

## Module 2 Concepts in Mortality

### 1. Introduction

In this module, the learning objective is to grasp the basic concepts of mortality, mortality rates, crude and specific rates. The definitions of these concepts have been given along with their illustrations. Many of these concepts are standard definitions that are used across the world, although they might differ by the multiplier number, example 1000 or 100,000.

### 2. Death: Concept and definition

Death is considered to occur *after live birth*. The measurement of mortality begins after live birth (Prakasam 2017). It is usually expressed in terms of deaths per 1000 live births of a population.

According to the United Nations (2017), death is defined as,

“...the permanent disappearance of all evidence of life at any time after live birth has taken place...”, where the definition of death does not include foetal deaths or deadborn foetus.

Data on mortality is often recorded in terms of deaths by place, by time and by cause. Organisations such as the World Health Organisation (WHO) which provide data on mortality, are based on national data on mortality from different countries as per the deaths registered by the civil registration systems in the different countries.

The underlying cause of death is identified by the national authority and a code is assigned in conjunction with international classifications such as the guidelines developed in the International Classification of Diseases ICD -10. Underlying cause of death as per the International Classification of Diseases is defined as:

“the disease or injury which initiated the train of morbid events leading directly to death, or the circumstances of the accident or violence which produced the fatal injury” (WHO 2017).

#### 2.1. Live Birth

Since death occurs after live birth, and death is measured in terms of number of live births in a population, it is important to know the definition of live birth.

The United Nations defines live birth as,

“..the complete expulsion or extraction from its mother of a product of conception, irrespective of duration of pregnancy, which after such separation, breathes or shows any evidence of life, such as beating 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 Live Born..” (UN 2017).

According to this definition of life birth, and the definition of death, a death that occurs prior to live birth is not counted as a death as per the measures of mortality. Therefore, abortion and still births, defined below, are referred to as foetal loss or foetal deaths, occurring prior to live birth.

Given below is the definition for foetal death and abortions.

#### 2.2. Foetal Death

According to the United Nations (2003),

“a foetal death is a death prior to the complete expulsion or extraction from its mother as product of conception, irrespective of duration of pregnancy; and after such separation, the foetus does not breath or show any other evidence of life, such as beating of heart, pulsation of the umbilical cord or definite movement of voluntary muscles..”

#### 2.3. Early Foetal Mortality (also known as Miscarriages and Abortion):

Early Foetal Mortality is mortality that occurs before the twentieth week of the gestational life. It is also referred to as miscarriages or abortion. The definition of abortion is given below:

Abortion is defined as (United Nations 2003):

“...any interruption of pregnancy before 28 weeks of gestation with a dead foetus. There are two major categories of abortion: spontaneous and induced. Induced abortions are those initiated by deliberate action undertaken with the intention of terminating pregnancy; all other abortions are considered as spontaneous.”

#### 2.4. Intermediate Foetal Mortality:

Mortality that occurs between the twentieth and twenty eighth week of the gestational life is known as intermediate foetal mortality (UN 2010). That is, it is after the Early Foetal Mortality and before the late Foetal Mortality.

#### 2.5 Late foetal mortality (also known as Stillbirth):

Mortality after twenty eight weeks of gestational life is known as late foetal mortality, also referred to as still birth. It is birth not having any signs or symptoms of life after cutting the umbilical cord (separation) from mother (IIPS N.D.)

##### 2.5.1. Equation for Stillbirth Ratio

The equation to calculate the stillbirth ratio is as follows:

$$\text{Stillbirth ratio} = \frac{\text{Number of stillbirths}}{\text{Total live births}} \times 1000$$

##### 2.5.1.1. Example 1 using Stillbirth ratio (GOI 2015)

The example below discusses Stillbirth ratio for Greater Bombay in 1989.

