth or death registration can also be made by comparing the actual number of registered vital events with an independent estimate of the crude birth or death rate. Each year, the United Nations prepares estimates of crude birth and death rates for member nations using demographic estimation techniques. Using these UN estimates of crude rates, the completeness of birth or death registration can be approximated. However, the reliability of the estimates of completeness depends on the reliability of the estimates of the crude birth and death rates.

$$\textbf{Percent estimated birth registration completeness} = \frac{\textbf{Number of registered births}}{\textbf{(Crude birth rate per 1,000 X Total population of country / 1,000)}} \textbf{ X 100}$$

$$\textbf{Percent estimated birth registration completeness} = \frac{\textbf{Number of registered deaths}}{\textbf{(Crude death rate per 1,000 X Total population of country / 1,000)}} \textbf{ X 100}$$

Comparisons of estimated completeness across geographic areas can be used as an indicator of the quality of the estimation method for a given area. An example of registration coverage for Kenya for 2009 is shown in Appendix J. Registration coverage rates in Kenya vary from 2.09 percent coverage for births in Ruiru District (not including two districts that reported 0 births) to 186.64 percent coverage in Kiambu East District. For deaths, rates varied from 1.15 percent coverage in Wajir South District (not including one district that reported 0 deaths) to 981.54 percent coverage in Ruiru District (perhaps a data entry error). The wide variation seen in rates across Kenyan districts brings to question the quality of this estimation method for this area.

Accuracy–Direct Matching: Another way to detect problems with completeness of registration of vital events is directly matching individual vital records that have been registered with records from an independent source. Different independent sources can be used. Civil registration records provide one source such as matching infant death records to birth records or expanding that to death records of all children matched to births. Vital event records can also be matched to other types of government records

such as school enrollment, hospital records, baptism and burial records, population censuses, or survey data. Using this method means that individual records from each of the two sets must be linked which can be quite expensive and requires extensive planning.

Directly matching individual vital events with records in another independent set is known as the dual record system. When the records from the two systems are linked, the results yield three categories:

1. The record is in the vital events register and the independent set.
2. The record is in the vital events register but not in the independent set.
3. The record is not in the vital events register but is in the independent set.

There is also actually a fourth category with an unknown number of events that can be estimated using statistical techniques that are beyond the scope of this course:

4. The record is not in either the vital events register or the independent set.

Direct matching produces a good estimate of registration completeness and can be applied at the national level or a local level. However, the independent source used for the match must have high quality information on its records and be truly independent. Matching records is often difficult to accomplish especially in areas with many common names (e.g., Maria, Mohammad) that can easily be confused, and the selection of matching criteria must be made carefully to avoid mismatches. While automation can help with the matching process, it can still be slow and labor intensive requiring some manual verification of matches and processing of unmatched records. Since direct matching can be very time consuming and costly, it is usually not done on a routine basis.

Accuracy–Direct Assessment: An assessment of coverage errors can be made by directly monitoring local registrars for under-reporting or over-reporting of vital events from their local area. (While duplicate reports can occur, under-reporting is the main problem.) An audit can be done on a set time schedule to determine if local registrars are forwarding vital events regularly and on time, that all local registrars have reported their vital events for a specific period, and that the number of vital events reported is close to the expected number for the same time period (e.g., comparing the number of vital events for the current month with previous months). If there are any deviations or apparent gaps, the local registrar should be queried to explain any discrepancies.

Accuracy–Indirect Assessment: There are a variety of indirect assessment methods that can be used to assess data quality. Comparison of trends or frequency distributions over time is one common method. Since statistical series tend to follow certain clearly defined patterns and recognizable distributions, any deviation from these historical distributions or patterns might indicate the need for further inquiry.

The number of reported vital events can be compared with the same time period for the previous year to allow for the seasonality of vital events. This can be done by the statistical agency by reporting area on a monthly basis to determine if all of the vital events they are expecting have been received. Allowances should be made for unusual events such as rapid population change in size or characteristics, migration in or out of an area, war, epidemics, etc.

Births in particular can be compared to a population census to assess birth registration. The number of births minus the number of infant deaths in a given year should be consistent with the number of children under one year of age in the census. However, this is just a rough estimate since the difference could be due to errors in the census as well as under-registration of births. Under-enumeration of infants and misstatement of age for infants can be a problem in censuses in some countries.

Birth registration can also be assessed by comparison of sex ratios. Generally, a sex ratio of 105 male births to 100 female births indicates an acceptable level of registration or a problem that is not sex-specific. A sizeable deviation in the sex ratio could indicate the under-registration of male or female infants who died shortly after birth. However, the sex ratio varies by race and ethnicity so it must be adjusted to be specific to the population being monitored.

The proportion of registrations that are delayed can be monitored to determine possible under-reporting for previous time periods. The interval between the date of the event and the date of registration can also help assess the completeness of registration. Increasing intervals could mean a deteriorating system and more events missing from the annual tabulations. Transmissions of vital events from the civil registration agency to the statistical agency can also be monitored for delays that could affect the annual data.

Birth and death rates can also be compared to countries or areas with similar population characteristics that are known to have good registration coverage. In some cases, survey data or counts from other sources with similar demographic characteristics may be used to estimate the level of under-registration of vital events.

There are also demographic techniques for indirect estimation of registration completeness that are not covered in this course but are sometimes used by statistical agencies or academic institutions. These methods use measures of basic demographic patterns to assess incomplete vital event data to estimate birth and death rates, for example, and compare those estimated rates to the rates from records that were registered.

Accuracy–Reasons for Under-Coverage: As part of assessing vital registration completeness, the reasons for under-coverage should also be evaluated. Under-coverage may be due to a lack of having a functioning civil registration system in some geographic areas of the country or the civil registration system could function differently in different geographic regions. This could be due to a lack of resources to operate effectively in certain districts, or the region could be remote and travel difficult for families to register a birth or death in a local registration office.

In some countries, certain population groups that do not have a need for registration documents are more likely to have higher rates of under-coverage due to ethnic or local customs. Unmarried mothers of illegitimate children may not register the births due to the social stigma. Births and deaths that occur outside of health facilities are less likely to be registered, and in some cases, certain health facilities may not be encouraged to register vital events or it may be difficult for them to do so.

If monitoring delayed or late registrations indicate they are increasing, the reasons for the increase should be investigated especially if the vital events are not registered in time to be included in annual tabulations. Often, certain types of vital events, such as deaths from a particular cause, are delayed due to procedural problems in the system. For example, violent, unexplained, or sudden deaths often need to be investigated by the police or a medical examiner or coroner to determine the cause of death. These deaths may involve postmortem examinations and/or laboratory analysis which can take many months and sometimes years to resolve. Maternal deaths or deaths that occur in certain medical facilities may require additional investigations depending on a country's laws and procedures. If many of these types of deaths are missing from the annual vital statistics tabulations, the statistics will be inaccurate and misleading.

While all countries have under-registration to some degree, there are a number of inherent issues that could cause problems. Some countries may lack civil registration laws or their laws may not require registration of vital events. Some countries may require fees for registration that discourage compliance. Under-registration may occur if informants do not see a reason to register the vital event when they do not have a need for certified copies, or they may not be aware of the law or the procedures for registration. Problems in local registration offices or lack of competence of the local registrar may cause disturbances or interruptions in the system leading to under-registration.

Accuracy–Improving Coverage: Many of the techniques used to improve coverage are the same as those to improve the civil registration and vital statistics system as a whole and will be covered in more detail later in the course. One way to improve coverage is reducing barriers to registration by having more registration locations such as satellite offices in remote areas, increasing hours of operation, adding part-time registration officials who perform a limited number of functions, using religious or health workers to perform registration functions, and eliminating fees for vital events registered appropriately and on time. Other methods include implementing an educational campaign in hospitals, community medical facilities, and/or to medical personnel to stress the importance of registration of births and deaths and the need for data for setting national public health priorities.

Particular emphasis should be placed on registration of problem records such as infant deaths and fetal deaths which are frequently under-registered. A program to track and monitor pregnant women to determine birth outcomes might help ensure proper registration of births, fetal deaths, and infant deaths. To look for under-reporting of maternal deaths, deaths records for women of reproductive age can be matched to birth or fetal death records to determine if the women were pregnant during the

period preceding death. Some countries have added a pregnancy question to their death records to obtain information about pregnancy-related deaths. Local registrars may also be able to improve death registration by developing relationships with police, coroners, and funeral directors to educate them about the importance of timely registration of violent, sudden and unnatural deaths.

Statistical adjustment for under-reporting or data from surveys can be used to supplement registration data. Other methods can also be used to reduce bias from data that are derived only from selected areas or from certain groups.

Accuracy–Content Error: The other aspect of accuracy is content error which includes missing or erroneous data, improbable classifications, and on death records, use of ill-defined categories. These kinds of errors may be caused if information is provided incorrectly by the informant, or the error may be made at some stage in the processing of the vital record. Some examples of possible processing errors were described in the sections on coding, keying, querying, and editing the records.

Missing data can occur on any type of vital record and may be due to the informant's refusal to provide the information, or the informant may not know the information and leave the question blank, or the question may be accidentally missed when the vital record is being completed prior to registration. If records from a local area are copied or keyed into a computer system, an item can be missed at that point. Anytime the data are passed from one system to another, there is a chance that an item can be missed. Missing data can be evaluated by calculating the percentage of each type of missing item (e.g., the percentage of records with age or sex data missing). Further evaluations can be done to see if there are a large number of missing items from a particular local area or for a particular demographic group. Missing data should be queried as early in the process as possible to try to obtain the information and resolve any problems.

Erroneous data can also be introduced at any stage in registration and processing of vital records. The informant may remember the information incorrectly or deliberately give an incorrect response, or he or she may misunderstand the question. Errors can be caused when the record is transcribed or coded and keyed into a computer system or when query responses are entered into the system. Computer software can cause errors when data are changed to different formats or when data files are prepared. Basically, errors can be inadvertently created at any stage in processing the vital record and tabulating the data.

Erroneous data or response error can be evaluated directly by matching a sample of vital event records with an independent set of records such as census records, autopsy reports, hospital records, medical records, or re-interviews of the informant. Agreement between the two sources is assessed as in the dual record system described previously.

While there will always be some items classified as "unknown," a high proportion of these answers in any frequency distribution means the data are not considered reliable. For example, a high frequency of unknowns for age at death would make the

accuracy of responses in every other age group questionable. (Note that "unknown" is generally considered as an answer to a question and is different from an item that is left completely blank or missing.)

An indirect technique for assessing response error is to look at the internal consistency of the data. For example, comparing the number of early infant deaths with the number of late fetal deaths may indicate a misunderstanding of the definition of live birth. Investigations can be done of data series with "heaping" or over reporting of numbers ending in 0 or 5, such as ages or birth weights, due to incorrect rounding of the data. Data items can also be compared for inconsistencies such as date of registration prior to date of birth, a high birth weight with a low length of gestation, or a high education for a child on a death record.

Coding errors or keying errors can be found by having two different sets of individuals code or key the same vital records and resolve any discrepancies. This method could be used on a sample of records to assess accuracy or on certain critical items on the record.

Another source of content error is the **use of ill-defined categories** for the cause of death on death certificates. Ill-defined categories include such things as fever, headache, senility, convulsions, sudden death, and unknown. If a large number of deaths fall into the ill-defined categories, then it is likely that the frequencies of known causes of death are not reliable. The United Nations has used 25 percent of "ill-defined" and "unknown" causes of death as the upper limit for inclusion of deaths by cause for a given country in its annual demographic yearbook.

The last source of content error is death records with **improbable classifications** for age or sex categories by cause of death, for example, a female with prostate cancer as a cause of death. Another example might be an infant dying from Alzheimer's disease. However, an adult could die from a congenital anomaly, which is usually considered an "infant" cause of death, if the congenital anomaly started the chain of events that led to the adult's death. Improbable classifications can be measured by the percent of deaths assigned to improbable age or sex categories per 100,000 coded deaths.

Timeliness: Timely production and release of vital statistics means that data are made available to users on a prompt and regular basis. While timeliness is generally thought of in terms of civil registration and having all vital events reported within the legally required time frame, it actually has three parts that influence timely vital statistics data:

1. Promptness of registration of vital events
2. Transmission of data or records from local civil registration offices to the national office
3. Promptness of data production and dissemination

To have adequate and quality vital statistics, all vital events must be included in the production of annual statistics, and a delay in any part of the system will mean delays in production of annual statistical data.

Prompt registration of vital events is required for timely production of statistical data. Civil registration laws and regulations should include a time limit for registering vital events and some kind of legal backup for enforcing the time requirement. While time limits vary, many countries require that births be registered within one month of the event, and deaths are generally within three to seven days of the event. However, actually meeting the required time limits can be a challenge in areas with limited registration offices, rough terrain, harsh climate, poor communications, or cultural issues. It is virtually impossible to expect perfect adherence to the legal requirements, and enforcing those requirements is also difficult. Thus, a certain amount of late or delayed registrations is inevitable.

How delayed registration affects timeliness depends on the amount of delayed registration and the effect it has on the production of annual vital statistics. In many countries, vital events that are registered after a set cut off point are not included in the annual vital statistics file. Instead those events are counted with the current year's data with the idea that the numbers are small and they will balance out delayed records for the current year. One way to evaluate delayed registrations is to look at the percentage of vital events in the current file that actually occurred in previous years and when they actually occurred. Having too many vital events that occurred several years ago would make the usefulness of the vital statistics data questionable for monitoring current public health issues.

Promptness in processing the records after they have been registered also affects timeliness. Procedures should be in place to monitor transmission of records from local offices to the national office and any problems should be resolved promptly. Coding, keying, editing, and querying of the records should also be done as quickly as possible following an established schedule. Most places have a set cut off time to close the data files for a calendar year and begin production of the annual tabulations. One measure of timeliness is comparing the reference year of the data with the date of publication. Many places strive for a goal of tabulation and dissemination of annual data within 12 months of the end of the data year. Timeliness can also be evaluated by production time and regularity where production time is calculated as the mean time from the end of a reference period until production of annual publications and regularity is the standard deviation of production times.

If there is an unusual situation and it is known that certain vital events (e.g., certain violent deaths) will be delayed, the national statistical agency can decide to treat it in several ways:

1. Delay release of the annual file until the records are received
2. Publish annual vital statistics without the delayed records
3. Use surrogate statistics to estimate the effect of the delayed records

The third option is useful when the delay will be long and there is a known effect on the statistical file of not including the records. For example, in the United States, while most death records for victims of the 9/11 tragedies were reported within the allotted time to be included in the 2001 file, some were not, including death certificates for the terrorists on the airplanes which crashed. Since it was not certain when (or if) the remaining death certificates would be filed, and since information about the numbers of victims and terrorists was available from other sources, the 2001 final mortality report included a special table detailing the total number of deaths from terrorism on September 11, 2001. The victims were classified as homicide deaths and the terrorists as suicide.

Comparability: Comparability means the degree to which a particular statistic measures the same thing in the same way over time and across geographic areas. For data to be comparable, definitions used in collection of vital events, coding schemes used for data preparation, and tabulation formats should be uniform from year to year and uniform across areas.

While definitions, preparation procedures, and/or tabulations need to be changed to remain current, any changes should be done in a manner to ensure that vital statistics remain comparable. Changes in the content or layout of registration forms used to collect vital events can also affect comparability of vital statistics. Information on any differences in collection methods, processing procedures, and/or tabulation formats should be provided to users to explain those differences and how those differences will affect the data.

In addition to being comparable internationally, vital statistics should also be comparable from one area to another within a country. Definitions used for vital events should be uniform and follow standards, and for cause of death data, there should be consistency in application of the ICD. Although countries may say they conform to standard definitions, in actuality they may not. For countries that do conform to standards at the national level, local areas or health agencies may not always follow the national standards. For example, the United States recommended a new version of the birth registration form in 2003, but as of 2012, not all states had switched to the new form. Therefore, data comparability is an issue when analyzing birth statistics between states using the new form and those still using the old form.

Relevance: Relevance is the degree to which cross-tabulations for characteristics of importance to users are provided by the statistical agency. From a public health standpoint, users want cross tabulations for demographic characteristics such as sex and age groups, and for local (small) geographic areas based on usual place of residence.

Standard age groups used by many countries are as follows:

- For general vital statistics, routine tabulations should be by sex and 5-year age groups
- For deaths to children under 5 years of age, tabulations should be for age groups 0 and 1-4.

- For cause of death data, tabulations should be by sex and at least by eight broad age groups: 0, 1-4, 5-14, 15-29, 30-44, 45-59, 60-69, and 70+. However, it would be better to use 10-year age groups as follows: 0, 1-4, 5-14, 15-24,…65-74, 75+.

Accessibility: Accessibility means the ease with which users can access and make sense of the data. Data should be disseminated in a variety of media or formats including print, electronic, and over the Internet. The number of formats in which data are released can be used as one measure of accessibility. To aid users in utilizing the data for analysis, they should be provided with metadata or information about the data including such things as documentation of data elements and their definitions, methods of collection, potential for errors, etc. The availability of metadata and the quality of documentation is another area that should be considered in evaluating accessibility. Another aspect of accessibility is the responsiveness of user service. User service refers to the official structure that is in place for providing assistance and support to users of vital statistics and it includes such things as distribution of data products, responding to queries, productive interaction with data producers, and data availability.

Appendix K has an example from South Africa of how the Mahapatra framework was used to analyze their 2009 mortality data from death notification.

Assessing The Quality Of Mortality Data

The purpose of assessing the quality of mortality data is to identify weaknesses and opportunities for improvement in the data. The assessment process, followed by corrective action, should be conducted on an ongoing basis and integrated into routine activities of health information systems. Steps for assessing the quality of mortality data are outlined in a 10 step process in a publication entitled "Mortality statistics: a tool to improve understanding and quality" from the Health Information Systems Knowledge Hub at the University of Queensland.[7-4] The 10 steps include:

1. Prepare basic tabulations of deaths by age, sex and cause of death
2. Review crude death rates
3. Review age and sex-specific death rates
4. Review the age distribution of deaths
5. Review child mortality rates
6. Review the distribution of major causes of death
7. Review age patterns of major causes of death
8. Review leading causes of death
9. Review ratio of noncommunicable to communicable disease deaths
10. Review ill-defined causes of death

The process may be applied to mortality data from any source; common sources of mortality data include: national civil registration and vital statistics systems, censuses, longitudinal demographic surveillance, and routine health information systems. An Excel tool developed by the World Health Organization (ANACoD) can be used to automate the data quality assessment process described in these 10 steps.[7-5]

Review

- To meet the vital statistics goal of having complete, accurate, and timely data for all vital events in a country, the civil registration goal (to record all vital events in a country as they occur), must also be met.
- To determine if these two goals are being achieved, a country's civil registration and vital statistics system should be evaluated periodically.
- Vital statistics quality can be assessed by evaluating accuracy, timeliness, comparability, relevance, and accessibility.
- To assess accuracy of vital statistics both completeness/coverage error and content error need to be examined.
- Completeness/coverage of civil registration can be measured by determining if all births and deaths have been registered for all geographic areas of the country and all population groups.
- Completeness/coverage can be evaluated by direct comparison with an independent data source through the dual record system and/or by indirect evaluations of trends and frequency distributions to locate discrepancies.
- Content error includes missing and erroneous data, use of ill-defined categories for cause of death, and improbable classifications for age or sex by cause of death.
- Timeliness depends on promptness of registration of vital events, transmission of data or records from local civil registration offices to the national office, and promptness of data production and dissemination.
- Comparability means the degree to which a particular statistic measures the same thing in the same way over time and across geographic areas.
- Relevance is the degree to which cross-tabulations for characteristics of importance to users are provided by the statistical agency.
- Accessibility means the ease with which users can access and make sense of the data.

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Section 8

Evaluating and Improving Civil Registration and Vital Statistics Systems

Civil Registration And Vital Statistics Systems

Previous International Efforts to Strengthen Civil Registrtion and Vital Statistics Systems

As noted in the preceding section, a country's civil registration and vital statistics system should be assessed periodically to determine if its goals are being met, and the statistical data produced from the system is adequate and of high quality. Evaluating and improving these systems is essential for having useable vital statistics data for monitoring and improving public health.

The paper by Mahapatra, et. al.,[8-1] mentioned in the previous section, describes some of the international efforts made during the past 60 years to strengthen and improve civil registration and vital statistics systems to obtain usable vital statistics for public health purposes in the following areas:

- **Setting Standards to Improve Consistency and Comparability of Vital Statistics:**

  The United Nations Statistics Division published Principles and Recommendations for a Vital Statistics System[8-2] in 1953 (revised in 1973 and 2001) to promote uniform methods for data acquisition through civil registration systems and comparability of concepts for vital statistics. These principles have improved the comparability of vital statistics by standardizing fundamental ideas in vital statistics, including date and place of events. To improve comparability of infant mortality and stillbirth rates, WHO has provided definitions for live birth and fetal death.

  As early as 1851, an international collaboration began work on a uniform nomenclature and classification of cause of death, which is essential for comparability. WHO continued this work, adopting the sixth revision of the International Classification of Diseases (ICD) system in 1948 and guiding all subsequent revisions. The ICD is one of the earliest examples of an international classification for statistical use. Another major accomplishment toward comparability of cause-of-death statistics was the development of the International Form of Medical Certification of cause of death, the concept of underlying cause of death, and the rules for coding cause of death using the ICD. However, only about 80 member countries, representing 27% of the world's population, have reported useable cause of death data to WHO in the past decade.

  Physicians in all countries should be offered training in the proper completion of the medical certification form, and detailed training for coders is also needed. One problem in getting comparable results for certified causes of death is the lack of interest from the medical profession, especially in developing countries where doctors do not attend most deaths and have no professional incentive in determining their cause.

Since more than half of the world's population lives in countries where medical attendance at death or medical certification of cause of death is rare, many of these countries use verbal autopsy to determine cause of death. However, verbal autopsy methods and procedures, usually developed for specific studies, vary widely. WHO has recently begun efforts to improve the comparability of cause of death from verbal autopsy.

- **Collection and Publication of Data:**

  The UN Statistics Division compiles and disseminates official national data for fertility and mortality, and WHO publishes vital statistics including causes of death. Access to data has improved with regular publications and Internet releases.

  Official statistics reported by countries lack external validation and are subject to bias. Since 2000, WHO has been publishing mortality estimates by adjusting for known biases and using disease models and extrapolations to make estimates to ensure internal consistency and improve comparability over time. Since discrepancies exist between figures reported by countries and estimates produced by WHO, original data and adjustment procedures should be made publicly available to add transparency.

- **Strengthening National Systems:**

  For the past 50 years, WHO and the UN have tried to assist countries in developing capacities for health statistics. However, efforts to improve health statistics have been limited to sporadic and short-term measures that were not maintained by the relevant government agency after outside support ended. Also, many projects financed by development partners focused on poverty measurement and economic statistics, rather than civil registration systems and measures needed to develop and sustain them.

The paper notes that there has been success in setting standards and some progress in collection and publication of data, but little headway in strengthening national systems. The failure is attributed to

1. governments not making civil registration systems a priority, and
2. development partners not recognizing these systems as key components of development infrastructure.

While investments have been made in developing disease programs, little effort has been put into strengthening vital statistics systems to measure progress in these programs and to have usable data to set priorities and the development of public health initiatives.

Evaluating Civl Registrtion and Vital Statistics Systems

Since the civil registration system was originally established with the legal purpose of registering vital events and operates as required under the laws and regulations in a country, it is often difficult to change or modify the system to meet a changing environment. However, the existing system should be periodically evaluated to determine if it meets the current needs of its users for vital statistics data for demographic, economic, social, and public health program planning and management, and how easily it can transform to meet new data requirements as the country grows and expands its programs. If the civil registration and vital statistics functions are in different agencies or ministries, the coordination between the two agencies should be examined to ensure that both agencies are responsive to the requirements of the statistics program. And, since organizations tend to maintain the status quo, there is a need to look for ways to improve efficiency such as taking advantage of new technology.

The cost of the vital statistics system should also examined to determine if current methods and procedures can be altered or enhanced to decrease costs, or if funds can be diverted to make advancements in the system to improve the adequacy of statistical data. The cost can be broken down into three parts:

1. The cost of collecting the raw data
2. The cost of processing the raw data
3. The cost of disseminating the statistics to users

In some countries that do not have many items on their vital records other than those necessary for civil registration purposes, the cost of collecting the raw data from the vital statistics point is not a major concern. Processing and dissemination costs require more scrutiny. Using technology may improve processing and timeliness and may allow vital statistics data to be disseminated more widely, but the costs of introducing technology could be prohibitive if budgets are limited. Technology also requires the availability of skilled technical staff who are usually higher paid than clerical staff, so all aspects of adding technology need to be considered.

Management responsible for vital statistics should take the lead in establishing procedures for evaluating the current system. The assessment of the existing system should not be done to hold individuals responsible for problems in the system, but instead to obtain information that can be used to develop an improvement plan. Information gained from the evaluation can also be used in discussions with donors, governments, and development partners to support the need for increased funding to strengthen the national civil registration system.

The system evaluation should be designed to identify structural weaknesses in the current system, provide a basis to correct observed biases in vital statistics data generated by the current system, and gather sufficient evidence to plan for

improvements in the current system. No amount of assessment is beneficial if action is not taken to correct problems that are identified.

Models for Evaluating the System: To strengthen national health information, the WHO Health Metrics Network developed the **WHO Guidance Tool**[8-3] to provide direction for a standards-based review of country practices in civil registration and vital statistics. The tool promotes international standards and practices, but does not prescribe what measures countries should adopt to achieve fully functioning systems. Methods and procedures for improving vital statistics systems are best when determined locally because so much depends on the local context, capacity, resources and traditions. The guidance tool is primarily directed to countries where civil registration is established but is subject to inadequacies in terms of coverage, quality, or both.

The WHO Guidance Tool consists of two components:

1. the Rapid Assessment Tool
2. the Detailed Assessment Tool

The **rapid assessment tool**[8-4] provides a way to quickly evaluate the state of the current civil registration and vital statistics system and to make a case for a more detailed assessment. It was developed to gather evidence for use in gaining support from senior management for a more detailed review. The rapid assessment is intended to be a group exercise and should be completed by persons knowledgeable about civil registration and vital statistics. While there are various ways to carry out the assessment, there should be a group discussion on each question leading to a common view on the issue. The purpose of the assessment is to engage in discussion on the possible weaknesses and strengths of the system.

The rapid assessment tool consists of 25 questions about how the current civil registration and vital statistics system functions. Each question allows countries to select one of four scenarios (A-D) describing a typical range of hypothetical situations. A value of 0-3 is attached to each scenario as follows: A=3, B=2, C=1 and D=0. A total score is then calculated to provide a rating, and suggested actions are associated with each rating. Countries with ratings below 65 are advised to complete the comprehensive detailed assessment, though the detailed review will be useful in identifying specific weaknesses in countries with a rating up to 84.

The **detailed assessment tool** consists of a **roadmap** that outlines the main steps for conducting the review and an **assessment framework** that serves as a template for the detailed review of the main aspects of the civil registration and vital statistics system. The detailed assessment tool focuses on births, deaths, and causes of death since these are the events countries need for basic vital statistics for health programs. The review covers the legal and regulatory framework; registration; death certification and coding practices; and the compilation, tabulation and use of the resulting data.

Since the assessment tool focuses on vital statistics data for health programs, a review of civil registration services for issuing certified copies of vital records is not included. Aspects of service to customers such as the process and location for applying for a certified copy, the average time it takes to receive a copy, and government services that require a birth or death certificate should be evaluated separately.

The **roadmap** goes through the main steps for conducting the review using the assessment framework and consists of three phases:

1. **Phase 1: Leadership Coordination and Review**–preparing for and carrying out the review
2. **Phase 2: Priority Setting and Planning**–developing a strategic plan for strengthening the system
3. **Phase 3: Implementation**–implementing the strategic plan

Detailed guidance is provided for Phases 1 and 2, but less detail is provided for Phase 3 because the steps are likely to vary for each country.

In **Phase 1** a lead agency is selected to start the process of forming a review or steering committee by identifying stakeholders and inviting them to participate. Before the review starts, government officials and policy-makers should be made aware of the need to improve the civil registration and vital statistics system. Prior to starting the detailed review, the steering committee should conduct a rapid assessment of the current system to build a case for a more detailed assessment. If the steering committee decides that a detailed assessment is needed, a launch meeting should be held to start the detailed review. The committee should be expanded to include representation from all parts of the vital statistics system, and subgroups should be formed to conduct the technical aspects of the review. After the launch meeting, the steering committee should meet to develop a work plan, a schedule, and a report-template for the subgroups. In the final step of Phase 1, the subgroups conduct detailed reviews of specific parts of the civil registration and vital statistics system using the detailed assessment framework and prepare reports with specific recommendations.

In **Phase 2** the steering committee conducts a meeting where all of the subgroups present their reports and recommendations. The reports are discussed, and an agreed upon set of priority recommendations are chosen. The steering committee then meets to develop a detailed strategic plan for improving the current vital statistics system with priorities and cost identified. The final step in Phase 2 is conducting a large stakeholder meeting to present the improvement plan and gain broad support and approval for the strategic plan.

Phase 3 is the implementation of the strategic plan which will vary by country depending on actions and recommendations required. Implementation may take a number of years and should have the support of various government agencies and local authorities that use information from civil registration and vital statistics. Progress in improving the system should be monitored and periodically assessed with regard to coverage, completeness, data quality, timeliness, and civil registration functions.

The WHO **assessment framework** is used by the subgroups in Phase 1 to conduct the detailed review of the country's civil registration and vital statistics systems. The framework has five key components (A-E) that cover the inputs, processes, and outputs that are crucial aspects to the functioning of a vital statistics system:

- **Inputs**
  - A. Legal basis and resources for civil registration
- **Processes**
  - B. Registration practices, coverage and completeness
  - C. Death certification and cause of death
  - D. ICD mortality coding practices
- **Outputs**
  - E. Data access, use and quality checks

The five components (A-E) are further broken down into 16 subcomponents that deal with the specific issues and questions within each component. The subcomponents assess coverage and completeness of the data produced, evaluate issues related to the functioning of the system that produces the data, and diagnose potential problem areas. All three parts (inputs, processes and outputs) are critical to the functioning of a vital statistics system and should be included in any in-depth review. The inputs and processes of civil registration and vital statistics must be understood if improvements are to be made to outputs.

Adequacy of Government Provisions: Included in the review of the civil registration system should be an evaluation of the government structure for the system. Appropriate legislation is essential for achieving a good civil registration and vital statistics system. Civil registration laws differ from country to country, but they should include a statement that makes civil registration compulsory and provides for complete nationwide coverage (both geographic and ethnic) of all vital events. The laws should also clarify the responsibilities of the different government agencies involved in the system. Current legislation should be critically reviewed and new laws created or existing laws revised as needed.

Government support in the form of adequate budgets to recruit and pay staff and to maintain facilities is also critical and should be reviewed. The overall organizational structure of the agencies involved in civil registration and vital statistics should be evaluated as well as management practices and staff guidelines and instruction manuals.

Flexibility: As noted in previous sections, any modern civil registration and vital statistics system must be flexible enough to accommodate changes and modifications to make it responsive to the changing requirements of its users. The system should also

be able to incorporate new technology to improve efficiency without major problems or delays. Evaluating the system's flexibility is another important aspect of assessing the civil registration and vital statistics system.

Improving Civl Registration and Vital Statistics Systems

Common Issues for Implementing Improvement Plans: Specific actions needed to improve the civil registration and vital statistics system will vary by country. Measures and improvements implemented should be guided by the results of the comprehensive evaluation and follow the strategic action plan developed as a result of the assessment. However, there are a number of common issues for implementing improvement plans as follows:

- **Costs Can Be Shared**–Often many departments are involved in collecting and producing vital statistics data and the data are used by many government programs, so some development costs can be shared.

- **Involve Local Authorities**–Local authorities are key players in civil registration and vital statistics improvement, so they must be convinced of the importance of proper birth and death registration and certification. They should understand that producing certified copies of vital records is a service for their citizens and is necessary to sustain the system and generate ongoing participation.

- **Motivate Individuals to Register Vital Events**–Participation in the system can be encouraged by requiring certificates for services (e.g., school enrollment, marriage licenses, driver licenses, etc.).

- **Include Local Vital Statistics Data**–Since local vital statistics data are often needed for local planning, they should be included in the implementation. However, a standardized methodology should be used to collect the data so national tabulations can be made.

- **Strategic Plan Should Provide for Long-term Investment**–Since civil registration is a continuing process and needs to be constantly maintained in all countries, the strategic plan should cover at least 5-10 years and reflect the long-term investment that is needed.

- **Strong Central Management of Implementation**–To ensure that vital statistics data are useful at the national level, a standardized approach to collecting vital event information is needed. Therefore, implementation of changes and improvements should be carefully managed at a central level.

- **Coordination between Registration and Statistical Units**–To ensure that vital statistics data are timely and accurate, the statistical unit must have good communication with the civil registration unit to resolve any issues or problems

- **Use of Interim Registration Points**–In countries where the infrastructure is lacking, schools and health-care facilities can be used as temporary registration points for vital events until the infrastructure can be extended.

Improvement Approaches and Activities: In the past, a number of different approaches and activities have been implemented in various countries to make improvements in the civil registration and vital statistics system. While the best approach is to conduct an evaluation and develop a strategic action plan for improvement, some of these activities may be initiated to begin making enhancements or included as part of the strategic plan.

- **Conduct Education Campaigns**–The importance of civil registration and vital statistics should be promoted among the general public, government officials, and others such as representatives of organizations that use statistical data and staff involved in the civil registration and vital statistics system.
  - **Government Officials**: Government officials at both the national level and local level need to understand that a strong civil registration and vital statistics system is important for the public who need certified copies as well as government programs that rely on the statistical data.
  - **Public**: The public should be made aware on an on-going basis of the requirements for registration and the benefits and value they will gain from having a good civil registration system. Requiring birth certificates for school enrollment or other services is a strong motivation for getting individuals to register vital events. Converting the public into advocates for a well-functioning civil registration system that produces timely certified copies of birth and death certificates will help convince government officials of the importance of the system.

- **Produce Small Area Information**–For small geographic areas with good civil registration coverage, tabulations and reports can be produced to show how vital statistics data can be used and its value for monitoring community public health programs. These reports can also be used to show other local officials how adequate vital statistics data can provide important public health and demographic information that is lacking for their areas and help to gain support for improving the system.

- **Provide Training Programs**–Training programs should provide those involved in civil registration and vital statistics with the knowledge and skills needed to effectively perform their required functions.
  - **Internal Training**: Training programs, such as seminars and workshops, should be conducted for civil registration and vital statistics staff to highlight techniques, methods, and skills necessary for them to perform their job duties properly and efficiently. Emphasis should be placed on how their roles and responsibilities fit within the total system. Periodic training also provides an

opportunity for feedback from staff about problems and possible alternative solutions.

- **External Training**: Training of external persons, such as local registrars, funeral directors, coroners, physicians and other medical personnel, involved in civil registration is critical to the smooth operation of the system. A good set of instruction manuals specific to each group should be prepared and updated to reflect any changes that occur.

- **Field Program**: Many countries have a field program to specifically target the individuals who are responsible for registering vital events or providing information for the records. As part of the field program, staff from the national civil registration office go into the "field" to visit with local registrars, hospital personnel, physicians, midwives, funeral directors and others involved in the preparation and registration of vital records to present specific training, answer questions, handle problems, and provide any assistance that they can to resolve issues with vital records.

- **Increase the Use of Technology**–Often the introduction of computer technology and automation will help to improve the timeliness and quality of vital statistics data and increase efficiency of the entire system. Government officials responsible for civil registration and vital statistics should routinely monitor new automation technologies to assess their applicability to the current system while considering both the benefits and costs of innovation.

- **Establish a Model Registration Area**–A small area can be selected to act as miniature system to test the all the aspects of a full national system. All vital events in the area should be registered and any proposed changes to the national system should be implemented in the area to determine how well they will function. Modifications can be made more easily in the one area and staff can gain experience prior to expanding the new procedures to the entire country.

- **Establish Demonstration Projects**–Demonstration or pilot projects can be used to test various approaches for making improvements in the civil registration and vital statistics system on a smaller scale to determine if they will be successful. Small scale projects cost less and can be closely evaluated to determine how well they will operate prior to spending large amounts of money on a national-level approach that might not be successful. The success of pilot projects depends on a country's ability to carry over to the national level the experiences and lessons learned. Thus, there must be a sufficient national commitment to provide the resources needed to continue the approach. For any pilot or demonstration project to be successful, an evaluation plan must be developed, implemented, and reviewed. A steering committee is generally established to oversee the project, evaluate and review the results, and make recommendations for discontinuing the particular approach or expanding the project on a larger scale.

Complementary Sources of Vital Statistics: While there is no substitute for an effective civil registration system as a source for vital statistics, in countries where civil registration is inadequate other demographic methods can be used to estimate vital statistics rates. These methods include the following:

- **Population Censuses:** Population censuses provide data for denominators and can provide an estimate of numerator data on births and deaths if they are collected as a characteristic of the household being enumerated; however, they cannot provide information on cause of death. Population censuses are also subject to recall error and misstatements of characteristics about the individuals involved in the events. Generally, censuses are only conducted every ten years so ongoing information for monitoring health programs is not available.

- **Household Sample Surveys:** Household sample surveys can be conducted on any subject and the questions can be more probing and tailored than in a census. Surveys can be conducted on a more frequent basis but they are subject to sampling error and also many other types of errors resulting from the interview process. Data can be collected through a retrospective household sample survey using a short questionnaire, or a specific set of questions can be included as part of a multi-purpose national survey. If more detail is needed, an extended questionnaire can be used to gain information on issues such as fertility, pregnancy history, etc. through an individual in-depth retrospective sample survey. Another survey method is a follow-up household sample survey in which a cluster of households is interviewed repeatedly within certain periods of time such as every three months to obtain current data on births and deaths within the household.

- **Sample Registration:** In some countries where civil registration systems are not well developed, sample registration can be used to register vital events and obtain information on causes of death. One technique involves an active follow-up of deaths in a community to determine their likely causes using a system called Sample Vital Registration with Verbal Autopsy or SAVVY. SAVVY includes a series of best practice manuals, training guides, and related materials. This technique provides nationally representative information on vital events from a sample of the population. If properly conducted and gradually expanded, sample registration can develop into a national civil registration system. Use of sampling can reduce costs and improve timeliness, and in some cases, provide higher quality national level data than a weak civil registration system.

Monitoring Progress: Any improvement process or implementation plan should be monitored to ensure that goals will be reached. A list of core performance indicators that are most likely to reflect progress in a country's specific areas of concern should be created. Indicators should focus on relevance, measurability, understandability, responsiveness to change, and data availability within the areas of system inputs, processes, and outputs. A monitoring plan should be established at the beginning of an improvement process, and progress should be measured every 3-4 years. Suggested indicators for monitoring progress in national civil registration and vital statistics systems from the WHO Guidance Tool are provided in Appendix L.

Review

- International efforts made during the past 60 years to improve civil registration and vital statistics systems have had success in setting standards and made some progress in collection and publication of data, but little headway has been made in strengthening national systems.
- The failure to improve national civil registration and vital statistics systems is attributed to (1) governments not making civil registration systems a priority, and (2) development partners not recognizing these systems as key components of development infrastructure.
- An evaluation of the existing civil registration and vital statistics systems should be done to gather sufficient evidence to plan for improvements in the current system.
- The WHO Guidance Tool was developed to give direction for a standards-based review of country practices in civil registration and vital statistics.
- The WHO Guidance Tool promotes international standards and practices but does not prescribe what measures countries should adopt to achieve fully functioning systems.
- The WHO Guidance Tool consists of two components: (1) the Rapid Assessment Tool and (2) the Detailed Assessment Tool.
- The rapid assessment tool provides a way to quickly evaluate the state of the current civil registration and vital statistics system and make a case for a more detailed assessment.
- The detailed assessment tool consists of a roadmap that outlines the main steps in conducting the review and an assessment framework that serves as a template for the detailed review of the main aspects of the civil registration and vital statistics system.
- The inputs and processes of civil registration and vital statistics must be understood if improvements are to be made to outputs.
- Specific actions needed to improve the civil registration and vital statistics system will vary by country.
- Any improvement process or implementation plan should be monitored to ensure that goals will be reached.

Section 8 References

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Appendix A

WHO/ICD Definitions

Civil Registration And Vital Statistics Systems

WHO/ICD Definitions

Note: These definitions have been adopted by the World Health Assembly (resolutions WHA20.19 and WHA43.24) under Article 23 of the Constitution of the World Health Organization

1. Causes of death

The causes of death to be entered on the medical certificate of cause of death are all those diseases, morbid conditions or injuries which either resulted in or contributed to death and the circumstances of the accident or violence which produced any such injuries.

2. Underlying cause of death

The underlying cause of death is (a) the disease or injury which initiated the train of events leading directly to death, or (b) the circumstances of the accident or violence which produced the fatal injury.

3. Definitions in relation to fetal, perinatal, neonatal and infant mortality

3.1. Live birth

Live birth is the complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of the pregnancy, which, after such separation, breathes or shows any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles, whether or not the umbilical cord has been cut or the placenta is attached; each product of such a birth is considered liveborn.

3.2. Fetal death [deadborn fetus]

Fetal death is death prior to the complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of pregnancy; the death is indicated by the fact that after such separation the fetus does not breathe or show any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles.

3.3. Birth weight

The first weight of the fetus or newborn obtained after birth.

3.4. Low birth weight

Less than 2500 g (up to, and including 2499 g).

3.5. Very low birth weight

Less than 1500 g (up to, and including 1499 g).

3.6. Extremely low birth weight

Less than 1000 g (up to, and including 999 g).