The Still birth ratio for Greater Bombay for year 1989 may be computed as follows:

Total number of still births in 1989 = 6174

Total live births = 209325

Therefore, the Still birth Ratio for greater Bombay for 1989 =  $\frac{6174}{209325} \times 1000 = 29.49$

##### 2.5.2. Equation for Stillbirth rate

$$\text{Stillbirth rate} = \frac{\text{Number of stillbirths}}{\text{Live births} + \text{Stillbirths}} \times 1000$$

##### 2.5.2.2. Example 2 using Stillbirth rate (GOI 2015)

The following example depicts the use of the stillbirth ratio with data for Greater Bombay, 1989

The Still birth rate for Greater Bombay for year 1989 may be computed as follows:

Total number of stillbirths, 1989 = 6174

Total live births = 209325

Therefore, the Still birth Rate for greater Bombay for 1989 =  $\frac{6174}{209325 + 6174} \times 1000 = 28.64$

### 2.5.3 Difference between the Stillbirth Rate and the Stillbirth Ratio

The difference between the two is in the denominator. In the equation for the stillbirth ratio, the number of stillbirths is divided by the total number of live births, while in the equation for the stillbirth rate, the number of stillbirths is divided by the combined total of live births and still births. Both are multiplied by 1000. As the number of stillbirths is divided by a bigger denominator in the stillbirth rate (live births + still births), the result thus yields a lower figure, as compared to the stillbirth ratio, where the denominator is live births.

### 2.6. Neo-natal Mortality Rate:

Mortality in the *first year of life* is frequently divided into neonatal mortality and post neonatal mortality. Neonatal mortality rate is defined as,

“..the number of deaths of infants under 4 weeks of age (28) days or under 1 month of age during a year per 1,000 live births during the year..”

Post neonatal mortality rate is defined as,

“.. the number of infant deaths at 4 through 51 weeks of age or 1 through 11 months of age during a year per 1000 live births during the year..”

(Shyrock, Siegel and Associates 1980)

#### 2.6.1. Neo-natal Mortality:

The mortality of live-born before completing four weeks or 28 days of life is known as neo-natal mortality.

The equation to calculate neonatal mortality is as follows:

$$\text{Neonatal mortality rate} = \frac{\text{Number of deaths between 0-4 weeks of life}}{\text{Total number of live births in that year}} \times 1000$$

##### 2.6.1.1. Example for Neo-natal mortality (GOI 2015)

The Neonatal mortality rate for Greater Bombay for year 1989 may be computed as follows:

Total number of deaths (between 0-4 weeks) during 1989 = 6673

Total number of registered live births during 1989 = 209325

Therefore, the neonatal Mortality Rate for greater Bombay for 1989 =  $\frac{6673}{209325} \times 1000 = 31.87$

#### 2.6.2. Post neo-natal Mortality:

The mortality of live-born after 28 days after birth, but before reaching the age of one year is called post-neo-natal mortality.

The equation is as follows:

$$\frac{\text{Number of Deaths between one month to one year of life}}{\text{Total number of live births in that year}} \times 1000$$

Total number of live births in that year

##### 2.6.2.1. Example for Post neo-natal mortality (GOI 2015)

The post neonatal mortality rate for Greater Bombay for year 1989 may be computed as follows:

Total number of deaths (1-4 year) during 1989 = 4121

Total number of registered live births during 1989 = 209325

Therefore, the Post neonatal Mortality Rate for greater Bombay for 1989 =  $\frac{4121}{209325} \times 1000 = 19.68$

Or

$$\begin{aligned} \text{Post Neonatal mortality rate} &= \frac{4121}{209325} \times 1000 \\ &= 10794.6673 / 209325 \times 1000 = 19.68 \end{aligned}$$

## 2.7. Perinatal Mortality:

Perinatal mortality refers to,

“Deaths between the periods of seven months of gestation (**still birth**) to the first week of life. The Perinatal mortality rate is defined as the number of deaths during the Perinatal period (the sum of late foetal deaths and early neonatal deaths) occurring in a community during specified year expressed as per 1000 of the sum of live births and still births during the same year.” (GOI 2015)

$$\text{Perinatal mortality ratio} = \frac{\text{Stillbirths} + \text{Early Neonatal Deaths}}{\text{Live births} + \text{still births}} \times 1000$$

Still births

$$\text{Perinatal mortality rate} = \frac{\text{Stillbirths} + \text{Early Neonatal Deaths (0 to one week)}}{\text{Live births} + \text{still births}} \times 1000$$

Live births + still births

## 2.8. Child Mortality:

### 2.8.1 Infant Mortality

The mortality of live born under one year of age is known as infant mortality

Infant Mortality Rate: (IMR) is defined as,

“the number of infant deaths occurring in a community within a specified calendar year per 1000 live births in the same community during the same calendar year.” (GOI 2015)

It is a good indicator of the health status of a given area or population, since it tends to reflect the population’s socio-economic condition and status of health services. It can be calculated as follows:

$$\text{IMR} = \frac{\text{Number of deaths of infants under age 1 in a given year and area}}{\text{Total live births in same year and area}} \times 1000$$

### 2.8.2 Under 5 Mortality

Mortality occurring to children below age 5 is known as under 5 mortality.