3.7. Gestational age

The duration of gestation is measured from the first day of the last normal menstrual period. Gestational age is expressed in completed days or completed weeks (e.g., events occurring 280 to 286 completed days after the onset of the last normal menstrual period are considered to have occurred at 40 weeks of gestation).

3.8. Pre-term

Less than 37 completed weeks (less than 259 days) of gestation.

3.9. Term

From 37 completed weeks to less than 42 completed weeks (259 to 293 days) of gestation.

3.10. Post-term

42 completed weeks or more (294 days or more) of gestation.

3.11. Perinatal period

The perinatal period commences at 22 completed weeks (154 days) of gestation (the time when birth weight is normally 500 g), and ends seven completed days after birth.

3.12. Neonatal period

The neonatal period commences at birth and ends 28 completed days after birth. Neonatal deaths (deaths among live births during the first 28 completed days of life) may be subdivided into early neonatal deaths, occurring during the first seven days of life and late neonatal deaths, occurring after the seventh day but before 28 completed days of life.

Notes on definitions

i. For live births, birth weight should preferably be measured within the first hour of life before significant postnatal weight loss has occurred. While statistical tabulations include 500 g groupings for birth weight, weights should not be recorded in those groupings. The actual weight should be recorded to the degree of accuracy to which it is measured.

ii. The definitions of “low”, “very low”, and “extremely low” birth weight do not constitute mutually exclusive categories. Below the set limits they are all-inclusive and therefore overlap (i.e. “low” includes “very low” and “extremely low”, while “very low” includes “extremely low”).

iii. Gestational age is frequently a source of confusion when calculations are based on menstrual dates. For the purposes of calculation of gestational age from the date of the first day of the last normal menstrual period and the date of delivery, it should be borne in mind that the first day is day zero and not day one; days 0-6 therefore correspond to “completed week zero”, days 7-13 to “completed week one”, and the 40th week of actual

gestation is synonymous with “completed week 39”. Where the date of the last normal menstrual period is not available, gestational age should be based on the best clinical estimate. In order to avoid misunderstanding, tabulations should indicate both weeks and days.

iv. Age at death during the first day of life (day zero) should be recorded in units of completed minutes or hours of life. For the second (day 1), third (day 2) and through 27 completed days of life, age at death should be recorded in days.

4. Definitions related to maternal mortality

4.1. Maternal death

A maternal death is the death of a woman while pregnant or within 42 days of 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.

4.2. Late maternal death

A late maternal death is the death of a woman from direct or indirect obstetric causes more than 42 days but less than one year after termination of pregnancy.

4.3. Pregnancy-related death

A pregnancy-related death is the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the cause of death.

Maternal deaths should be subdivided into two groups:

4.4. Direct obstetric deaths

Direct obstetric deaths are those resulting from obstetric complications of the pregnant state (pregnancy, labour and puerperium), from interventions, omissions, incorrect treatment, or from a chain of events resulting from any of the above.

4.5. Indirect obstetric deaths

Indirect obstetric deaths are those resulting from previous existing disease or disease that developed during pregnancy and which was not due to direct obstetric causes, but which was aggravated by physiologic effects of pregnancy.

Appendix B

Life Expectancy

Civil Registration And Vital Statistics Systems

Life Expectancy

1. Definition:

LIFE EXPECTANCY most often is referenced as at birth and derived through life table calculations, although such calculations allow for estimation of life expectancy at a series of age intervals. Life expectancy at birth is a standardized summary measure, sometimes used as an overall gauge of health, based on a population's age structure and mortality experience. As such, it is an index of the level of mortality within a population, and it represents a hypothetical number of years a newborn would live, on average, if he or she experienced the prevailing or some other set levels of mortality within each age group as he or she aged.

2. Calculation:

[Note: Due to the complexity and subtleties of life table construction, the following is not intended as a "how to" primer. (Please see the references listed at the end as starting points for learning more about life tables and their mechanics.) Instead, the following highlights the uses and meanings of life table statistics, especially life expectancy.]

There are several methods available, with perhaps subtle differences among them, for calculating a life table and the resulting byproduct of life expectancy. For this illustration, the method described by Schoen (see references below) is used, which is relatively simple and accurate for producing abridged, period life tables (using ages 0, 1-4, 5-9, 10-14, . . ., 80-84, and 85 years and older). Abridged refers to life tables that contain data for age groups instead of single-year ages. Period means the current (or some other particular period's) age-specific death rates are applied to the life table's hypothetical cohort, instead of tracking a real cohort throughout their lives to see what levels of mortality the cohort actually experienced. Therefore, in the life table the lx column values and all those in the columns to the right are hypothetical, including life expectancy (ex).

Life Table for Illinois Residents, 1999-2001

		Of 100,000 born alive		Staionary Population		
Age at start of Interval	Probability of dying during interval	Number living at start of interval	Number dying during interval	In the interval	In the interval and all subsequent intervals	Average years of remaining lifetime
x	***nqx***	***lx***	***ndx***	***nLx***	***Tx***	***ex***
0	0.00842	100,000	842	99,229	7,682,595	76.8
1	0.00132	99,158	131	396,306	7,583,366	76.5
5	0.00072	99,027	71	494,956	7,187,060	72.6
10	0.00093	98,956	92	494,632	6,692,103	67.6
15	0.00347	98,864	343	493,535	6,197,472	62.7
20	0.00499	98,521	491	491,374	5,703,937	57.9
25	0.00443	98,030	434	489,090	5,212,563	53.2
30	0.00555	97,595	542	486,695	4,723,473	48.4
35	0.00760	97,054	737	483,565	4,236,779	43.7
40	0.01161	96,316	1,118	479,004	3,753,214	39.0
45	0.01766	95,199	1,681	472,041	3,274,211	34.4
50	0.02458	93,517	2,299	462,316	2,802,169	30.0
55	0.03950	91,219	3,603	447,796	2,339,853	25.7
60	0.06192	87,615	5,425	425,422	1,892,057	21.6
65	0.09363	82,190	7,695	392,871	1,466,635	17.8
70	0.14175	74,495	10,560	347,266	1,073,764	14.4
75	0.20809	63,935	13,304	287,616	726,498	11.4
80	0.31556	50,631	15,977	216,239	438,882	8.7
85	1.00000	34,654	34,654	222,643	222,643	6.4

In this Illinois example, three years of deaths (1999-2001) surrounding the 2000 census year were used to calculate the age-specific death rates in the life tables (used to calculate the probability of dying). Using three years of mortality minimizes the effects of influenza epidemics, heat waves and other periodic or one-time mortality impacts. The following is a brief description of the life table columns shown in the above table.

x - the age in years at the start of the interval. The interval implied is the age at the start through to, but not including, the next stated age.

nqx - the probability of dying during the interval.

lx–the number alive at the start of the age interval of a hypothetical birth cohort of 100,000 (or some other arbitrary starting number, called a radix).

ndx–the number dying during the age interval of a hypothetical birth cohort of 100,000 experiencing the ***ndx*** values at each interval.

$_nL_x$–the number of person-years lived during the age interval of a hypothetical birth cohort of 100,000 experiencing constant rates of mortality, number of births, age structure and size (called the stationary population).

T_x - the total number of person-years lived in the age interval and all subsequent age intervals of the stationary population.

e_x - the expectation of life remaining at the start of the age interval. ***e_x*** is calculated ***T_x/l_x***

3. Example:

In the above life table for Illinois, life expectancy at birth (beginning of age interval 0) was 76.8 years (about the same value as for the United States during this identical period). The life expectancy at age 1 year was 76.5 years, decreasing only a fraction of a full year of life expectancy compared to age 0. This is often the case because the probability of dying during the first year of life often is much higher than immediate subsequent years. (Where infant mortality rates are high, often the life expectancy at age 1 year is used for comparative purposes.) In the same manner, life expectancy at age 65 years in this example is 17.8 years.

Life tables and life expectancy can be for specific subpopulations, such as by sex, race category, ethnicity, geography, year(s) period, etc. or a combination of such characteristics provided matching mortality and population data are available. Expanding on the Illinois example, life expectancy at birth often is higher for females (79.5 years) than males (74.0), higher for some race categories (77.8, white) than others (70.6 years, black) and higher for some time periods (76.8, 1999-2001) than others (73.5, 1979-1981). As a further example, life expectancy differences can be compared by time period, sex and race category. In Illinois from 1979-1981 to 1999-2001, life expectancy at age 20 years improved 1.1 years for black females and 2.6 years for black males.

4. Technical Notes:

- A life table, in some respects, is an elegant way of summarizing age-specific mortality. It also represents an instance where demographic theory and practice meet. Yet more than that, life tables and life expectancy are used in many applications beyond vital statistics, especially in business applications and assessments of risk: actuarial tables, battery life, hospital stays, etc., or circumstances where binary status changes (on/off, yes/no) can be measured by duration (e.g., in hospital/discharged from hospital) and summarized by cohort.
- Besides the more practical life table interpretation of it representing the mortality experience of a birth cohort going through its entire course of life (and death), an alternative interpretation is the stationary population. The more theoretical stationary population is where the total number of the population and the age distribution do not change or, put another way, the number of births in a period (e.g., 100,000) equals the number of deaths (and assuming no migration). The life table columns (lx and those to the right) then become predictions of population structure given these circumstances.

- While all standardized measures are designed for comparative uses, like life expectancy within a life table, they also are hypothetical based on "what if" scenarios. In our Illinois example, what would be the life expectancy at birth if the prevailing death rates were applied to the life table?
- There are several reasons to suppose that the 78.6 years might not be correct as a prediction or
- estimate: it is quite unlikely that all or even most people will experience the same probabilities of dying in each age interval over the course of their lifetimes, in and out-migration will occur, periodic mortality episodes likely will happen (e.g., influenza, results of military actions, etc.), new diseases might be introduced and others better managed (i.e., advances in medicine), birth rates likely will change over time, and so forth. The only true way to assess this is to observe a birth cohort and follow it, longitudinally, until all its members have died and from that determine the experienced average life expectancy.
- What do changes in life expectancy at birth actually reflect? An increase in life expectancy generally means decreases among the age-specific death rates within a population. Those decreases could be caused by any number of reasons: reduction in infectious diseases, fewer accidents or other preventable external causes, or any health-related actions that would contribute to a decrease in mortality (smoking cessation, use of condoms, increased seat-belt usage, etc.). In other words, changes in life expectancy are multi-factorial and rarely due primarily to one or two causes. In this respect, life expectancy is similar to infant mortality, fertility rates, and other summary measures where many cause-and-effect relationships could be reflected in their values. As such, life expectancy should not be used as a stand-alone indicator when seeking understanding about health status. Instead, life expectancy should be factored in with other measures and data, such as death rates by cause and age, access to and affordability of health care, environmental conditions, etc. when assessing the health of a population.
- Life expectancy is not the same as "life span." Conceptually, life span is the theoretical temporal limit of a single human life.
- Besides life expectancy, life tables can define the probability of surviving. For example, in the Illinois example, what is the probability of a neonate surviving to age 65? The answer is l65 / l0 = 82,190 / 100,000 = .82190 The median age at death in the life table population is defined as wherever the lx = 50,000 value lies. In the Illinois example, this would be about age 80 years.
- Theoretical life expectancy improvements can be measured via multiple decrement life table construction. For example, what impact does homicide have on male life expectancy at birth? In this exercise, in essence all homicide deaths are eliminated from the standard life table and the probabilities of dying from the remaining causes are recalculated. Again using Illinois as an example, based on 1989-1991 life tables, life expectancy at birth would have improved 0.48 years or about six months, on average. (For females, it was 0.14 years improvement.)
- One life table technique that can have an impact on the life table functions, including life expectancy, is data "smoothing." That is, based on a set of principles or criteria, mortality numbers or age-specific death rates are homogenized or

adjusted, usually without changing the total number of deaths for the population. For example, if a principle is that in a population a male death rate should always be higher than a female death rate for any given age group, then that would be a basis for such an adjustment.

- The idea is to eliminate abnormalities, especially when the numbers of deaths for age groups become small. The risk is that real or true information is being eliminated instead of data anomalies.
- Outside of vital statistics, some people add a half year to life expectancy because people who do not survive to their next birthday usually do not die the day after their previous birthday, say. That is, a failure to reach their next birthday could have occurred actually anytime during the interval and so, some think, are due a 0.5 year credit. (maf;7/2009)

References

[*Note: This set of references is not intended to be an exhaustive list. Instead, they are provided as starting points for a handful of common life table and life expectancy topics.*]

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(09/15/09)

Appendix C

Age-Adjusted Death Rate

Civil Registration And Vital Statistics Systems

Age-Adjusted Death Rate

1. Definition:

Age-Adjusted Death Rate is a death rate that controls for the effects of differences in population age distributions. When comparing across geographic areas, some method of age-adjusting is typically used to control for the influence that different population age distributions might have on health event rates.

Direct age-adjustment (or age standardization) is the same as calculating a weighted average. It weights the age-specific rates observed in a population of interest by the proportion of each age group in a standard population (Lilienfeld & Stolley, 1994).

In 1998, the Centers for Disease Control and Prevention revised the standard population weights for direct age-adjustment (Klein & Schoenborn), replacing the 1940 U.S. standard population weights that had been used for the previous several decades. Table 1., below, contains the standard population weights published by the CDC. They represent the proportion of the U.S. 2000 population in each age group, and sum to 1.0.

Table 1. US2000 Standard Population Weights for Age Standardization

	Age Group	U.S. 2000 Population Projection (in thousands)	Weight
1	Under 1 Year	3,795	0.013818
2	1-4 Years	15,192	0.055317
3	5-14 Years	39,977	0.145565
4	15-24 Years	38,077	0.138646
5	25-34 Years	37,233	0.135573
6	35-44 Years	44,659	0.162613
7	45-54 Years	37,030	0.134834
8	55-64 Years	23,961	0.087247
9	65-74 Years	18,136	0.066037
10	75-84 Years	12,315	0.044842
11	85 Years and Over	4,259	0.015508

2. Calculation:

To apply direct age-adjustment to a set of rates, the age-specific rate for each age group in the study population is multiplied by the appropriate weight in the standard population. The sum of these products is the directly age-adjusted, or age-standardized rate. The age-adjusted rate can be considered an average of each of the individual age-specific rates, but rather than being a simple average, it is a weighted average with each age-specific rate weighted by the proportion of people in the same age group in the standard population.

3. Examples:

Tables 2a. and 2b. demonstrate the method used in calculating age-adjusted rates. Notice that using crude death rates in Tables 2a. and 2b., one might conclude that persons in Sierra County have a higher underlying risk for Diabetes death compared with the state of New Mexico.

Table 2a. Age-adjusted Death Rate for Diabetes Mellitus, State of New Mexico, 2003-2005

Age Group	Number of Deaths (3-Year Sum)	Population Counts (3-Year Sum)[1]	Age-Specific Rate[2]	US2000 Std Pop Weight	Gross Products[3]
Under 1 Year	0	84,952	0	0.013818	0
1-4 Years	0	325,508	0	0.055317	0
5-14 Years	2	828,663	0.24	0.145565	0.30502
15-24 Years	2	893,809	0.22	0.138646	0.030502
25-34 Years	19	718,484	2.64	0.135573	0.357918
35-44 Years	61	810,632	7.52	0.162613	1.222855
45-54 Years	160	833,948	19.19	0.134834	2.587478
55-64 Years	297	602,768	49.27	0.087247	4.298757
65-74 Years	443	381,451	116.14	0.066037	7.669339
75-84 Years	546	235,030	232.31	0.044842	10.41697
85 Years and over	369	82,660	446.41	0.015508	6.923177
All ages	1,899	5,797,906	[4]32.754	1	[5]33.54

[1]Bureau of Business and Economic Research (BBER), UNM
[2] Rate per 100,000 = (Age-specific death count * 100,000) / Age-specific
[3]Age-specific death rate * US2000 Std Pop Weight
[4]Crude death rate
[5]Age-adjusted rate

Table 2b. Age-adjusted Death Rate for Diabetes Mellitus, Sierra County, New Mexico, 2003-2005

Age Group	Number of Deaths (3-Year Sum)	Population Counts (3-Year Sum)[1]	Age-Specific Rate[2]	US2000 Std Pop Weight	Gross Products[3]
Under 1 Year	0	350	0	0.013818	0
1-4 Years	0	1,266	0	0.055317	0
5-14 Years	0	4,384	0	0.145565	0
15-24 Years	0	4,526	0	0.138646	0
25-34 Years	0	2,977	0	0.135573	0
35-44 Years	1	4,269	23.43	0.162613	3.81038
45-54 Years	0	5,581	0	0.134834	0
55-64 Years	1	5,985	16.71	0.087247	1.457931
65-74 Years	11	5,946	185.01	0.066037	12.21719
75-84 Years	6	4,086	146.85	0.044842	6.584872
85 Years and over	3	1,584	189.45	0.015508	2.938097
All ages	22	40,952	[4]53.72	1	[5]27.01

[1]Bureau of Business and Economic Research (BBER), UNM
[2] Rate per 100,000 = (Age-specific death count * 100,000) / Age-specific
[3]Age-specific death rate * US2000 Std Pop Weight
[4]Crude death rate
[5]Age-adjusted rate

4. Technical Notes:

- When reporting age-adjusted rates, always report the standard population used. When comparing age-adjusted results to other data, be sure to document that those data were age-adjusted to the same standard population, and report the standard population.

- The age-adjusted rate is hypothetical, and is useful only for comparing populations, either over time, by geographic area, by sex or by racial/ethnic subgroups.

- Although age-adjustment may be used with broad population age groups, such as adults (e.g., age 18+), it is not necessary (or meaningful) to age-adjust data for smaller age groups (e.g., age 18-24).

- Age adjustment is not appropriate if the age-specific death rates in the population of interest do not have a consistent relationship. For example, if death rates among younger persons are increasing over time, but death rates among older persons are decreasing over time, you would not want to age-adjust rates across years. One's conclusion of the trend in this death rate would be different, depending on which standard population is used. A younger standard population (such as the US 1940) would show an increase, whereas an older standard population (such as the US 2000) would show a decrease or no change at all. Care should be taken so that the selection of the standard population does not affect the comparisons. For more information, see Curtin & Klein.

- In order to determine reliability and the chance variation of a death or mortality rate (especially those based on smaller numbers of events) as well as to determine significant changes over time or significant differences when comparing rates (e.g. a county rate to the state rate), it is highly recommended that a standard error or confidence interval (usually at 95%) be calculated and shown for the rates.

- In some cases, such as when there are too few cases to stratify by age, "indirect age standardization" may be used. Indirect standardization is based on standard mortality and morbidity ratios (SMR), and adjusts the age-specific rates found in the standard population to the age distribution of the smaller area or sub-population. According to Curtin & Klein, "One of the problems with [direct age adjustment] is that rates based on small numbers of deaths will exhibit a large amount of random variation. A very rough guideline is that there should be at least 25 total deaths over all age groups." When fewer than 25 health events occurred over a time period, you may consider combining years, or using indirect age-adjustment.

- The direct method can present problems when population sizes are particularly small. Calculating directly standardized rates requires calculating age-group-specific rates, and for small areas these age-specific rates may be based on one or two events. In such cases, indirect standardization of rates may be used.

- Indirectly standardized rates are based on the standard mortality or morbidity ratio (SMR) and the crude rate for a standard population. Indirect standardization adjusts the overall standard population death rate to the age distribution of the small area (Lilienfeld & Stolley, 1994). It is technically appropriate to compare indirectly standardized rates only with the rate in the standard population, not with each other.

- The Division of Vital Statistics (DVS) at NCHS follows standards for use of the terms "death rate" and "mortality rate" in naming and reporting common vital statistics rates for deaths. The NAPHSIS standard measures shown here follow the DVS standards, primarily to maintain consistency with DVS for naming conventions. Please note that states/registration areas and other federal government organizations within and outside NCHS/CDC may not follow the DVS standards when naming and reporting death/mortality rates.

    ▶ According to DVS standards, the following naming conventions are used for the common vital statistics rates for deaths:

Mortality Rates

- Infant Mortality Rate
- Neonatal Mortality Rate
- Postneonatal Mortality Rate
- Perinatal Mortality Rate

- Fetal Mortality Rate
- Maternal Mortality Rate

Death Rates

- Crude Death Rate
- Age-Specific Death Rate
- Cause-Specific Death Rate
- Age-Adjusted Death Rate

5. FAQs for Age-adjustment:

Event Rates for a Subpopulation

Q: I am looking at death rates for female breast cancer. Which standard population should I use, females in US 2000 or all persons?

A: Theoretically, it doesn't matter, as long as you use the same standard population for all your analyses. But the recommended standard population is now the U.S. 2000 total population, even for analyses that apply only to a particular sex, race, or other subgroup.

When NOT to Age-Adjust

Q: Are there times I should NOT age-adjust?

A: Yes. Do NOT use age-adjustment when...

- You are comparing populations with similar age distributions, and age-adjustment does not produce a rate that is substantively different from the crude rate.
- You are comparing groups with the same, narrow, age range.
- Do not use Direct Age-adjustment if you have too few cases (you should have a least 25 events across all age groups). Instead, use Indirect Age-Adjustment.

Age Subpopulations

Q: I am looking at adults, only. If I use the weights in Table 1, above, they will not sum to one. Is that okay?

A: No. The weights must always sum to one. Weights for certain age subgroups have been published by the CDC. But you may also recompute the proportions in Table 1, using only the age range that is relevant to your analysis.

Age/Sex Adjusted Rates

Q: I have a report that uses age AND SEX adjusted rates. What is this, and why doesn't NMIBIS produce age and sex adjusted rates?

A: It is sometimes appropriate to adjust by other variables besides age. Rates that have been adjusted by age and sex use age- and sex-specific rates, weighted by twice the number of weights (one set for males and one set for females), but the total of all the weights still must sum to 1.0. IBIS-Q doesn't compute these rates because there is little demand for it.

Confidence Intervals for Age-adjusted Rates

Q: Can I use the confidence interval for the crude rate with the age-adjusted rate?

A: No, a new confidence interval for the age-adjusted rate must be calculated. Methods for calculation of this confidence interval may be found in HUCurtin & KleinUH.

6. References:

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Appendix D

WHO World Standard Population

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WHO World Standard Population

Table 4. WHO World Standard Population Distribution (%), based on world average population between 2000-2025

Age group	World Average 2000-2025
0-4	8.86
5-9	8.69
10-14	8.60
15-19	8.47
20-24	8.22
25-29	7.93
30-34	7.61
35-39	7.15
40-44	6.59
45-49	6.04
50-54	5.37
55-59	4.55
60-64	3.72
65-69	2.96
70-74	2.21
75-79	1.52
80-84	0.91
85-89	0.44
90-94	0.15
95-99	0.04
100+	0.005
Total	**100**

The Standard Populations in the table can be combined by summing them together to form larger age groups; for example: the Standard Population for 40-54 is (6.59 + 6.04 + 5.37) = 18.00.

Note: The Standard Populations in the table are given as a percentage distribution. To use the distribition as weights for age adjusting, the numbers need to be divided by 100.

From: *Age Standardization of Rates: A New WHO Standard* by Omar B. Ahmad, Cynthia Boschi-Pinto, Alan D. Lopez, Christopher JL Murray, Rafael Lozano, Mie Inoue; GPE Discussion Paper Series: No. 31; EIP/GPE/EBD, World Health Organization, 2001

Appendix E

Principles Governing International Statistical Activities

Civil Registration And Vital Statistics Systems

Principles Governing International Statistical Activities

Bearing in mind that statistics are essential for sustainable economic, environmental and social development and that public trust in official statistics is anchored in professional independence and impartiality of statisticians, their use of scientific and transparent methods and equal access for all to official statistical information, the Chief Statisticians or coordinators of statistical activities of United Nations agencies and related organizations, agree that implementation of the following principles will enhance the functioning of the international statistical system.

In doing so, they note the endorsement of these principles by the Committee for the Coordination of Statistical Activities on 14 September, 2005; they further recall the adoption by the United Nations Statistical Commission of the Fundamental Principles of Official Statistics in its Special Session of 11-15 April 1994, and the endorsement of the Declaration of Good Practices in Technical Cooperation in Statistics in its 30th Session of 1-5 March 1999.

1. **High quality international statistics, accessible for all, are a fundamental element of global information systems**

   Good practices include:

   - Having regular consultations with key users both inside and outside the relevant organisation to ascertain that their needs are met
   - Periodic review of statistical programmes to ensure their relevance
   - Compiling and disseminating international statistics based on impartiality
   - Providing equal access to statistics for all users
   - Ensuring free public accessibility of key statistics

2. **To maintain the trust in international statistics, their production is to be impartial and strictly based on the highest professional standards**

   Good practices include:

   - Using strictly professional considerations for decisions on methodology, terminology and data presentation
   - Developing and using professional codes of conduct
   - Making a clear distinction, in statistical publications, between statistical and analytical comments on the one hand and policy prescriptive and advocacy comments on the other

3. The public has a right to be informed about the mandates for the statistical work of the organisations

Good practices include:

- Making decisions about statistical work programmes publicly available
- Making documents for and reports of statistical meetings publicly available

4. Concepts, definitions, classifications, sources, methods and procedures employed in the production of international statistics are chosen to meet professional scientific standards and are made transparent for the users

Good practices include:

- Aiming continuously to introduce methodological improvements and systems to manage and improve the quality and transparency of statistics
- Enhancing the professional level of staff by encouraging them to attend training courses, to do analytical work, to publish scientific papers and to participate in seminars and conferences.
- Documenting the concepts, definitions and classifications, as well as data collection and processing procedures used and the quality assessments carried out and making this information publicly accessible
- Documenting how data are collected, processed and disseminated, including information about editing mechanisms applied to country data
- Giving credit, in the dissemination of international statistics, to the original source and using agreed quotation standards when reusing statistics originally collected by others
- Making officially agreed standards publicly available

5. Sources and methods for data collection are appropriately chosen to ensure timeliness and other aspects of quality, to be cost-efficient and to minimise the reporting burden for data providers

Good practices include:

- Facilitating the provision of data by countries
- Working systematically on the improvement of the timeliness of international statistics
- Periodic review of statistical programmes to minimise the burden on data providers
- Sharing collected data with other organisations and collecting data jointly where appropriate
- Contributing to an integrated presentation of statistical programmes, including data collection plans, thereby making gaps or overlaps clearly visible
- Ensuring that national statistical offices and other national organisations

for official statistics are duly involved and advocating that the Fundamental Principles of Official Statistics are applied when data are collected in countries

6. Individual data collected about natural persons and legal entities, or about small aggregates that are subject to national confidentiality rules, are to be kept strictly confidential and are to be used exclusively for statistical purposes or for purposes mandated by legislation

Good practices include:

- Putting measures in place to prevent the direct or indirect disclosure of data on persons, households, businesses and other individual respondents
- Developing a framework describing methods and procedures to provide sets of anonymous micro-data for further analysis by bona fide researchers, maintaining the requirements of confidentiality

7. Erroneous interpretation and misuse of statistics are to be immediately appropriately addressed

Good practices include:

- Responding to perceived erroneous interpretation and misuse of statistics
- Enhancing the use of statistics by developing educational material for important user groups

8. Standards for national and international statistics are to be developed on the basis of sound professional criteria, while also meeting the test of practical utility and feasibility

Good practices include:

- Systematically involving national statistical offices and other national organisations for official statistics in the development of international statistical programmes, including the development and promulgation of methods, standards and good practices
- Ensuring that decisions on such standards are free from conflicts of interest, and are perceived to be so
- Advising countries on implementation issues concerning international standards
- Monitoring the implementation of agreed standards

9. Coordination of international statistical programmes is essential to strengthen the quality, coherence and governance of international statistics, and avoiding duplication of work

Good practices include:

- Designating one or more statistical units to implement statistical programmes, including one unit that coordinates the statistical work of the organisation and represents the organisation in international statistical meetings
- Participating in international statistical meetings and bilateral and multilateral consultations whenever necessary
- Working systematically towards agreements about common concepts, classifications, standards and methods
- Working systematically towards agreement on which series to consider as authoritative for each important set of statistics
- Coordinating technical cooperation activities with countries between donors and between different organisations in the national statistical system to avoid duplication of effort and to encourage complementarities and synergy

10. Bilateral and multilateral cooperation in statistics contribute to the professional growth of the statisticians involved and to the improvement of statistics in the organisations and in countries

Good practices include:

- Cooperating and sharing knowledge among international organisations and with countries and regions to further develop national and regional statistical systems
- Basing cooperation projects on user requirements, promoting full participation of the main stakeholders, taking account of local circumstances and stage of statistical development
- Empowering recipient national statistical systems and governments to take the lead
- Advocating the implementation of the Fundamental Principles of Official Statistics in countries
- Setting cooperation projects within a balanced overall strategic framework for national development of official statistics

From: United Nations web site at:

http://unstats.un.org/unsd/methods/statorg/Principles_stat_activities/principles_stat_activities.asp

Appendix F

Checklist for International Comparisons of Health-Related Data

Civil Registration And Vital Statistics Systems

Checklist for International Comparisons of Health-Related Data

Consider these questions when presenting or interpreting an international comparison of health-related data. Additional questions specific to the subject area may also be required.

Data quality

- ☐ Consistency—are the data defined consistently across countries?
- ☐ Methodology—do all countries use the same method to collect the data?
- ☐ Coverage—do the data cover similar parts of the population?
- ☐ Time period—do the data refer to the same time period?

Choice of countries

- ☐ Comparability—are countries sufficiently similar to support comparison?

Presentation and interpretation

- ☐ Presentation—are the data presented appropriately?
- ☐ Explanation—is the variation between countries adequately explained?
- ☐ Underlying differentials—are differences within countries considered?
- ☐ Context—can the data be used outside of an international comparison?

From: *A Working Guide to International Comparisons of Health*, Cat. No. PHE 159, Australian Institute of Health and Welfare, Canberra, Australia, 2012 http://www.aihw.gov.au/publication-detail/?id=10737421561

Appendix G

European Perinatal Health Report: Maternal Mortality Ratio

Civil Registration And Vital Statistics Systems

European Perinatal Health Report: Maternal Mortality Ratio

Table 6.1 Maternal mortality ratio (numbers and ratios per 100 000 live births) in 2003-2004

Country/Coverage	Number of live births	Number of maternal deaths			Maternal Mortality Ratio per 100,000 live births
		All	Year 2003	Year 2004	
Belgium					
Flanders	119,167	5	4	1	4.2
Brussels*	32,400	2	1	1	6.2
Czech Republic	191,349	19	11	8	9.9
Denmark	129,466	12	7	5	9.3
Germany†‡	692,802	37	NA	37	5.3
Estonia	27,028	8	4	4	29.6
Ireland§					
Greece§	104,355	2	2	NA	1.9
Spain	896,472	41	20	21	4.6
France	1,529,280	107	55	52	7.0
Italy*†	539,066	17	17	NA	3.2
Cyprus§					
Latvia	41,340	5	3	2	12.1
Lithuania	61,017	6	1	5	9.8
Luxembourg†	27,252	2			7.3
Hungary**	190,274	14	7	7	7.4
Malta	7,923	0	0	0	0.0
Netherlands	362,012	32	18	14	8.8
Austria	155,912	10	2	8	6.4
Poland	707,203	31	14	17	4.4
Portugal	221,945	17	8	9	7.7
Slovenia††	34,907	4	4	0	11.5
Slovak Republic§					
Finland	114,018	9	2	7	7.9
Sweden*	200,316	4	2	2	2.0
United Kingdom	1,411,545	108	55	53	7.7

* Brussels, Italy, and Sweden provided data on maternal death without the number of live births. The number of live births was estimated by the number of live births from 2004, which was 16 200 for Brussels, 539 066 for Italy, and 100 158 for Sweden.
† Data on maternal deaths were provided for one year only by Germany (2004), Greece (2003) and Italy (2002), and for five years by Luxembourg (2000-2004).
‡ Germany provided data on maternal deaths by number of women (pregnancies) rather than by the number of live births.
§ Cyprus, Ireland, and the Slovak Republic provided no data on maternal deaths.
** Hungary provided data on maternal deaths for the years 2003 and 2004, but did not provide the number of live births for 2003. The number of live births for 2003 was estimated using the number of live births for 2004.
†† Slovenia provided data on maternal deaths for the years 2001 and 2002.

Table 6.1 Maternal mortality ratio (numbers and ratios per 100 000 live births) in 2003-2004

Country/Coverage	Number of live births	Number of maternal deaths			Maternal Mortality Ratio per 100,000 live births
		All	Year 2003	Year 2004	
England and Wales	1,261,190	91	45	46	7.2
Scotland	106,389	13	7	6	12.2
Northern Ireland	43,786	4	3	1	9.1
Norway	113,409	4	4	0	3.5

* Brussels, Italy, and Sweden provided data on maternal death without the number of live births. The number of live births was estimated by the number of live births from 2004, which was 16 200 for Brussels, 539 066 for Italy, and 100 158 for Sweden.
† Data on maternal deaths were provided for one year only by Germany (2004), Greece (2003) and Italy (2002), and for five years by Luxembourg (2000-2004).
‡ Germany provided data on maternal deaths by number of women (pregnancies) rather than by the number of live births.
§ Cyprus, Ireland, and the Slovak Republic provided no data on maternal deaths.
** Hungary provided data on maternal deaths for the years 2003 and 2004, but did not provide the number of live births for 2003. The number of live births for 2003 was estimated using the number of live births for 2004.
†† Slovenia provided data on maternal deaths for the years 2001 and 2002.

From: EURO-PERISTAT Project, with SCPE, EUROCAT, EURONEOSTAT, European Perinatal Health Report, 2008 (Table 6.1) Available at:

http://www.europeristat.com/reports/european-perinatal-health-report2004.html

Appendix H

Calculation of Confidence Intervals

Civil Registration And Vital Statistics Systems

Calculation of Confidence Intervals

From: Deaths: Final Data for 2008, Arialdi M. Minino, Sherry L. Murphy, Jiaquan Xu, and Kenneth D. Kochanek, National Vital Statistics Reports, Volume 59, Number 10, December 7, 2011, National Center for Health Statistics, Centers for Disease Control and Prevention, U.S. Department of Health and Human Services

Random Variation

The mortality data presented in this report, with the exception of data for 1972, are not subject to sampling error. In 1972, mortality data were based on a 50 percent sample of deaths because of resource constraints. Mortality data, even based on complete counts, may be affected by random variation—that is, the number of deaths that actually occurred may be considered as one of a large series of possible results that could have arisen under the same circumstances (99,100). When the number of deaths is small, perhaps fewer than 100, random variation tends to be relatively large. Therefore, considerable caution must be observed in interpreting statistics based on small numbers of deaths.

Measuring random variability—To quantify the random variation associated with mortality statistics, an assumption must be made regarding the appropriate underlying distribution. Deaths, as infrequent events, can be viewed as deriving from a Poisson probability distribution. The Poisson distribution is simple conceptually and computationally, and provides reasonable, conservative variance estimates for mortality statistics when the probability of dying is relatively low (99). Using the properties of the Poisson distribution, the standard error (*SE*) associated with the number of deaths (*D*) is:

1. $$SE(D) = \sqrt{\text{var}(D)} = \sqrt{D}$$

where var(*D*) denotes the variance of *D*.

The standard error associated with crude and age-specific death rates (*R*) assumes that the population denominator (*P*) is a constant and is:

2. $$SE(R) = \sqrt{\text{var}\left(\frac{D}{P}\right)} = \sqrt{\frac{1}{P^2}\text{var}(D)} = \sqrt{\frac{D}{P^2}} = \frac{R}{\sqrt{D}}$$

The coefficient of variation or relative standard error (*RSE*) is a useful measure of relative variation. The *RSE* is calculated by dividing the statistic (e.g., number of deaths, death rate) into its standard error and multiplying by 100. For the number of deaths:

$$RSE(D) = 100\frac{SE(D)}{D} = 100\frac{\sqrt{D}}{D} = 100\sqrt{\frac{1}{D}}$$

For crude and age-specific death rates:

$$RSE(R) = 100\frac{SE(R)}{R} = 100\frac{R/\sqrt{D}}{R} = 100\sqrt{\frac{1}{D}}$$

Thus:

3. $$RSE(D) = RSE(R) = 100\sqrt{\frac{1}{D}}$$

The standard error of the age-adjusted death rate (*R´*) is:

4. $$SE(R') = \sqrt{\sum_i \left(\frac{P_{si}}{P_s}\right)^2 \text{var}(R_i)} = \sqrt{\sum_i \left\{\left(\frac{P_{si}}{P_s}\right)^2 \left(\frac{R_i^2}{D_i}\right)\right\}}$$

where:

- Ri is the age-specific rate for the ith age group
- Psi is the age-specific standard population for the ith age group from the U.S. standard population age distribution (see Table VIII and age-adjusted death rate under ‘‘Definition of terms’’)
- Ps is the total U.S. standard population (all ages combined)
- Di is the number of deaths for the ith age group

The *RSE* for the age-adjusted rate, *RSE*(*R´*), is calculated by dividing *SE*(*R´*) from Formula 4 by the age-adjusted death rate, *R´*, and multiplying by 100:

$$RSE(R') = 100\frac{SE(R')}{R'}$$

For tables showing infant mortality rates based on live births (*B*) in the denominator, calculation of the standard error assumes random variability in both the numerator and denominator. The standard error for the infant mortality rate (*IMR*) is:

5. $$SE(IMR) = \sqrt{\frac{\text{var}(D) + IMR * \text{var}(B)}{E(B)^2}} = \sqrt{\frac{D}{B^2} + \frac{D^2}{B^3}}$$

where the number of births, *B*, is also assumed to be distributed according to a Poisson distribution and *E*(*B*) is the expectation of *B*.

The *RSE* for the *IMR* is:

6. $$RSE(IMR) = 100\frac{SE(IMR)}{IMR} = 100\sqrt{\frac{1}{D} + \frac{1}{B}}$$

Formulas 1–6 may be used for all tables presented in this report except for death rates and age-adjusted death rates shown in Tables 5, I-7, and I-8, which are calculated using population figures that are subject to sampling error.

Tables 5, I-7, and I-8—Death rates for Mexican, Puerto Rican, Cuban, and Other Hispanic populations in Table 5, by marital status in Table I-7, and by educational attainment in Table I-8 are based on population estimates derived from the CPS for 2008 and adjusted to resident population control totals. As a result, the rates are subject to sampling variability in the denominator as well as random variability in the numerator.

For crude and age-specific death rates (*R*), the standard error is calculated as:

7. $$SE(R) = R\sqrt{\frac{1}{D} + 0.67\left(a + \frac{b}{P}\right)}$$

For age-adjusted death rates (*R´*):

8. $$SE(R') = \sqrt{\sum_i \left\{ \left(\frac{P_{si}}{P_s}\right)^2 R_i^2 \left[\frac{1}{D_i} \quad 0.67\left(a + \frac{b}{P_i}\right)\right]\right\}}$$

where a and b in Formulas 7 and 8 represent parameters presented in Table XIV, which are derived from the CPS data for 2008 and 2009 and vary depending on the subgroup of interest (101,102).

Suppression of unreliable rates—Beginning with 1989 data, an asterisk is shown in place of a crude or age-specific death rate based on fewer than 20 deaths, the equivalent of an *RSE* of 23 percent or more. The limit of 20 deaths is a convenient, if somewhat arbitrary, benchmark, below which rates are considered to be too statistically unreliable for presentation. For infant mortality rates, the same threshold of fewer than 20 deaths is used to determine whether an asterisk is presented in place of the rate. For age-adjusted death rates, the suppression criterion is based on the sum of age-specific deaths; that is if the sum of the age-specific deaths is less than 20, an asterisk replaces the rate. These procedures are used throughout this report except for death rates shown in Tables 5, I-7, and I-8.

In Tables 5, I-7 and I-8, sampling variability in the population denominator has a substantial impact on the overall variability in the death rate. Therefore, the number of deaths in the numerator is not used as the sole suppression factor. *RSE*s for rates

shown in Tables 5, I-7, and I-8 are derived from Formulas 7 and 8 by dividing the result of Formula 7 by the crude/age-specific rate, and the result of Formula 8 by the age-adjusted rate, and then multiplying by 100. Rates are replaced by asterisks if the calculated RSE is 23 percent or more. In some cases, for smaller population subgroups, the estimated sample population from the CPS may be zero, even though deaths are presented for the subgroups. In these cases, the death rate is incalculable and automatically replaced with an asterisk.

Confidence intervals and statistical tests based on 100 deaths or more—When the number of deaths is large, a normal approximation may be used in calculating confidence intervals and statistical tests. How large, in terms of number of deaths, is to some extent subjective. In general, for crude and age-specific death rates and for infant mortality rates, the normal approximation performs well when the number of deaths is 100 or greater. For age-adjusted rates, the criterion for use of the normal approximation is somewhat more complicated (68,98,103). Formula 9 is used to calculate 95 percent confidence limits for the death rate when the normal approximation is appropriate:

9. 9. $$L(R) = R - 1.96(SE(R)) \text{ and } U(R) = R + 1.96(SE(R))$$

where L(R) and U(R) are the lower and upper limits of the confidence interval, respectively. The resulting 95 percent confidence interval can be interpreted to mean that the chances are 95 in 100 that the ''true'' death rate falls between L(R) and U(R). For example, suppose that the crude death rate for Malignant neoplasms is 186.0 per 100,000 population based on 565,469 deaths. Lower and upper 95 percent confidence limits using Formula 9 are calculated as:

L(186.0) = 186.0 – 1.96(.25) = 185.5 and

U(186.0) = 186.0 + 1.96(.25) = 186.5

Thus, the chances are 95 in 100 that the true death rate for malignant neoplasms is between 185.5 and 186.5. Formula 9 can also be used to calculate 95 percent confidence intervals for the number of deaths, age-adjusted death rates, infant mortality rates, and other mortality statistics when the normal approximation is appropriate by replacing R with D, R´, IMR, or others.