The Under-five mortality rate is defined as the probability of death occurring between birth and age 5 (exact) for every per 1,000 live births in a given geographical area (UNDP 2016)

The equation is given as follows:

$$\frac{\text{Deaths occurring to children under the age of 5 in a particular area in a given year}}{\text{Total live births in the same year and area}} \times 1000$$

## 2.9. Maternal Mortality

Maternal death is defined as,

“the death of a woman while pregnant or within 42 days of termination of pregnancy irrespective of the duration and site of the pregnancy, from any causes related to, or aggravated by the pregnancy or its management, but not from accidental or incidental causes..” (WHO 2018)

Given below are two equations, one on the maternal mortality rate, and the second on the maternal mortality ratio. The differences are outlined after the equation.

$$\text{Maternal Mortality Rate} = \frac{\text{Number of maternal deaths* in age group 15–49 in a given year and area}}{\text{Number of women in age group 15–49 in that year and area}} \times 100,000$$

$$\text{Maternal Mortality Ratio} = \frac{\text{Number of maternal deaths* in age group 15–49 in a given year and area}}{\text{Number of live births in that year and area}} \times 100,000$$

### 2.9.1. Difference between the two measures

One can observe that there is a basic difference in the two measures of Maternal Mortality given above. In the first measure, Maternal Mortality Rate, the numerator is a part of the denominator, Whereas, in Maternal Mortality Ratio, the numerator is not a part of the denominator

## 2.10. Crude Death Rate (CDR)

The simplest measure of mortality is the “Crude death rate (CDR); It is given by the equation

$$\text{Crude Death rate} = \frac{\text{Number of deaths during the year in a given Geographic area}}{\text{Mid-year population in the same year and same area}} \times 1000$$

### 2.10.1 Example using the CDR (GOI 2015)

The CDR for Greater Bombay for year 1989 may be computed as follows:

Total number of deaths during the year 1989 = 73469

Total population at the middle of the year i.e., midyear population during 1989 = 8243405

Therefore, the CDR for greater Bombay for 1989

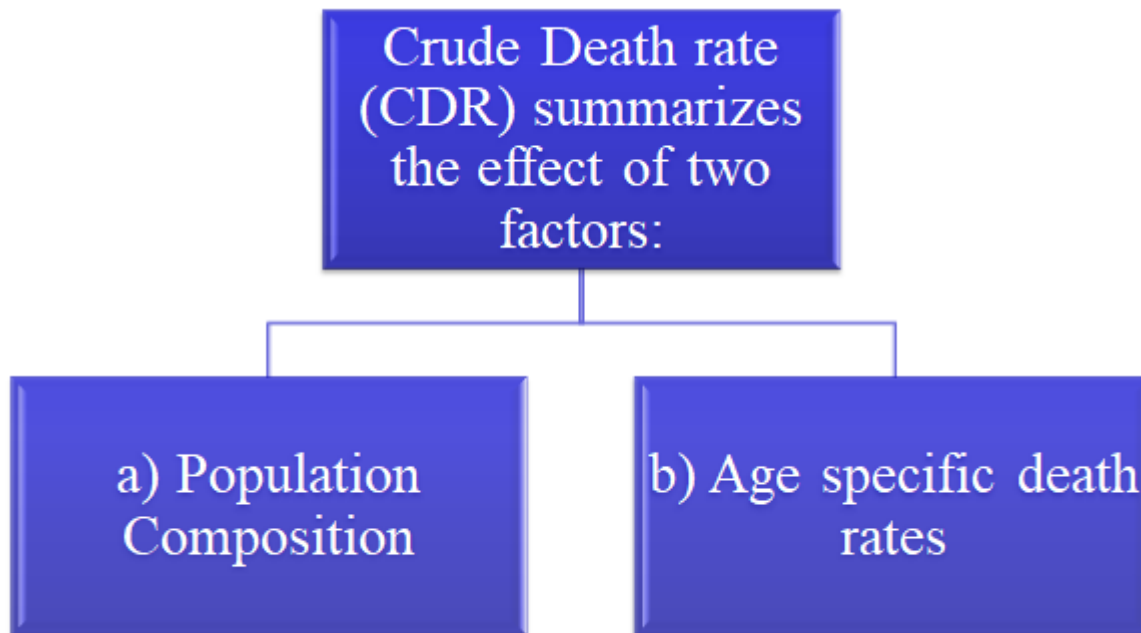
$$= \frac{73469}{8243405} \times 1000 = 8.9$$