When testing the difference between two rates, R1 and R2 (each based on 100 or more deaths), the normal approximation may be used to calculate a test statistic, z, such that:

10. 10. $$z = \frac{R_1 - R_2}{\sqrt{SE(R_1)^2 + SE(R_2)^2}}$$

If |z|≥ 1.96, then the difference between the rates is statistically significant at the 0.05 level. If |z|< 1.96, then the difference is not statistically significant. Formula 10 can also be used to perform tests for other mortality statistics when the normal approximation is appropriate (when both statistics being compared meet the normal criteria) by replacing

R_1 and R_2 with D_1 and D_2, R'_1 and R'_2, or others. For example, suppose that the male age-adjusted death rate for Malignant neoplasms of trachea, bronchus, and lung (lung cancer) is 65.1 per 100,000 U.S. standard population in 2007 (R_1) and 63.6 per 100,000 U.S. standard population in 2008 (R_2). The standard error for each of these figures, SE(R_1) and SE(R_2), is calculated using Formula 4. A test using Formula 10 can determine if the decrease in the age-adjusted rate is statistically significant:

10b. $$Z = \frac{65.1 - 63.6}{\sqrt{(0.222)^2 + (0.217)^2}} = 4.83$$

Because z = 4.83 > 1.96, the decrease from 2007 to 2008 in the male age-adjusted death rate for lung cancer is statistically significant.

Confidence intervals and statistical tests based on fewer than 100 deaths—When the number of deaths is not large (fewer than 100), the Poisson distribution cannot be approximated by the normal distribution. The normal distribution is symmetrical, with a range from $-\infty$ to $+\infty$. As a result, confidence intervals based on the normal distribution also have this range. The number of deaths or the death rate, however, cannot be less than zero. When the number of deaths is very small, approximating confidence intervals for deaths and death rates using the normal distribution will sometimes produce lower confidence limits that are negative. The Poisson distribution, in contrast, is an asymmetric distribution with zero as a lower bound—confidence limits based on this distribution will never be less than zero. A simple method based on the more general family of gamma distributions, of which the Poisson is a member, can be used to approximate confidence intervals for deaths and death rates when the number of deaths is small (98,104). For more information regarding how the gamma method is derived, see Derivation of the gamma method at the end of this section.

Calculations using the gamma method can be made using commonly available spreadsheet programs or statistical software (e.g., Excel, SAS) that include an inverse gamma function. In Excel, the function "gammainv (probability, alpha, beta)" returns values associated with the inverse gamma function for a given probability between 0 and 1. For 95 percent confidence limits, the probability associated with the lower limit is .05/2 = .025 and with the upper limit, 1-(.05/2) = .975. Alpha and beta are parameters associated with the gamma distribution. For the number of deaths and crude and age-specific death rates, alpha = D (the number of deaths) and beta = 1. In Excel, the following formulas can be used to calculate lower and upper 95 percent confidence limits for the number of deaths and crude and age-specific death rates:

L(D) = GAMMAINV(.025, D, 1) and U(D) = GAMMAINV(.975, D+1, 1)

Confidence limits for the death rate are then calculated by dividing L(D) and U(D) by the population (P) at risk of dying (see Formula 17).

Alternatively, 95 percent confidence limits can be estimated using the lower and upper confidence limit factors shown in Table XV. For the number of deaths, D, and the death

rate, R,

11. L(D)= L x D and U(D)= U x D
12. L(R)= L x R and U(R)= U x R

where L and U in both formulas are the lower and upper confidence limit factors that correspond to the appropriate number of deaths, D, in Table XV. For example, suppose that the death rate for AIAN females aged 1–4 is 39.5 per 100,000 and based on 50 deaths. Applying Formula 12, values for L and U from Table XV for 50 deaths are multiplied by the death rate, 39.5, such that:

L(R) = L(39.5) = 0.742219 x 39.5 = 29.3 and

U(R) = U(39.5) = 1.318375 x 39.5 = 52.1

These confidence limits indicate that the chances are 95 out of 100 that the actual death rate for AIAN females aged 1–4 is between 29.3 and 52.1 per 100,000.

Although the calculations are similar, confidence intervals based on small numbers for age-adjusted death rates, infant mortality rates, and rates that are subject to sampling variability in the denominator are somewhat more complicated (68,98).

Refer to the most recent version of the Mortality Technical Appendix for more details at http://www.cdc.gov/nchs/products/vsus.htm#appendices.

When comparing the difference between two rates (R_1 and R_2), where one or both of the rates are based on fewer than 100 deaths, a comparison of 95 percent confidence intervals may be used as a statistical test. If the 95 percent confidence intervals do not overlap, then the difference can be said to be statistically significant at the 0.05 level. A simple rule of thumb is: If $R_1 > R_2$, then test if $L(R_1) > U(R_2)$, or if $R_2 > R_1$, then test if $L(R_2) > U(R_1)$. Positive tests denote statistical significance at the 0.05 level. For example, suppose that AIAN females aged 1–4 have a death rate (R_1) of 39.5 based on 50 deaths and API females aged 1–4 have a death rate (R_2) of 20.1 per 100,000 based on 86 deaths. The 95 percent confidence limits for R_1 and R_2 calculated using Formula 12 would be:

L(R) = L(39.5) = 0.742219 x 39.5 = 29.3 and

U(R) = U(39.5) = 1.318375 x 39.5 = 52.1

L(R2)= L(20.1) = 0.799871 x 17.9 = 16.1 and

U(R2)= U(20.1) = 1.234992 x 17.9 = 24.8

Because R1> R2 and $L(R_1) > U(R_2)$, it can be concluded that the difference between the death rates for AIAN females aged 1–4 and API females of the same age is statistically

significant at the 0.05 level. That is, taking into account random variability, API females aged 1–4 years have a death rate significantly lower than that for AIAN females of the same age.

This test may also be used to perform tests for other statistics when the normal approximation is not appropriate for one or both of the statistics being compared, by replacing R_1 and R_2 with D_1 and D_2, R'_1 and R'_2, or others.

Users of the method of comparing confidence intervals should be aware that this method is a conservative test for statistical significance—the difference between two rates may, in fact, be statistically significant even though confidence intervals for the two rates overlap (104). Caution should be observed when interpreting a nonsignificant difference between two rates, especially when the lower and upper limits being compared overlap only slightly.

Derivation of the gamma method—For a random variable X that follows a gamma distribution $\Gamma(y,z)$, where y and z are the parameters that determine the shape of the distribution (105), $E(X)= yz$ and $Var(X)= yz^2$. For the number of deaths, D, E (D) = D and Var (D) = D. It follows that y = D and z = 1, and thus:

13. $D \sim \Gamma(D,1)$

From Equation 13, it is clear that the shape of the distribution of deaths depends only on the number of deaths.

For the death rate, R, E(R) = R and $Var (R) = D/P^2$. It follows, in this case, that y = D and $z = P^{-1}$, and thus:

14. $R \sim \Gamma(D,P^{-1})$

A useful property of the gamma distribution is that for $X \sim \Gamma(y,z)$, X can be divided by z such that $X/z \sim \Gamma(y,1)$. This converts the gamma distribution into a simplified, standard form, dependent only on parameter y. Expressing Equation 14 in its simplified form gives:

15. $R/P^{-1} = D \sim \Gamma(D,1)$

From Equation 15, it is clear that the shape of the distribution of the death rate is also dependent solely on the number of deaths.

Using the results of Equations 13 and 15, the inverse gamma distribution can be used to calculate upper and lower confidence limits. Lower and upper $100(1-\alpha\Gamma)$ percent confidence limits for the number of deaths, L(D) and U(D), are estimated as:

16. $L(D)= \Gamma^{-1}_{(D,1)}(\alpha / 2)$ and $U(D)= \Gamma^{-1}_{(D+1,1)}(1-\alpha /2)$

where Γ^{-1} represents the inverse of the gamma distribution and D+1 in the formula for U(D) reflects a continuity correction, which is necessary because D is a discrete random variable and the gamma distribution is a continuous distribution. For a 95 percent confidence interval, $\alpha = .05$. For the death rate, it can be shown that:

17. L(R)= L(D)/P and U(R)= U(D)/P

For more detail regarding the derivation of the gamma method and its application to age-adjusted death rates and other mortality statistics, see "References" (68,98,103).

Table XV. Lower and upper 95 percent confidence limit factors for the number of deaths and death rate when the number of deaths is less than 100

Number of deaths (D)	Lower confidence limit (L)	Upper confidence limit (U)	Number of deaths (D)	Lower confidence limit (L)	Upper confidence limit (U)
1	0.025318	5.571643	51	0.744566	1.314815
2	0.121105	3.612344	52	0.746848	1.311367
3	0.206224	2.922424	53	0.749069	1.308025
4	0.272466	2.560397	54	0.751231	1.304783
5	0.324697	2.333666	55	0.753337	1.301637
6	0.366982	2.176579	56	0.755389	1.298583
7	0.402052	2.060382	57	0.75739	1.295616
8	0.431729	1.970399	58	0.759342	1.292732
9	0.457264	1.898311	59	0.761246	1.289927
10	0.479539	1.839036	60	0.763105	1.287198
11	0.499196	1.789276	61	0.764921	1.284542
12	0.516715	1.746799	62	0.766694	1.281955
13	0.532458	1.71003	63	0.768427	1.279434
14	0.546709	1.67783	64	0.770122	1.276978
15	0.559692	1.649348	65	0.771779	1.274582
16	0.571586	1.623937	66	0.7734	1.272245
17	0.582537	1.601097	67	0.774986	1.269965
18	0.592663	1.580431	68	0.776539	1.267738
19	0.602065	1.561624	69	0.77806	1.265564
20	0.610826	1.544419	70	0.779549	1.26344
21	0.619016	1.528606	71	0.781008	1.261364
22	0.626695	1.514012	72	0.782438	1.259335
23	0.633914	1.500491	73	0.78384	1.25735
24	0.640719	1.487921	74	0.785215	1.255408
25	0.647147	1.476197	75	0.786563	1.253509
26	0.653233	1.465232	76	0.787886	1.251649
27	0.659006	1.454947	77	0.789184	1.249828
28	0.664493	1.445278	78	0.790459	1.248045

Table XV. Lower and upper 95 percent confidence limit factors for the number of deaths and death rate when the number of deaths is less than 100

Number of deaths (D)	Lower confidence limit (L)	Upper confidence limit (U)	Number of deaths (D)	Lower confidence limit (L)	Upper confidence limit (U)
29	0.669716	1.436167	79	0.791709	1.246298
30	0.674696	1.427562	80	0.792938	1.244587
31	0.679451	1.41942	81	0.794144	1.242909
32	0.683999	1.411702	82	0.79533	1.241264
33	0.688354	1.404372	83	0.796494	1.23965
34	0.692529	1.3974	84	0.797639	1.238068
35	0.696537	1.390758	85	0.798764	1.236515
36	0.700388	1.384422	86	0.799871	1.234992
37	0.704092	1.378368	87	0.800959	1.233496
38	0.70766	1.372578	88	0.802029	1.232028
39	0.711098	1.367033	89	0.803082	1.230586
40	0.714415	1.361716	90	0.804118	1.22917
41	0.717617	1.356613	91	0.805138	1.227778
42	0.720712	1.351709	92	0.806141	1.226411
43	0.723705	1.346993	93	0.807129	1.225068
44	0.726602	1.342453	94	0.808102	1.223747
45	0.729407	1.338079	95	0.80906	1.222448
46	0.732126	1.33386	96	0.810003	1.221171
47	0.734762	1.329788	97	0.810933	1.219915
48	0.737321	1.325855	98	0.811848	1.21868
49	0.739806	1.322053	99	0.812751	1.217464
50	0.742219	1.318375			

Appendix I

Assessment Framework for Vital Statsitics From Civil Registration Systems

Civil Registration And Vital Statistics Systems

Assessment Framework for Vital Statistics

Retyped from: Who Counts? 2, Civil registration systems and vital statistics: successes and missed opportunities, Prasanta Mahapatra, Kenji Shibuya, Alan D. Lopez, Francesca Coullare, Francis C. Notzon, Chalapati Rao, Simon Szreter, on behalf of the Monitoring Vital Events (MoVE) writing group; The Lancet, Volume 370, November 10, 2007

	General vital statistics	Cause-of death statistics
Accuracy		
Coverage	% of population living in areas where CRS is functional	% of population covered by medical certification of cause of death
Completeness	% of events contributing to fertility/ mortality statistics	% of deaths with medically-certified cause of death
Missing data	% of key variables with response not stated	% of cause-of-death reports for which age/sex data are missing
Use of ill-defined categories		% of deaths classified under various miscellaneous and ill-defined categories
Improbable classifications		Number of deaths assigned to improbable age or sex categories per 100,000 coded deaths
Consistency between cause of death and general mortality		% of cause-of-death data points deviating more than 2 (or 3) SDs from general mortality based predictions
Relevance		
Routine tabulations	By sex and 5-year age groups, based on place of usual residence. Deaths in children under 5 years tabulated by 0 and 1-4 age-group	By sex, and at least by eight broad age groups—namely, 0, 1-4, 5-14, 15-29, 30-44, 45-59, 60-69, and 70+ years
Small area statistics	Number of general vital statistics tabulation areas per million population	Number of cause-of death tabulation areas per million population
Comparability		
Over time	Stability of key definitions over time	Consistency of cause specific mortality proportions over consecutive years
Across space	Uniformity of definitions across areas	ICD to certify and code deaths; revision used and code level to which tabulations are published
Timeliness		
Production time	Mean time from end of reference period to publication	Mean time from end of reference period to publication
Regularity	SD of production time	SD of production time

CRS = civil registration systems. SD = standard deviation.

	General vital statistics	Cause-of death statistics
Accessibility		
Media	Number of formats in which data are released	Number of formats in which data are released
Metadata	Availability and quality of documentation	Availability and quality of documentation
User service	Availability and responsiveness of user service	Availability and responsiveness of user service

CRS = civil registration systems. SD = standard deviation.

Glossary

Coverage of civil registration systems refers to the extent to which geographical or political units of the country have established these systems. For cause of death, coverage refers to the population living in areas where medical certification of cause of death has been legally mandated.

Completeness is measured by the percentage of vital events actually recorded in the vital statistics and is estimated by comparison with an independent estimate for the population under consideration, with either direct or indirect methods. For cause-of-death statistics, completeness is the number of cause-of-death reports as a percentage of estimated deaths in the population.

Cross-tabulation is recording of the event of interest by various characteristics associated with the event—eg, tabulation of births by age of mother and birthweight, etc.

Relevance is the degree to which cross-tabulation for priority characteristics—from a demographic and public-health perspective—are provided by the data source. The UN principles list relevant characteristics of vital events and discuss their importance. Cross-tabulation of vital events, at least by priority characteristic, would show important relations.

Small areas denote the smallest population groups or units for which tabulation of vital events are available.

Timeliness means that statistics are made available to their users on a prompt and regular basis—eg, yearly.

Comparability means the extent to which a statistic estimates the same thing in the same way over time and across areas.

Accessibility refers to the ease with which users can access and make sense of the data.

Media refers to dissemination of data in several formats—ie, print, electronic, internet, etc.

Metadata refers to information about the data, such as documentation of data elements, their definition, method of collection, manner of presentation, potential for errors, etc. Its purpose is to enhance usability of data for public-health analysis.

User service refers to dedicated institutional mechanism for distribution of data products, clarification of user queries, and productive engagement with data producers, and also data accessibility.

Appendix J

Kenya Country Profile

Civil Registration And Vital Statistics Systems

Kenya Country Profile

Population

From the 1999 population census, the projected population for Kenya is 39 million for 2009 and increase further to 40 million by 2010 (Table 1). It is, however, worth noting that a national census conducted in August 2009 will facilitate updating Kenya's demographic information once the results are out.

Table 1: Distribution Of Estimated Population By Province And Year (In Millions)

Province	2006	2007	2008	2009	2010
Nairobi	2924.3	3934.4	3146.3	3260.1	3357.8
Central	4454.1	4556.7	4666.8	4784.8	4884.9
Coast	3138.3	3228.4	3322.1	3419.8	3502.9
Eastern	5658.0	5802.1	5955.1	6117.7	6256.8
North					
Eastern	1286.1	1313.8	1349.7	1394.4	1440.5
Nyanza	5316.2	5443.9	5580.3	5725.7	5849.7
Rift Valley	9100.5	9402.5	9714.7	10037.8	10316.6
Western	4261.1	4402.2	4542.8	4683.1	4797.2
Total	31,138.7	37,183.9	38,277.9	37,423.3	40,406.4

Source: Kenya National Bureau of Statistics-Statistical Abstract, 2007

Expected Births And Deaths

Population projections have been made from the results of 1999 population and housing census since the 2009 population and housing census results are not yet out. At the same time, expected births are computed using crude birth rate from 1999 population census. The assumption is that the crude birth rate remains constant or that there was not likely to be substantial changes in the crude birth rate over the period. Note: The crude birth rate is considered "crude" because it ignores the age structure of the population, and it doesn't take into account who among the population were actually able to give birth.

Expected events were obtained by dividing the crude rates by 1000 population and multiplied by the projected population.

Thus the birth coverage rate was obtained by

$$\text{Expected births} = \frac{\text{Crude Birth Rate (CBR)}}{1000} \text{ X Projected Population}$$

Similarly, expected deaths were obtained by dividing the crude death rates by 1000 population and multiplied by the projected population. The assumption is that the crude death rate remains constant or that there was not likely to be substantial changes in the crude death rate over the period.

Republic of Kenya, Ministry of State for immigration and Registration of Persons. Department of Civil Registration. Annual Civil Registration Statistics Report, 2009, 1st Draft. Statistics Section. July, 2010.

Thus

$$\text{Expected deaths} = \frac{\text{Crude Death Rate (CDR)}}{1000} \text{ X Projected Population}$$

Expected Births

Table 2: Expected Births by Year and Region

Province	2008		2009	
	Projected Population	Expected Births	Projected Population	Expected Births
Nairobi	3038553	97234	3260124	104324
Central	4145915	136815	4668550	154062
Western	4375097	796879	4620978	207944
Eastern	5492443	221895	6081340	245686
Coast	3115774	133355	3524702	150857
Nyanza	5184974	237472	6025362	275962
North Rift	4893596	218744	5198348	232366
South Rift	4351594	194516	5798587	259197
North Eastern	1410342	68543	1465083	60508
Total	**36008288**	**1487142**	**40643074**	**1586582**

Expected Deaths

Table 3: Expected Deaths by Year and Region

Province	2008			2009		
	Population	Registered Deaths	Expected Deaths	Population	Registered Deaths	Expected Deaths
Nairobi	3038553	20640	28259	3260124	22207	30319
Central	4145915	26865	35618	4668550	21138	40616
Western	4375097	27292	59162	4620978	24756	67004
Eastern	5492443	27349	51433	6081340	28290	59597
Coast	3115774	17825	37527	3524702	12223	42649
Nyanza	5184974	44001	96399	6025362	35748	114482
North Rift	4893596	14056	41953	5198348	13769	47900
South Rift	4351594	15263	43802	5798587	19367	54922
North Eastern	1410342	680	13004	1465083	854	11281
Total	**36008288**	**193971**	**412604**	**40643074**	**178352**	**462253**

Registration coverage rates

Registration coverage rates evaluate the extent to which registration has been achieved nationally and by region.

Coverage rates are obtained by dividing the actual registered events by the expected events and then multiplying by 100.

$$\text{Birth coverage rate} = \frac{\text{Actual registered births}}{\text{Expected births}} \text{ X } 100\%$$

Thus, the birth coverage rates were obtained by:

Similarly, death coverage rates were obtained by dividing the actual registered deaths by the expected deaths and then multiplying by 100.

Thus,

$$\text{Death coverage rate} = \frac{\text{Actual registered deaths}}{\text{Expected deaths}} \text{ X } 100\%$$

Table 4: Registration Of Births And Deaths, Number Expected And The Coverage Rates In The Year 2009

PROVINCE/ DISTRICT	POP.	REG. BIRTHS	CBR	EXP. BIRTHS	COV. RATE: BIRTHS	CDR	REG. DEATHS	EXP. DEATHS	COV. RATE: DEATHS
Nyeri Central	281525	9843	29.4	8277	118.92	9.7	2578	2731	94.40
Nyeri South	87374	430	29.4	2569	16.74	9.7	204	848	24.07
Mathira	148847	1669	29.4	4376	38.14	9.7	492	1444	34.08
Kieni East	175812	5176	29.4	5169	100.14	9.7	1462	1705	85.73
Kiambu East	253751	15487	32.7	8298	186.64	12.2	2594	3096	83.79
Githunguri	147763	723	32.7	4832	14.96	12.2	262	1803	14.53
Kiambu West	520856	9713	32.7	17032	57.03	12.2	2868	6354	45.13
Kirinyaga	528054	9949	30.3	16000	62.18	9.6	2775	5069	54.74
Muranga East	269253	7410	30.4	8185	90.53	10.3	2472	2773	89.14
Muranga West	138477	436	30.4	4210	10.36	10.3	139	1426	9.75
Muranga South	308935	6508	33.3	10288	63.26	10.7	2226	3306	67.34
Kigumo	123766	137	33.3	4121	3.32	10.7	64	1324	4.83
Nyandarua N.	308551	12961	39.4	12157	106.61	8.1	3295	2499	131.84
Nyandarua S.	287717	4176	39.4	11336	36.84	8.1	1205	2331	51.71
Thika	408711	17127	32	13079	130.95	12.2	5178	4986	103.85
Ruiru	241007	161	32	7712	2.09	12.2	28860	2940	981.54
Gatundu	214791	4552	32	6873	66.23	10.7	1308	2298	56.91
Western	4334282	81510	45	195043	41.79	14.5	28824	62847	45.86
Bungoma	972433	14684	46.6	45315	32.40	12.3	5967	11961	49.89
Bungoma East	230253	2696	46.6	10730	25.13	12.3	690	2832	24.36
Busia	394575	9864	47.5	18742	52.63	20.6	4449	8128	54.74

Table 4: Registration Of Births And Deaths, Number Expected And The Coverage Rates In The Year 2009

PROVINCE/ DISTRICT	POP.	REG. BIRTHS	CBR	EXP. BIRTHS	COV. RATE: BIRTHS	CDR	REG. DEATHS	EXP. DEATHS	COV. RATE: DEATHS
Samia	93500	536	47.5	4441	12.07	20.6	230	1926	11.94
Mt. Elgon	172377	4003	48.9	8429	47.49	17.7	638	3051	20.91
Kakamega	561538	11534	44	24708	46.68	14.3	5188	9077	57.15
Kakamega N.	205166	2356	44	9027	26.10	14.3	954	3171	30.09
Vihiga	554622	11689	37.6	20854	56.05	15.3	5302	8486	62.48
Teso	255871	5185	49	12538	41.36	10.3	1232	2635	46.75
Lugari	292151	4544	44.8	13088	34.72	9.5	1190	2775	42.88
Butere	242415	6571	46.4	11248	58.42	13	2259	3151	71.68
Mumias	359381	10204	46.4	16675	61.19	13	2414	4672	51.67
Eastern	5668123	100530	40.4	228992	43.94	9.8	31436	55548	56.59
Embu	296992	8756	32.8	9741	89.88	8.8	2398	2614	91.75
Isiolo	143294	2721	43.8	5276	43.35	11.7	392	1677	23.38
Kitui	447613	8592	45.6	20411	42.09	13.9	3213	6222	51.64
Mutomo	180148	5154	45.6	8215	62.74	13.7	1014	2468	41.09
Machakos	825065	17745	38.5	31765	55.86	13.1	6907	10808	63.90
Yatta	273519	839	38.5	10530	7.97	13.1	480	3583	13.40
Makueni	431148	8808	41.6	17936	49.11	13.9	4352	5993	72.62
Kibwezi	453379	1112	41.6	18861	5.90	13.9	703	6302	11.16
Marsabit	187367	1837	44.8	8394	21.88	13.9	298	2604	11.44
Meru Central	580319	10569	33.9	19673	53.72	9.5	3386	5513	61.42
Mwingi	244981	6898	47.6	11661	59.15	11.3	2332	2768	84.24
Kyuso	139967	0	47.6	6662	0.00	11.3			
Mbeere	219220	4000	47.7	10457	38.25	10.7	1073	2346	45.74
Moyale	103799	2349	48.8	5065	46.37	12.3	245	1277	19.19
Tharaka	130098	2913	44.8	5828	49.98	14.6	408	1899	21.48
Meru South	286729	5733	32.7	9376	61.15	9.6	1561	2753	56.71
Meru North	775982	12604	45.6	35385	35.62	10.7	2674	8303	32.21
Nyanza	5442711	93200	45.8	249276	37.39	19	40870	103412	39.52
Kish Central	480360	11412	42.8	20559	55.51	11.5	5192	5524	93.99
Masaba	233347	3447	42.8	9987	34.51	11.5	1097	2683	40.88
Nyamira	486975	7153	43.4	21135	33.84	7.4	1891	3604	52.48
Kisumu	473649	17615	43.5	20604	85.49	21.6	8069	10231	78.87
Kisumu West	144907	3550	43.5	6303	56.32	21.6	1876	3130	59.94
Migori	335873	8922	50.5	16962	52.60	22.7	3705	7624	48.59
Rongo	325211	1077	50.5	16423	6.56	22.7	247	7382	3.35
Kuria	256086	5457	54.3	13905	39.24	13.6	619	3483	17.77
Homa Bay	366620	4605	50.8	18624	24.73	25.1	2450	9202	26.62
Siaya	550224	9118	42.7	23495	38.81	9.7	6589	5337	123.45
Suba	214463	3191	49.9	10702	29.82	23.9	982	5126	19.16
Rachuonyo	382711	5080	48	18370	27.65	21.7	2459	8305	29.61
Nyando	350353	4634	44.1	15451	29.99	22.4	2599	7848	33.12

Table 4: Registration Of Births And Deaths, Number Expected And The Coverage Rates In The Year 2009

PROVINCE/ DISTRICT	POP.	REG. BIRTHS	CBR	EXP. BIRTHS	COV. RATE: BIRTHS	CDR	REG. DEATHS	EXP. DEATHS	COV. RATE: DEATHS
Bondo	292080	6098	45.3	13231	46.09	23.4	3247	6835	47.51
Gucha	390803	5777	44.8	17508	33.00	11.3	1846	4416	41.80
Gucha South	159049	3061	44.8	7125	42.96	11.3	975	1797	54.25
Rift Valley	10006805	160326	44.7	447304	35.84	8.6	46996	86059	54.61
South Rift	5023260	91283	44.7	224540	40.65	8.6	19824	43200	45.89
Bomet	397104	9861	48.8	19379	50.89	7.1	2131	2819	75.58
Kajiado	459816	5749	40.9	22487	25.57	8	931	4399	21.17
Loitoktok	137496	1058	40.9	5624	18.81	8	170	1100	15.45
Kericho	590690	7963	43.2	25518	31.21	10.3	2383	6084	39.17
Laikipia East	174796	2230	39.4	6887	32.38	7.9	1688	1381	122.24
Laikipia West	224382	648	39.4	8841	7.33	7.9	236	1773	13.31
Nakuru	473288	20719	40.9	19357	107.03	11.2	5865	5301	110.64
Nakuru North	211691	726	40.9	8658	8.39	11.2	210	2371	8.86
Naivasha	376243	10217	40.9	15388	66.39	11.2	2790	4214	66.21
Molo	542103	2319	40.9	22172	10.46	11.2	487	6072	8.02
Transmara	274532	9578	54	14825	64.61	10.1	511	2773	18.43
Bureti	494731	8319	46.9	23203	35.85	6.8	1372	3364	40.78
Narok	576388	5424	51.1	29453	18.42	8.3	992	4784	20.74
North Rift	4906441	69043	51.1	250719	27.54	9.3	15349	45630	33.64
Baringo	389329	2561	50	19466	13.16	9	522	3504	14.90
Keiyo	182875	3279	45.7	8357	39.23	7.7	667	1408	47.37
Koibatek	166232	4766	42.8	7115	66.99	9.6	647	1596	40.54
Nandi North	517943	4717	44.3	22945	20.56	10.6	1336	5490	24.33
Nandi South	157967	6588	44.3	6998	94.14	10.6	1298	7674	77.52
Samburu	223947	3110	52.1	11668	26.65	9.3	482	2083	23.14
Trans-Nzoia West	387366	13856	45.1	17470	79.31	9.3	3373	3603	93.63
Trans-Nzoia East	431391	823	45.1	79456	4.23	10.3	176	4443	3.96
Turkana	855399	5070	45.3	38750	13.08	8.1	974	6929	14.06
Eldoret West	391655	14067	42.2	16528	85.11	7.6	4565	2977	153.36
Eldoret East	502524	0	42.2	21207	0.00	8.6	0	4322	0.00
Marakwet	187123	2537	47.7	8926	28.42	8.2	355	1534	23.14
West Pokot	512690	7669	54.7	28044	27.35	11.4	954	5845	16.32
North Eastern	2310757	22145	48.6	112303	19.72	7.7	1449	17793	8.14
Garissa	530397	10435	47.7	25300	41.25	7.7	524	4084	12.83
Ijara	92663	790	47.7	4420	17.87	7.7	81	714	11.35
Mandera	1025756	8287	49.3	50570	16.39	7.3	320	7488	4.27
Wajir East	359923	2633	47.7	17168	15.34	6.7	380	2411	15.76
Wajir South	130070	279	47.7	6204	4.50	5.7	10	871	1.15
Total	**38610097**	**717988**	**34.8**	**1343631**	**63.44**	**9.72**	**216161**	**375290**	**57.60**

Registration Trend

Table 5 below shows the registration trend for the last five years. Registration of births has been increasing in total numbers from 455,264 in 2005 to 717,988 in 2009. However, registration of deaths has been fluctuating in the last five years from 203,579 in 2005 to 230,912 in 2006 and then down to 216,161 in 2009.

Table 5: Registration trend in the last five years

	Registered births	Registered deaths
2005	455,264	203,759
2006	590,004	230,912
2007	642,359	194,485
2008	680,112	199,567
2009	717,988	216,161

Figure 1: Graph Showing Registration Trends

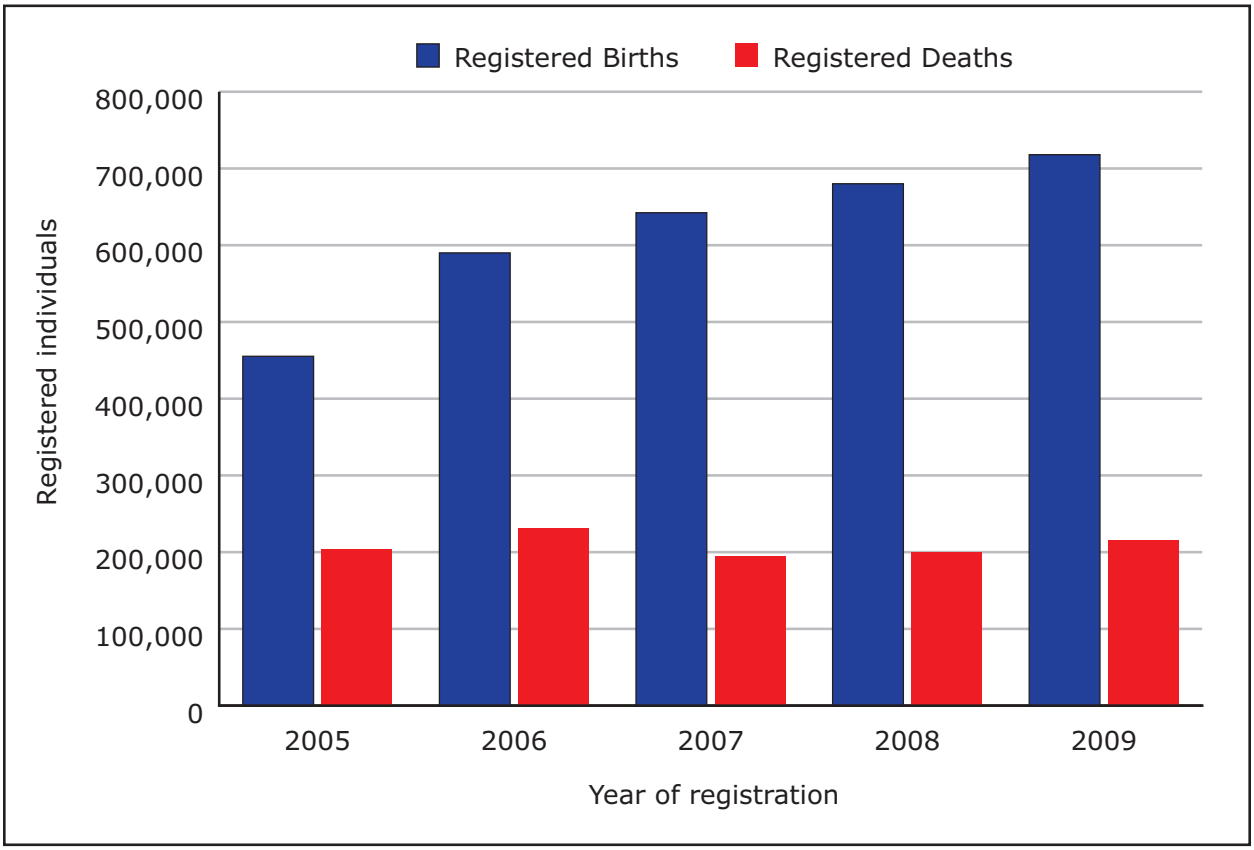
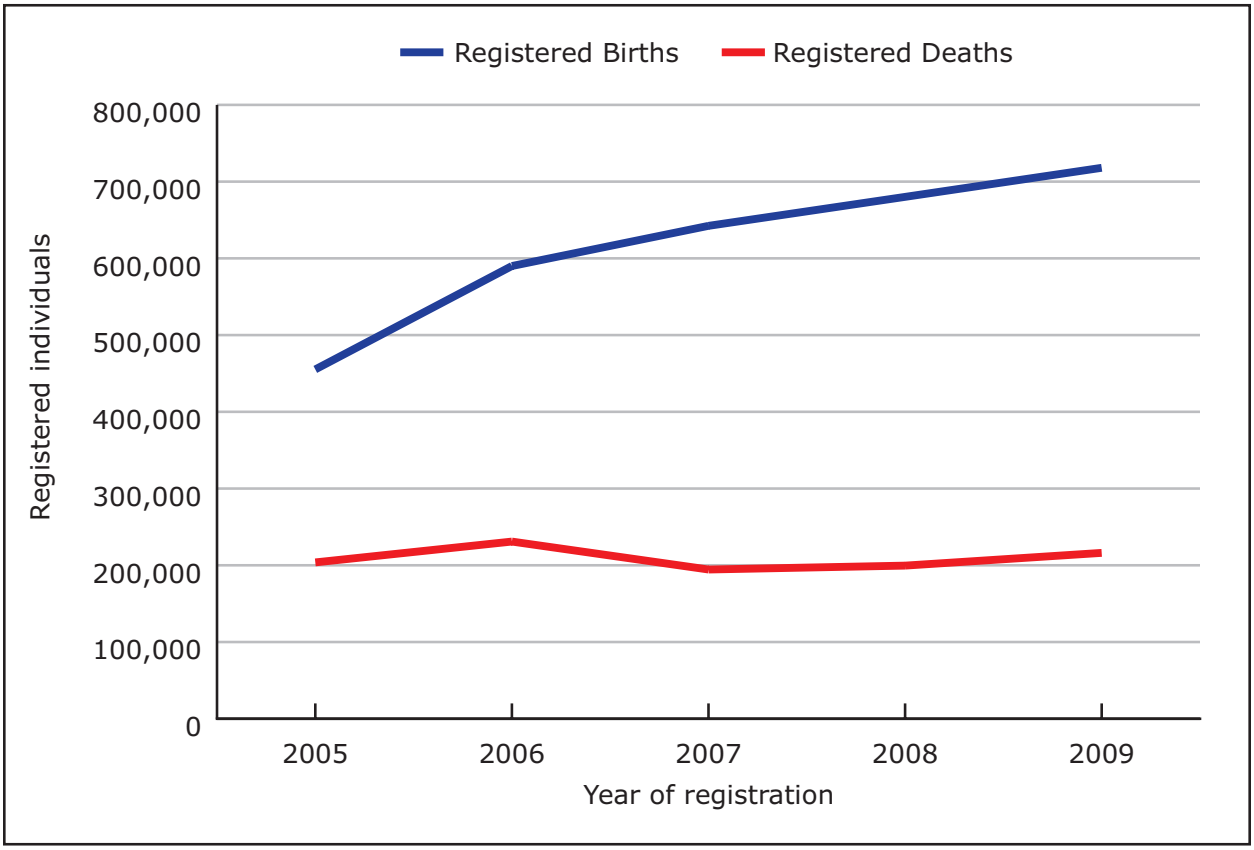


Figure 2: Chart Showing Registration Trends



Appendix K

Assessment of the 2009 South African Death Statistics from Civil Registration System Using the Framework Proposed by Mahapatra et. al. (2007)

Civil Registration And Vital Statistics Systems

Assessment of the 2009 South African Death Statistics

Table 2.5: Assessment of the 2009 South African death statistics

General vital statistics	
Criteria and indicators	**Measure**
Accuracy (%)	
Completeness of death registration	93%
Missing data	
Population group	26,2%
Province of birth	21,8%
Province of residence	10,0%
Age	0,2%
Sex	0,2%
Relevance	
Routine tabulations by sex and 5-year age groups	100%
Deaths in children under five years tabulated by 0 and 1-4 year age group	100%
Comparability	
Stability of key definitions over time	100%
Uniformity of definitions across areas	100%

Cause-of-death statistics	
Accuracy (%)	
Proportion of deaths that occurred in healthcare facilities	48,6%
Proportion of deaths assigned to symptoms and signs of disease not elsewhere classified	13,7%
Relevance	
Routine tabulation by sex and 5-year age groups	100%
Number of cause-of-death tabulation areas	9 Provinces and 52 district municipalities
Comparability	0,2%
Consistency of cause specific mortality proportions over consecutive years	100%
ICD coding for certification and coding of causes of deaths, revision used and code level to which tabulations are published	No coding for certification; coding causes of death using the tenth revision at 3-digit level
Timeliness	
Processing time	18 months
Mean time from end of reference period to publication	Two years
Accessibility	
Media – number of formats in which data are released	Two: website and compact discs
Metadata	Published with compact disc and available on request
Availability of user service	Email: info@statssa.gov.za / Tel: 012 310 8600 / Fax (012) 310 8500 / 8495

Statistics South Africa. Mortality and causes of death in South Africa, 2009: Findings from death notification. Statistical release P0309.3. (p16)

Appendix L

Suggested Indicators for Monitoring Progress in National Civil Registration and Vital Statistics Systems

Civil Registration And Vital Statistics Systems

Suggested Indicators for Monitoring Progress in National Civil Registration and Vital Statistics Systems

From: Improving the Quality and Use of Birth, Death and Cause-of-Death Information: Guidance for a Standards-Based Review of Country Practices, World Health Organization, May 2010, Annex C

Table C1 Suggested indicators

Inputs

- Budgets of the civil registration and vital statistics systems
- Human resource component of these budgets
- Number of staff doing registration duties

Processes

- Access to civil registration (see Box 3.3 in main text)
- Availability of civil registration (number of registration points)
- Number and percentage of hospitals with registrars in situ
- Completeness of birth registration, nationally and by region
- Completeness of death registration, nationally and by region
- Medically certified deaths as a percentage of total deaths annually
- Number and percentage of civil registration points that report late (i.e. after scheduled date)
- Percentage of all registration offices linked by computers to central level

Outputs

- Time lag between data collection and publications (years)
- Number of tables provided to the UN Demographic Yearbook (the UN asks countries to provide 30 tables on fertility and mortality for this publication)
- Ill-defined causes of death as a percentage of all deaths annually
- Cancer deaths assigned to ill-defined site as a percentage of all cancer deaths annually
- Cardiovascular deaths assigned to ill-defined causes as a percentage of all cardiovascular deaths annually
- Injury deaths assigned to undetermined causes as a percentage of all injury deaths
- Infections and parasitic disease deaths assigned to septicaemia as a percentage of all infectious and parasitic deaths

Activity Materials

The following materials are provided for completion of select activities included throughout the slide sets. Materials are provided for the following activities:

Analysis Of Vital Statistics Data: Exercise Worksheets for Select Indicators

Analysis Of Vital Statistics Data: Analysis Activity–South Africa Example

Data Uses And Dissemination: Data Comparison Activity

Data Uses And Dissemination: Vital Statistics Report Review

Assessing Vital Statistics: Data Quality Review Prompts

Analysis of Vital Statistics Data: Exercise Worksheets for Select Indicators

Civil Registration And Vital Statistics Systems

Analysis of Vital Statistics Data

Exercise Worksheets for Select Indicators

Total Fertility Rate (TFR):

Steps 2 and 3. Calculate and sum the age-specific birth rate (ASBR).

Mother's Age Group	2000 Live Births (Bx)		2000 Female Population (Px)				ASBR
10–14	300*	÷	165,00	X	1,000	=	
15–19	11,000	÷	179,000	X		=	
20–24	20,000	÷	192,000	X		=	
25–29	22,000	÷	222,000	X		=	
30–34	20,000	÷	213,000	X		=	
35–39	10,000	÷	212,000	X		=	
40–44	2,000	÷	210,000	X		=	
45–49	500*	÷	200,000	X		=	
						ASBR sum:	0

Step 4. Multiply the ASBR sum by 5.

TFR = ASBR Sum x 5 = 0

*For groups 10-14 & 45-49, births to ages < 15 and 45+ are used.

Direct Age-Adjustment

Step 2. Calculate age-specific rate for each age group.