### 2.10.2. CDR: Summary of two factors

Crude Death rate (CDR) summarizes the effect of two factors (GOI 2015):

- a) Population Composition and,
- b) Age specific death rates

**Figure 1: Crude Death Rate, the summary of two factors**



Source: Data from above

That is, every population has a considerable amount of heterogeneity with many different sub-groups. Thus, a summary measure such as the crude death rate summarises the specific values for these sub-groups that comprise the population, by weighting them by size, wherein the weights chosen are such that they enable comparisons to be drawn. The larger the sub-group is, the more weight it will have on the overall measure. However, it must be noted that summary measures such as the crude death rate mask information, such as the heterogeneity of the population.

An example is of a population with five age groups, and each of these age groups have a certain number of people. The following year will see some of each group experiencing a certain number of deaths. The crude death rate then becomes the summary measure of the mortality rates of each of these sub-groups, weighted by the size of the sub-group. As there is a strong link between mortality and age, the mortality rates within each sub-group will widely differ, which the summary measure does not explicitly reflect (Schoenbach 1999).

### 2.10.3. CDR Limitation

One problem with CDR is that it does not take into account the age structure of the population, due to which it is called a *crude* measure.

If a comparison is drawn between the death rates of two countries with very different age structures, then drawing conclusions about health status based on the compared crude death rates may be misleading. A more valid comparison of the crude death rate for two countries is drawn when the crude death rates are

recalculated by assuming the same age structure for the two populations through what is known as methods of standardisation, which allows for a common base (Indrayan N.D.).

Hence Crude death rate is a “*crude*” measure. Correcting crude death rates is needed towards addressing the limitation of completeness of registration of deaths. That is, in many developing countries, the data on mortality is incomplete in the sense that not all deaths are registered, and also there may be under-enumeration of population, data inaccuracies and other limitations to the data.

If satisfactory estimates of under-registration of deaths and under-enumeration of population are available, CDR may be adjusted with a correction factor according to the formula given below:

$$\text{Correcting CDR} = \frac{\text{Deaths / Percentage of completeness of registration of deaths}}{\text{Deaths / Percentage of completeness of the census count (population count)}}$$

### 2.11. Age Specific Death Rates (ASDR) (GOI 2015)

Death rates at specific ages of the age structure of the population is calculated with the equation given below:

$$\text{Age specific death rate (ASDR)} = \frac{\text{Number of deaths in a particular age group}}{\text{Number of persons living in that age group}} \times 1000$$

Age specific death rate for the age group 15-19 in a geographical area in a give year is given by:

$$\frac{\text{Number of deaths in the age group 15-59 years}}{\text{In a given year and in a given geographic area}} \times 1000$$

$$\frac{\text{Mid-year population of persons in the age group 15-59}}{\text{In same year and in a given geographic area}}$$

The Age Specific Death Rates can be calculated for the age groups 20-24, 25-29, 30-34, 35-39, 40-44, 45-49 and other age groups as per available data about deaths in the particular age group considered and the mid-year populations in the same age group for any given region.

The Age specific rates, if taken for two areas or for the same area at two different time periods, can provide an adequate comparison of the health status in two areas or at two times for that particular age group.

#### 2.11.1 Example using ASDR

In a given year, say 2006, the ASDR in the age group of 5-14 years was 1.0 in **Peru**. On the other hand, it was only 0.08 in **Sweden** per 1000 population in that particular age group. That is, the rate in Peru was 10+ times, which indicates a qualitative difference in deaths between the two countries, Peru and Sweden (Indrayan N.D.)