	State A					State B		
Age Group	# of Deaths		Population Counts		Age-Specific Rate	# of Deaths	Population Counts	Age-Specific Rate
Under 1	0	X	84,952	=		0	350	
1-4	0	X	325,508	=		0	1,266	
5–14	2	X	828,663	=		0	4,384	
15–24	2	X	893,809	=		0	4,526	
25–34	19	X	718,484	=		0	2,977	
35–44	61	X	810,632	=		1	4,269	
45–54	160	X	833,948	=		0	5,581	
55–64	297	X	602,768	=		1	5,985	
65–74	443	X	381,451	=		11	5,946	
75–84	546	X	235,030	=		6	4,086	
85 +	369	X	82,660	=		3	1,584	
All Ages	1,899	X	5,797,906	=		22	40,952	

Steps 2 and 3. Multiply age-specific rate for each age group by weight. Sum the products.

	State A					State B		
Age Group (years)	**Age-Specific Rate**		**WHO Standard Pop Weight**		**Age Adjusted Rate**	**Age-Specific Rate**	**WHO Standard Pop**	**Age Adjusted Rate**
Under 1	0	X	0.018	=	0			
1–4	0	X	0.07	=		0	0.07	
5–14	0.24	X	0.173	=		0	0.173	
15–24	0.22	X	0.167	=		0	0.167	
25–34	2.64	X	0.155	=		0	0.155	
35–44	7.52	X	0.138	=		23.43	0.138	
45–54	19.19	X	0.114	=		0	0.114	
55–64	49.27	X	0.083	=		16.71	0.083	
65–74	116.14	X	0.052	=		185.01	0.052	
75–84	232.31	X	0.024	=		146.85	0.024	
85 +	446.41	X	0.006	=		189.45	0.006	
All Ages				(sum)	0			0

Indirect Age-Adjustment (Standardized Mortality Ratio)

Step 1. Calculate number of expected deaths in population.

Age Group	**National (Standard) Population Death Rate per 100,000**		**District A Population (#)**			**Expected Deaths (rounded)**
0	5.3	X	154,585	/100,000	=	
1-4	25.6	X	607,984		=	
5-14	14.1	X	1,585,503		=	
15-24	69.2	X	1,440,136		=	
25-34	83.6	X	1,528,427		=	
35-44	156.5	X	1,616,982		=	
45-54	373.2	X	1,337,298		=	
55-64	770.5	X	872,216		=	
65-74	1,822.10	X	527,629		=	
75-84	4,626.50	X	365,602		=	
85+	11,873.40	X	138,471		=	
All Ages					(sum of expected deaths)	0

Analysis of Vital Statistics Data: Analysis Activity South Africa Example

Civil Registration And Vital Statistics Systems

Analysis Activity–South Africa Example

Vital Statistics Formulae

- Crude birth rate among residents
  = total resident live births/ total population x 1,000
- Sex ratio at birth among residents
  = # of resident male live births / # of resident female live births x 100 (or 1,000)
- Percent low (very low) birth weight
  = # of resident live births < 2,500 (1,500) grams / # of resident live births X 100
- Percent of premature (or preterm) births
  = # of preterm (<37 weeks) live births / # of live births x 100
- Age-specific birth rate
  = # of resident live births to women in a specific age group / # of women in the same age group X 1,000
- General fertility rate
  = # of resident live births / # of females aged 15-49 x 1,000
- Total fertility rate
  = sum of the age-specific birth rates (5-yr age groups between 10 & 49) for female residents of a specific area during a specified period, multiplied by 5
- Crude death rate
  = # of resident deaths / total population x 100,000
- Age-specific death rate
  = # of resident deaths in specified age group / total population in same specified age group x 100,000
- Cause-specific death rate
  = # of resident deaths from a specific cause / total population in same specified age group x 100,000
- Infant mortality rate
  = # of infant deaths / # of live births x 1,000
- Neonatal mortality rate
  = # of neonatal (0-28 days) deaths / # of live births x 1,000
- Post-neonatal mort. rate
  = # of post-neonatal (29-364 days) deaths / # of live births x 1,000

- Maternal mortality rate
  = # of resident maternal deaths / # resident live births x 100,000

- Pregnancy-related mortality rate
  = # of resident pregnancy-related deaths / # resident live births x 100,000

- Years of potential life lost
  = Difference between a predetermined end point age (usually 75 years) and the age at death for a death or deaths that occurred prior to that end point age

Table 1: 2009 Mid-year population estimates by population group, sex, and age group

Age (years)	African/Black	Coloured (Mixed Race)	Indian/Asian	White	Total
			Male		
0-4	2,210,825	203,095	50,002	132,658	2,596,580
5-9	2,224,240	204,195	46,159	138,610	2,613,204
10-14	2,227,526	2 02,827	50,963	153,205	2,634,521
15-19	2,193,234	198,332	54,863	165,195	2,611,624
20-24	2,046,229	184,079	60,900	159,035	2,450,243
25-29	1,777,557	177,676	64,470	146,037	2,165,740
30-34	1,546,832	182,621	55,896	140,201	1,925,550
35-39	1,230,764	173,563	45,349	147,241	1,596,917
40-44	814,124	143,342	40,696	172,414	1,170,576
45-49	712,865	125,198	38,070	171,787	1,047,920
50-54	624,178	100,747	34,520	169,013	928,458
55-59	486,996	75,592	29,957	153,470	746,015
60-64	357,137	54,215	23,364	139,653	574,369
65-69	255,759	34,909	17,165	112,055	419,888
70-74	171,451	23,636	11,082	72,703	278,872
75-79	103,488	13,223	6,650	43,148	166,509
80+	68,292	8,263	4,482	38,629	119,666
				Total Male	24,046,652
			Female		
0-4	2,177,990	203,461	48,739	128,441	2,558,631
5-9	2,190,823	205,503	44,994	134,468	2,575,788
10-14	2,196,120	203,477	49,724	148,975	2,598,296
15-19	2,169,075	200,228	53,829	160,734	2,583,866
20-24	2,063,253	189,487	58,399	155,825	2,466,964
25-29	1,924,785	190,880	60,332	146,481	2,322,478
30-34	1,663,523	198,559	53,793	141,562	2,057,437
35-39	1,360,756	191,633	45,411	149,154	1,746,954
40-44	912,840	160,928	41,713	172,813	1,288,294
45-49	822,814	141,782	39,379	174,766	1,178,741
50-54	734,407	115,628	36,109	176,006	1,062,150
55-59	586,447	89,226	32,362	160,063	868,098
60-64	464,074	67,565	26,669	153,057	711,365
65-69	346,530	45,889	20,230	125,448	538,097
70-74	255,111	35,312	14,390	88,656	393,469
75-79	164,502	22,211	9,359	62,360	258,432
80+	122,339	16,014	7,460	73,289	219,102
				Total Female	25,428,162
				Total	49,474,814

Source: Statistics South Africa. Mid-year population estimates, South Africa (2009), derived from interactive time series data. Pretoria: Statistics South Africa. The methodology of the Stats SA projections can be downloaded from the Stats SA website.

Table 1A: 2009 Mid-year population estimates by population group, sex, and age group

Age (years)	African/Black	Coloured (Mixed Race)	Indian/Asian	White	Total
			Total		
0-4	2,210,825	203,095	50,002	132,658	5,155,211
5-9	2,224,240	204,195	46,159	138,610	5,188,992
10-14	2,227,526	202,827	50,963	153,205	5,232,817
15-19	2,193,234	198,332	54,863	165,195	5,195,490
20-24	2,046,229	184,079	60,900	159,035	4,917,207
25-29	1,777,557	177,676	64,470	146,037	4,488,218
30-34	1,546,832	182,621	55,896	140,201	3,982,987
35-39	1,230,764	173,563	45,349	147,241	3,343,871
40-44	814,124	143,342	40,696	172,414	2,458,870
45-49	712,865	125,198	38,070	171,787	2,226,661
50-54	624,178	100,747	34,520	169,013	1,990,608
55-59	486,996	75,592	29,957	153,470	1,614,113
60-64	357,137	54,215	23,364	139,653	1,285,734
65-69	255,759	34,909	17,165	112,055	957,985
70-74	171,451	23,636	11,082	72,703	672,341
75-79	103,488	13,223	6,650	43,148	424,941
80+	68,292	8,263	4,482	38,629	338,768
				TOTAL	49,474,814

Source: Statistics South Africa. Mid-year population estimates, South Africa (2009), derived from interactive time series data. Pretoria: Statistics South Africa.
A document describing the methodology of the Stats SA projections can be downloaded from the Stats SA website.

Table 2: Birth occurrences (as of 30 April 2010) by sex and citizenship, South Africa: 2005-2009

	Total			South African Citizens		
Year	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**
2005	1,033,695	519,971	513,724	1,033,600	519,921	513,679
2006	1,053,863	529,209	524,654	1,053,778	529,166	524,612
2007	1,027,386	517,002	510,384	1,027,299	516,959	510,340
2008	1,033,403	519,480	513,923	1,033,343	519,443	513,900
2009	937,531	471,827	465,704	937,495	471,804	465,691

Table 2A: Birth occurrences (as of 30 April 2010) by sex and citizenship, South Africa: 2005-2009

	Non-South African Citizens			Other*		
Year	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**
2005	59	30	29	36	20	16
2006	50	25	25	35	18	17
2007	40	23	17	47	20	27
2008	14	11	3	46	26	20
2009	6	5	1	30	18	12

*Other refers to those people whose citizenship was under investigation and had not yet been resolved on 30 April 2010.
Source: Statistics South Africa. Recorded live births, 2009. Statistical release P0305.

Table 3: Preterm births, South Africa: 2010

Live Births	1,059,000
Number of Preterm Births	84,800

Source: "National, regional and worldwide estimates of preterm birth rates in the year 2010 with time trends for selected countries since 1990: a systematic analysis and implications", Hannah Blencowe, Simon Cousens, Mikkel Z Oestergaard, Doris Chou, Ann-Beth Moller, Rajesh Narwal, Alma Adler, Claudia Vera Garcia, Sarah S Rohde, Lale Say, Joy E. Lawn. Estimates for World Health Organisation, 2012

Table 4: Number of deaths by age and sex, South Africa, 2009				
Age Group	**Male**	**Female**	**Unspecified**	**Total**
0–28 d	-	-	13,443	13,443
29–364 d	-	-	24,531	24,531
1–4 y	6,511	5,959	27	12,497
5–9 y	2,309	1,998	6	4,313
10–14 y	2,347	2,046	4	4,397
15–19 y	4,598	4,078	21	8,697
20–24 y	9,798	11,591	45	21,434
25–29 y	17,376	21,356	60	38,792
30–34 y	24,563	23,810	73	48,446
35–39 y	27,259	22,091	46	49,396
40–44 y	24,784	18,909	50	43,743
45–49 y	24,010	17,097	40	41,147
50–54 y	22,529	15,378	33	37,940
55–59 y	21,465	14,935	26	36,426
60–64 y	18,951	14,219	19	33,189
65–69 y	17,970	15,526	11	33,507
70–74 y	14,990	15,777	16	30,783
75–79 y	12,573	17,587	7	30,167
80–84 y	9,662	14,943	9	24,614
85–89 y	6,070	11,082	2	17,154
90+ y	5,196	11,572	0	16,768
Unspecified	858	308	123	1,289
Total	273,819	260,262	38,592	572,673

Source: Statistics South Africa. Mortality and causes of death in South Africa, 2009: Findings from death notification. Statistical release P0309.3.

Age-Specific & Age-Adjusted Death Rate Worksheet

- **To calculate the age-specific death rate, use the table below. Note that you may need to combine data for some age categories.**

Age	Population	Deaths	Age-specific Death Rate per 100,000
0-4			0
5-9			0
10-14			0
15-19			0
20-24			0
25-29			0
30-34			0
35-39			0
40-44			0
45-49			0
50-54			0
55-59			0
60-64			0
65-69			0
70-74			0
75-79			0
80+			0
Unspecified*			0

*Note: Deaths for which age is unspecified should be removed from the calculation. They should not be distributed across the other ages.

- **To calculate the age-adjusted death rate, we'll use the direct method of age standardization.**

1. Need standard population weights. Use the WHO Standard Population Weights in Table A. Note that the age categories in Table A differ from those from South Africa (Tables 1 & 4). Thus, we'll need to match categories across all data sources- see the matched categories in Table B.
2. Calculate age-specific death rate for each age group. Calculate the rates in Table B. First, complete columns 2 and 3, combining categories as needed. Then, calculate the age-specific death rate in column 4.
3. Multiply the age-specific death rate for each group by the weight. First list the appropriate weight in column 5 of Table B. Combine the weights as needed to match the age categories. Record the products in column 6.
4. Sum the products. Sum the age-adjusted death rates for each age group in column 6 of Table B.

Table A. WHO Standard Population

Age Group	Weight	World Avg. (%)
0	0.018	1.8
1–4	0.07	7.0
5–14	0.173	17.3
15–24	0.167	16.7
25–34	0.155	15.5
35–44	0.138	13.8
45–54	0.114	11.4
55–64	0.083	8.3
65–74	0.052	5.2
75–84	0.024	2.4
85+	0.006	0.6
All Ages	1.00	100.0

Table B.							
1	**2**	**3**	**4**		**5**		**6**
Age (years)	**# of Deaths**	**Population**	**Age-specific Death Rate per 100,000**	**X**	**WHO Standard Population Weight**	**=**	**Age-adjusted Death Rate**
0			0				0
1–4			0				0
5–14			0				0
15–24			0				0
25–34			0				0
35–44			0				0
45–54			0				0
55–64			0				0
65–74			0				0
					All Ages (sum of age-adjusted death rates)		0

Data Uses and Dissemination: Data Comparison Activity

Civil Registration And Vital Statistics Systems

Data Uses and Dissemination

Data Comparison Activity

Review the information presented in the international comparison of Maternal Mortality Ratio (European Perinatal Health Report, Table 6.1, Appendix G in Participant Notes).

Now review information about the sources of data used to generate the comparison for the following six countries.

1. Czech Republic
2. Malta
3. Netherlands
4. Poland
5. United Kingdom , England and Wales
6. Norway

Information on data sources, together with WHO recommended definitions, can be found in the following handouts:

- "Information on Data Sources" table (see below)
- Table 3.1 Lower limits of registration of stillbirths and live births (see below)
- WHO-ICD Definitions Handout (Appendix A in Participant Notes)

Using the criteria you learned for international comparisons of health-related data (slide set 6; see Checklist handout (Appendix F)), complete the following:

A. Comment on the strengths and weaknesses of the information presented.

B. What are the implications of these strengths and weaknesses on the interpretation of the results?

C. What additional information about the data would you like to have?

Use the Worksheet provided below to help compile your findings for A and B. Summarize your findings into a two-minute statement about the data used in this comparison. Share your findings and discuss with your classmates.

Optional: For additional information about the use of maternal mortality ratio as a health indicator, see: EURO-PERISTAT Project, with SCPE, EUROCAT, EURONEOSTAT. European Perinatal Health Report. Data from 2004. 2008. P 95-97. Available: www.europeristat.com.

Data Comparison Activity–Information on Data Sources

Country	Coverage	Source Name	Institution	Date	Data Type P=population H=hospital	Recorded Deaths C=cohort deaths P=deaths during year R=deaths registered in year
Czech Republic	$19,061.07	Central Statistics Office	Czech Statistical Office	2003-2004	P	P
Malta	$19,874.00	National Mortality Register	Department of Health Information	2003-2004	P	C
Netherlands	$34,181.87	Commission on Maternal Mortality	-	2003-2004	P	-
Poland	$13,146.01	Birth and death certificates	Central Statistical Office	2003-2004	P	R
UK England and Wales	$31,097.52*	Civil registration of births and deaths, ONS	Data analyzed and published by the Office for National Statistics	2004-2005	P	C,P,R
Norway	$46,387.00	Medical Birth Registry of Norway	Medical birth registry of Norway	2003-2004	P	C

Source: EURO-PERISTATA Project, with SCPE, EUROCAT, EURONEOSTAT. European Perinatal Health Report. 2008. Available: www.europeristat.com
*Income per person for all United Kingdom.

Data Comparison Activity–Information on Data Sources (continued)

Country	Coverage N=national R=regional S=sample	Completeness U=unknown	Participation C=compulsory V=voluntary U=unknown	Collection Procedures	Expansion Plans/Use of Data	Other Comments on Data Source
Czech Republic	N	100%	C	Where the deaths occur on death certificate	-	-
Malta	N	100%	C	The doctor certifying the death	-	Data since 1991 on computer
Netherlands	N	U	V	-	-	Notification by caregivers
Poland	N	100%	C	Medical part - medical person-nel; social part - local adminis-trator responsible for the regis-tration of birth/death	Polish birth and death certificate should be modified; however, both CSO and Ministry of Health are resistant to changes	-
UK England and Wales	N	100%	C	Local registrar of births, mar-riages and deaths for the Gen-eral Register Office	Birth records now linked to NHS Num-bers for Babies dataset which has addi-tional data items. Project for linkage to Maternity Hospital Episode Statistidcs, PEDW and Welsh Child Health system has been funded and is about to start	Published statis-tics do include births to mothers resident outside UK.
Norway	N	U	C	Hospital staff	Not at the current time	-

Source: EURO-PERISTATA Project, with SCPE, EUROCAT, EURONEOSTAT. European Perinatal Health Report. 2008. Available: www.europeristat.com
*Income per person for all United Kingdom.

Table 3.1 Lower limits of registration of stillbirths and live births

Country/coverage	Stillbirths	Lower limits for registration
Belgium		
Flanders	≥ 500 g	no limit
Brussels	≥ 22 weeks or ≥ 500 g	no limit
Czech Republic	≥ 22 weeks, official registration at 1000 g	≥ 500 g or any BW surviving first 24 hours
Denmark	≥ 22 weeks	no limit
Germany	≥ 500 g	no limit
Estonia	≥ 22 weeks or ≥ 500 g	no limit
Ireland	≥ 24 weeks or ≥ 500 g for civil registration, ≥ 500 g for the national perinatal register	No limit for civil registration, ≥ 500 g for the national perinatal register
Greece	≥ 28 weeks	na
Spain	no limit	no limit
Valencia	> 22 weeks	no limit
France	≥ 22 weeks or ≥ 500 g	≥ 22 weeks or ≥ 500 g
Italy	Registered at 180 days (25 weeks + 5 days), but fetal deaths at 24, 23, and 22 weeks are available in register of spontaneous abortions	no limit
Cyprus	No register of stillbirths	no limit
Latvia	≥ 22 weeks	Heartbeat present, GA or BW criterion not specified
Lithuania	≥ 22 weeks	≥ 22 weeks
Luxembourg	Official civil registration at 180 days (25 weeks + 5 days). For birth registry, recommendation is 28 weeks, but many nurses and doctors report babies with lower gestational age	Official civil registration at 180 days (25 weeks + 5 days). For birth registry recommendation is 28 weeks, but many nurses and doctors report babies with lower gestational age
Hungary	≥ 24 weeks	no limit
Malta	≥ 22 weeks or ≥ 500 g	No limit for National Obstetrics Information System, ≥ 22 weeks or ≥ 500 g for National Mortality Register ≥ 22 weeks or ≥ 500 g, if GA is unknown
Netherlands	≥ 22 weeks or ≥ 500 g, if GA is unknown	no limit
Austria	≥ 500 g	≥ 500 g
Poland	≥ 500 g	no limit
Portugal	≥ 24 weeks	no limit
Slovenia	≥ 500 g	no limit
Slovak Republic	≥ 22 weeks	no limit
Finland	≥ 22 weeks or ≥ 500 g	no limit
Sweden	≥ 28 weeks	no limit
United Kingdom	≥ 24 weeks is the legal limit, but voluntary notification at 22 and 23 weeks	≥ 12 weeks
Norway	≥ 12 weeks	

GA: gestational age; BW: birth weight; na: not available.

Data Comparison Activity - Worksheet

Use additional paper as necessary.

Criteria	Information Source	Comment on Strengths and Weaknesses	Implications
Data Quality			
Consistency			
Methodology			
Coverage			
Time period			

Criteria	Information Source	Comment on Strengths and Weaknesses	Implications
Choice of Countries			
Comparability			
Presentation & Interpretation			
Presentation			
Explanation			
Underlying differentials			
Context			

Data Uses and Dissemination: Vital Statistics Report Review

Civil Registration And Vital Statistics Systems

Vital Statistics Report Review

Review your vital statistics report and answer the following:

1. A good vital statistics report should include the sections listed below. Does this report include each of these sections?

    A. Preface & letter of transmittal

    B. Table of contents & lists of tables and figures

    C. Introductory & explanatory notes

    D. Summary highlights

    E. Mid–year population estimates (data used in computations)

    F. Statistics: natality / mortality

    G. Annex / appendix

        a. Details of national tabulation program

        b. Outlines of essential tables

        c. Technical notes & definitions

        d. Confidence interval calculation / table

2. What is the report's date of publication?
3. What is the time period covered by the data?
4. What is the difference between the date of publication and the date the data were reported? What can explain this difference?
5. What is the source of the data? Is there any missing/excluded data? If so, how is sing data handled?
6. Does the report include delayed and late registrations?
7. Does the report describe any methodological changes in how the vital events data were collected / coded / reported? If so, describe the changes.
8. The United Nations calls for "detailed annual tabulations for vital events cross classified by demographic and socioeconomic characteristics." What demographic and socioeconomic classifications are available in this report?

9. Annual vital statistics reports should include a variety of tabulations. Find an example of each of the following:
   - Time trends
   - Geographical differentials
   - Frequency distributions of vital events
10. Who are the likely users of this report? Do you think this report meets their needs?
11. Are original data files available to the public? If so, how can you access them?

Assessing Vital Statistics: Data Quality Review Prompts

Civil Registration And Vital Statistics Systems

Assessing Vital Statistics

Data Quality Review Prompts

Accuracy: Information on accuracy is likely to be contained in the introductory chapters and in technical notes on methods.

- **Coverage/Completeness**: Look for comment on coverage and the various measures of coverage errors in civil registration systems. Are data available from all regions in the country? Are there extreme changes in the number of events reported over time? What appear to be the reasons for any under-coverage observed? Look for the information on various comparisons between rates observed in similar populations or previous periods:
  - ♦ Vital statistics (# of events registered) in a given period with corresponding vital statistics in previous years
  - ♦ Vital statistics in a given period with population census or other estimates
  - ♦ Proportion of delayed registrations as an estimate of under-reporting in previous years
  - ♦ Portions of vital statistics with corresponding data collected through other means (i.e. fertility surveys)
  - ♦ Vital rates with corresponding rates for similar countries
  - ♦ Sex ratio at birth
- **Missing & Erroneous Data**: Are there missing or unknown items (e.g. missing sex or age). Are there zero cells in tables?
- **Use of ill-defined categories**: What percentage of deaths are classified as ill-defined/miscellaneous (for countries with medical certification of cause of death)? Is this less than 25% unknown?
- **Improbable classifications**: This information is likely corrected prior to publication. The technical notes may include comment on improbable classifications.

Timeliness: Review dates of data and date of publication. What is the average lag time? What is the shortest lag time? Is there information on the percentage of events that occurred in previous years?

Comparability: Are data comparable within the country? Do all registration areas use the same definitions? Are the data comparable to other countries? Does the country use ICD/WHO definitions?

Relevance: Are data available for sub-populations (e.g. race/ethnic, regions, urban/rural, age)? Are cross-tabulations provided for various sub-populations?

Accessibility: Are data available in any other format? Are user services available for questions or additional information requests? This information is likely contained in introductory sections or technical notes.

Assessing Vital Statistics: ANACoD—Analysing Mortality Levels & Cause-of-Death Data

Civil Registration And Vital Statistics Systems

Activity Guide (Participant Version)

About this mortality tool

The "Analysing mortality levels and causes-of-death" (ANACoD) electronic tool provides a step-by-step approach to enables users to quickly conduct a comprehensive analysis of data on mortality levels and causes of death. The tool automatically reviews the data for errors, tabulates the information, presents the results in the form of easy to use tables and charts, and provides the opportunity to compare the findings with those from other groups of countries.

Disclaimer

This tool is freely available for public use. However, requests for permission to translate or draw material from the tool should be addressed to WHO, Department of Health Statistics and information Systems, 20 Avenue Appia, 1211 Geneva 27, Switzerland, or emailed to healthstat@who.int. Responsibility for interpretation of the results of the use of the ANACoD tool lies entirely with the user. WHO cannot be held responsible for any misuse of the tool. Any use of the data currently integrated in the tool should be referenced as indicated therein.

In case of problems

For any questions on how to operate the tool, kindly send an email to mafatd@who.int stating the nature of the problems encountered, the Excel version used and your contact details and affiliation.

Suggested citation for the tool

World Health Organization (2013). Analysing mortality levels and causes-of-death (ANACoD) Electronic Tool, Version 1.1. Department of Health Statistics and Information Systems, WHO, Geneva, Switzerland.

References

AbouZahr C, Mikkelsen L, Rampatige R, Lopez A. Mortality statistics: a tool to improve understanding and quality. Health Information Systems Knowledge Hub, University of Queensland. Working Paper 13. Nov 2010.

World Health Organization (2013). Analysing mortality levels and causes-of-death (ANACoD) Electronic Tool, Version 1.1. Department of Health Statistics and Information Systems, WHO, Geneva, Switzerland.

Guided Interpretation of Tables and Figures

For each step, it is suggested that the participant click and review the information included in the ”Guidance” button at the top right of the each Excel worksheet (also available in the “ANACoD version 1.0 Guidance” handout). The following information provides supplementary guidance to interpreting the various tables and figures generated by ANACoD. Where noted, additional guidance on some points is provided in the University of Queensland Working Paper 13 on Mortality statistics: a tool to improve understanding and quality.

Quick Start

After downloading the zipped folder from the web site (http://www.who.int/healthinfo/anacod/en/), unzip and move the files to a directory on your hard drive. (Excel file provided for course: ANACoD version 1.1 2013Feb_blank.xls; save to your Desktop). The ANACoD tool is an Excel-based application with a size of about 7 MB once unzipped. Users are expected to have some basic Excel skills to operate the tool efficiently.

Use Excel to open ANACoD. Some Excel versions, particularly the latest ones will prompt a message to request macros to be enabled. Kindly ensure you have the macros enabled as instructed otherwise the tool will not work.

Input Data (Steps 0-1)

Step 0: Input Data

Go to sheet “step0-Input data”. Where the fields are marked in grey, it indicates that you need to select or input data. Start by:

- Selecting the country in row 4 (Colombia)
- Entering the year in row 5 (use format “XXXX”) (2009)
- Selecting the source of data in row 6 (Civil registration)
- Selecting the ICD level used in row 7 (ICD-10, 4-character codes)
    - ▶ Note that the “Income group” in row 8 auto-populates.
- Entering the source of population data in row 11 (any text format) (national registration office)

You need to have a cause-of-death data set prepared as in the format shown in sheet “step0-Input data”, row 19. The population data should be in the format as shown in row 13 of the same sheet. For the course, this Excel file is provided: Country Data_Anacod.xlsx. The file has two worksheets: “Population” and “Deaths.”

- From the "Population" worksheet, copy Cells 2B-3W and paste into the corresponding cells in Rows 14 and 15 of the ANACoD tool (step0).

    - Shortcut to copy cells: Click in cell 2B; click Ctrl+Shift+🡻; then click Ctrl+Shift+➔. Cells 2B-3W should all be highlighted. Click Ctrl+c to copy the cells.
    - In the ANACoD tool (step0), click in cell E14. Click Ctrl+p to paste the cells.
    - Cells 14D and 15D should automatically populate.

- From the "Deaths" worksheet, copy Cells 2B-4728Y and paste into the corresponding cells starting with Cell 20C in the ANACoD tool (step 0).

    - Shortcut to copy cells: Click in cell 2B; click Ctrl+Shift+🡻; then click Ctrl+Shift+➔. Cells 2B-4728Y should all be highlighted. Click Ctrl+c to copy the cells.
    - In the ANACoD tool (step0), click in cell C20. Click Ctrl+p to paste the cells.

Note that the oldest age-group for both the population and cause-of-death data could either be 85 years and above or 95 years and above. The tool will eventually aggregate them all to 85 years and above.

Note that the tool analyses only one year of data per country. For e.g. you are able to analyse data for country named "CCC" for year 2010. If you wish to analyse more than one year of data, you would need to run the tool several times and each time with the corresponding mortality and population data per year. The tool handles only mortality data as coded to either the 3 or 4 characters of the ICD-10.

For further information on the analyses contained in each sheet, click on the button "Guidance" located on the top right of each sheet.

If you notice you have entered the data wrongly and wish to start all over again, click on the button "Clear data" on the top right of the sheet "Step0-Input data". Only this sheet is intended for users to input data. The remaining sheets automatically generate results of all the step-by-step analyses.

Step 1: Basic check of input data

After inputting the data, click on sheet "Step1-check first". Wait for a few seconds before results will be shown in all the remaining sheets.

A summary of the analyses can be printed from sheet "Summary".

1. Population – The demographic table and population pyramid for the country/ year are automatically generated by ANACoD. We will discuss these further in Step 2.

2. Death

   a. Check total number of deaths (years) - Table 2.1 is checking to see if the total number of deaths reported from "all causes" from a country (rows 33-34) equals the sum of all the deaths that were reported by the individual ICD 10 codes (rows 36-37). All numbers in the third row of Table 2.1 (rows 39-40) should sum to "0". If something does not equal "0", Table 2.1 will give an indication of in which age group the country data are not consistent.

      Are the number of deaths from "all causes" consistent with the sum of all deaths reported by individual ICD 10 codes for this country?

   b. Distribution of total death

      Table 2.2: The number of deaths for "all ages" in Table 2.2 should equal the number of deaths for "all ages" listed in Table 2.1. However, the deaths for which age is missing or unknown (MUN column in Table 2.1) are distributed proportionally across all age categories in Table 2.2. Thus, the age-specific number of deaths in Table 2.2 may vary slightly from those in Table 2.1.

      The age distribution of reported deaths figure is another way of presenting the "Percentage of total deaths" column in Table 2.2. The distribution of total death is further explored in Step 4.

      The percentage of total deaths listed in Table 2.2 and age distribution of reported deaths (Figure 2.2) can quickly be reviewed for expected patterns:

      – Higher percentages in the 0 and 65+ age groups;

      – Higher percentages for males compared to females in the 15-64 age groups, due to a higher number of deaths attributed to external causes for males;

      – Higher percentages for females compared to males in the oldest age groups.

      Deviations from these expected patterns may indicate errors in age or sex information.

      Review Table/Figure 2.2 for this country. Do the data follow the expected patterns?

   c. Age-specific mortality rate – This table and figure are calculated from data entered in Step 0 and population data for the country. The age distribution of deaths is further explored in Step 4.

      A graph of the log mortality rates facilitates a quick visual test for abnormalities across age groups. Standard patterns observed in a graph of log mortality rates include:

      – Generally higher rates of male mortality compared to female mortality across all ages;

      – Lines that increase smoothly and linearly with age after about age 35.

Do the data in Table/Figure 2.3 follow expected patterns?

d. Deaths (in years) labelled with codes not valid for underlying cause of death according to ICD10 If data are entered correctly, all cells should contain a "0" or "0%," indicating that there are no deaths with ICD10 codes that should not be used for causes of deaths or that all codes used exist in ICD10. Click the "ICD10" button or the "ICD 10 list" sheet to see a list of valid ICD codes for underlying causes of death. Click the button "Go" to see column AB in sheet 'step0-Input data,' where non valid codes are (or would be) flagged. Are there any cells without a "0" or "0%".

e. Cause, age, sex specific check

   Are any deaths indicated in the upper left table, cells F111-117? Deaths in this column would indicate clearly incorrect causes of death, based on implausible sex/cause of death combinations.

   Are any deaths indicated in the lower left table, cells F122-132? Deaths in this column would indicate likely incorrect causes of death, based on diseases unlikely to cause death.

   Are any deaths indicated in the table to the right, cells O110-139? Deaths in this column would indicate likely incorrect causes of death, based on implausible disease/age combinations.

Mortality Levels Analysis (Steps 2-5)

Step 2: Crude death rates

The population pyramid presented at the top of the worksheet in Step 2 aids in understanding the population's age-sex structure, and thus helps in the interpretation of the CDR. Populations that have a high proportion of the population in age groups where mortality rates are highest (i.e., below 4 years and 60+ years) can be expected to have a higher CDR. The lower limit for the CDR in any country is around 5 per 1000; CDRs below 5 per 1000 should be considered suspicious. If the age distribution shown in the population pyramid suggests that a country should have a higher CDR, and the observed CDR based on a country's mortality data is suspiciously low, under-reporting of deaths and incomplete civil registration are expected. This observation may be further confirmed by the estimates of completeness of civil registration data, which are also included in Step 2. See the UQ Working Paper 13 for an additional explanation about trends in crude death rates.

Population Pyramid - What does the population pyramid tell us about the CDR for this country?

a. In what age group is the highest proportion of the population?
b. Is the mortality rate generally high or low for this population?
c. Based on the responses to a and b, do you expect the CDR to be high or low for this country?

Completeness of civil registration data – UN standards define a "good" level of completeness as ≥ 90%. How does this country rate?

Observed – the crude death rates, % annual rate of population growth, and life expectancy at birth are generated from data entered in Step 0 and UN population data sources.

Crude death rate per 1000 population: What is the crude death rate (CDR) for males, females, and both sexes in this population? Is this plausible?

a. Do the CDRs fall above, at, or below the lower limit of the expected CDR for any country?
b. Is this observation consistent with the expected CDR based on observations of the population pyramid?
c. Given the responses to a and b, are deaths likely under-, over- or appropriately reported in this country?
d. Is the reponse to c consistent with the reported completeness of civil registration data?

The CDR figures reported in Step 2 are used to compare expected crude death rates to observed crude death rates.

Expected crude death rates at different levels of life expectancy and population growth

Using the observed life expectancy at birth and % annual rate of population growth, determine the expected CDRs for males and females in the country.

a. Do the observed CDRs (based on the mortality data entered) under- or over-estimate the expected CDRs?
b. Is this observation consistent with the observed CDRs and registration completeness?

Step 3: Age- and sex-specific death rates

The tables show the calculated age-specific mortality rate (ASMR) for males and females. These calcultations are also presented in the ASMR graph (top left figure). See the UQ Working Paper 13 for an additional explanation about dealing with fluctuations in the ASMR due to small population numbers.

Using Figure 3 in the 'ANACoD verstio 1.0 Guidance' document as a reference, comment on the relative age patterns (not the comparison of the absolute levels of mortality) of the country's male and female ASMR patterns.

a. At what ages are the rates highest? (look at the ANACoD table and figure) Do these observations follow the expected patterns?
b. Is the expected exponential increase present after about 55 years?

c. Are there any unexpected bumps or dips for males or females? If so, what is a possible explanation?

Note the table listing male:female mortality ratio, which is calculated by dividing the male ASMR by the female ASMR. Using Figure 5 in the 'ANACoD version 1.0 Guidance' document as a reference, comment on the country's patterns in ratio of male to female ASMR. Note that the country's infant mortality rate was 16 per 1000 live births in 2010 (WHO Global Health Observatory).

a. Based on the morality ratio, do males or females have a higher mortality rate? Does this observation suggest that there is or is not likely to be sex discrimination in death registration?
b. At what ages is there a peak in the ratio? Is this consistent with the expected pattern shown in Figure 5 in the ANACoD version 1.0 Guidance' document? What does this peak likely indicate?
c. Is the magnitude of the peak greater or less than that in Figure 5? What does this likely indicate?
d. Are there any other differences between the observed ratio and the expected ratio in Figure 5? If so, what is a possible explanation for these differences?

Observe the patterns in the graph showing the log of age-specific mortality rates for the country compared to other country groupings. Recall from Step 1/2.3 above that a graph of the log mortality rates facilitates a quick visual test for abnormalities across age groups. The line should increase smoothly and linearly as age increases after about age 35.

a. Is the country's line (for males and females) generally higher, lower, or the same as that of other upper-middle income countries? Does this observation indicate that there is likely under-, over-, or appropriate reporting of deaths?
b. For what sex/age is the country's line above that of other upper-middle income countries? What may be an explanation for this observation?
c. Other upper-middle income countries show an increase in deaths in 0-4 years and a linear increase in deaths after age 40. Does this country show similar patterns?

Step 4: Review the age distribution of deaths

Step 4 facilitates a comparison of the age distribution of reported deaths for the country of interest to expected patterns observed from other countries in the same income group (the University of Queensland Working Paper 13 discusses comparisons to countries with similar levels of infant mortality).

Expected patterns in age-specific mortality rates include:

- Generally higher rates of male mortality compared to female mortality across all ages (except the oldest age group); for low income countries and countries with high infant mortality rates, female rates may be more comparable to male rates;

- A peak in both male and female mortality in the 0-4 age group and the oldest age groups; the peak in the 0-4 age group is generally less pronounced in high income countries and countries with low infant mortality rates; and the peak in the oldest age groups is less pronounced in low income countries and countries with high infant mortality rates;

- A peak in male mortality between the ages of 15 and 44, accounting for an increase in external causes.

A departure from the expected patterns may indicate selective bias in age-specific death reporting.

Compare this country's figure of age distribution of reported deaths to the figure for the corresponding income level. Do the figures show similar patterns? What might be possible reasons for departures from the expected pattern?

a. Are male deaths general higher than female deaths as expected? Are there any exceptions? If so, are these exceptions expected?
b. A peak in the 0-4 and 80+ age groups for males and females is expected. Does this country have these expected peaks?
c. A peak in male mortality between the ages of 15 and 44 is expected. Does this country have this expected peak? If so, how does the magnitude of the peak compare to that of other upper-middle income countries? What are possible explanations?

Step 5: Child mortality rates

Infant and Under-Five Mortality Rates from the reported data are automatically calculated in Step 5. To interpret the Under-Fiver Mortality Rate, Step 5 refers users to www.childmortality.org to generate a graph comparing the country's Under-Five Mortality Rate, as measured by various data sources, including the census, surveys, and vital registration data. If access to the internet is available, complete the following steps to generate the graph for Columbia:

- Go to www.childmortality.org; click on "Country Data" in the upper-right menu; select "Colombia."
- In the upper-left of the screen, select the "Under-Five Mortality Rate" drop down menu; select "Under-Five Mortality Rate". The graph should appear.

- Check if the trend line (a solid blue line) is showing in the graph. If it is not showing, select the "View" drop down menu in the upper-right of the screen; check "Trend Line".
- Hover over the data points to identify the source of data for each line in the graph. How does the "vital registration" data line compare to the other data lines? Does this observation suggest that the is under-, over-, or appropriate reporting?

For additional information on ways to measure incompleteness of death reporting, see Step 5 in the ANACoD guidance document and the UQWP13.

Causes Of Death Analysis (Steps 6-10)

Step 6: Distribution of death according to the Global Burden of Disease list

In Step 6, from the data entered in Step 0, ANACoD shows the number of deaths assigned to the various ICD codes by sex and by age. A second table starting in row 173 shows the redistribution of deaths from 1) unknown age (despite incorrect title indicating redistribution of deaths from unknown sex), and 2) ill-defined diseases. In rows 184-186, this table shows the proportion of total deaths distributed to Groups 1, 2, and 3 after redistribution for both unknown age and ill-defined diseases.

Using Table 2 in the ANACoD Guidance document as a reference, compare the distribution of the country data to the expected distribution according to life expectancy.

- Use an independent data source (i.e., not the civil registration data) to determine Colombia's life expectancy. The WHO Global Health Observatory is recommended: http://apps.who.int/gho/data/node.main.3?lang=en.
- Are there any groups with significant differences between the expected and observed distributions? If so, are these differences consistent with previous findings?

Step 7: Age pattern of broad groups of causes of death (Distribution of major causes of death)

Compare the figures automatically created for the distribution of broad cause of death groups by age for males and females to the expected patterns shown in the figures for the corresponding income level. Do the observed data follow the expected data? Explain potential reasons for any differences observed.

a. For males, does the pattern for communicable diseases (Group I) follow the general expected pattern? Are there any age groups for which the distribution is higher or lower than expected? What are possible explanations for these differences?

b. For males, does the pattern for non-communicable diseases (Group II) follow the general expected pattern? Are there any age groups for which the distribution is higher or lower than expected? What are possible explanations for these differences?

c. For males, does the pattern for external causes (Group III) follow the general expected pattern? Are there any age groups for which the distribution is higher or lower than expected? What are possible explanations for these differences?

d. For females, does the pattern for communicable diseases (Group I) follow the general expected pattern? Are there any age groups for which the distribution is higher or lower than expected? What are possible explanations for these differences?

e. For females, does the pattern for non-communicable diseases (Group II) follow the general expected pattern? Are there any age groups for which the distribution is higher or lower than expected? What are possible explanations for these differences?

f. For females, does the pattern for external causes (Group III) follow the general expected pattern? Are there any age groups for which the distribution is higher or lower than expected? What are possible explanations for these differences?

Step 8: Leading causes of death

Compare the tables automatically created for the distribution of cause of death categories to the expected patterns shown in the tables for the corresponding income level. Does the order of leading causes for the observed data follow that of the expected data? Explain potential reasons for any differences observed. Also, comment on the percentage of ill-defined causes observed for this country.

Step 9: Ratio of non-communicable to communicable causes of death

In the automatically-generated figure, compare the ratio of non-communicable to communicable disease for Colombia to that of countries in the same income grouping (upper middle). Explain potential reasons for any differences observed. Is this observation consistent with previous findings?

Step 10: Ill-defined causes of death

Review the table that has been automatically populated with the proportion of deaths assigned to ill-defined causes for each age/sex category. Note which categories have >10% ill-defined. Comment on any trends/patterns. Then look at the pie chart that describes specific causes to which ill-defined deaths have been assigned. What recommendations would you make for an improvement program?

List of References

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Volume 1. Tabular List

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In addition to the references listed above, many other documents on all aspects of civil registration and vital statistics are available on the web sites for the United Nations http://www.un.org/en/ and the World Health Organization http://www.who.int/en/.