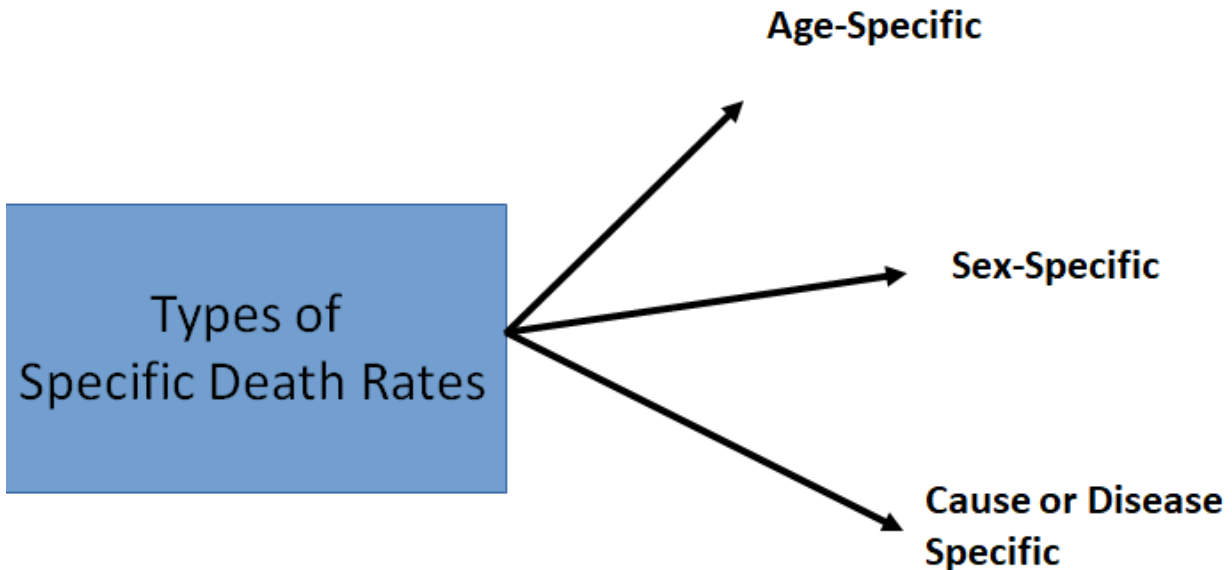
Specific death rate is calculated for:

1. Age-specific,
2. Sex-specific and

3. Cause or disease specific

viz: tuberculosis, cancer, accident etc.

**Figure 2: Types of Specific Death Rates**



Source: Data from above

Rates can also be made specific for many other variables such as income, religion, caste, housing etc., which help to identify at risk groups (Prakasam 2017)

**2.12. Cause specific death rate**

The cause specific death rate is calculated using the equation given below:

**Cause Specific Death Rate**

= Number of deaths due to a particular cause in a given year x 1000  
 and in a given geographic area

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 Mid-year population in same year and given geographic area

(Cause may be Cancer, TB etc)

Example using the Cause Specific Death Rate:

Say, a 10,000 deaths due to Disease A occurred in Town R (mid year population 100,000) in 2004. Then, the cause specific death rate can be calculated as:

$$\frac{10,000}{100,000} \times 1000 = 100$$

**2.13. Sex-specific death rate =**

The sex-specific death rate is calculated using the equation given below:



$$\frac{\text{Number of Male deaths  
In a given year and in a given geographic area}}{\text{Mid-year male population in same year  
And in a given geographic area}} \times 1000$$

Example using the sex-specific death rate:

Suppose in Town B, there were 400 male deaths in 2009. The midyear population in the same year for Town B in 2009 was 18,000.

Therefore, the sex-specific death rate can be calculated as:

$$\frac{400}{18,000} \times 1000 = 22.2$$

#### 2.14. Sex-Age-cause specific death rate:

Death rates that are specific to cause, age and sex is given by the equation below:

$$= \frac{\text{Number of deaths due to a specific cause in a particular age group in a region by sex}}{\text{Number of population in that age group in the region exposed to the specific cause by age and sex}} \times 1000$$

Number of population in that age group in the region exposed to the specific cause by age and sex

The denominator of cause specific death rate can be refined as,

“persons suffering with particular cause, according to availability of data.

Example using the formula for sex-age-cause specific death rate

In Town K, there were 8800 deaths due to disease J amongst males between the ages of 15-29 in 1996. The population of males between ages of 15-29 in the same town in 1996 was 500,000.

Therefore, the sex-age-cause specific death rate can be calculated as:

$$\frac{8800}{500,000} \times 1000 = 17.6$$

### 3.Summary

In this module, you would have become familiar with some of the basic concepts used in the study of mortality, as well as with the equations used in calculation of these concepts. These include definitions ranging from death and live birth to maternal mortality and infant mortality. You would also have learnt the different rates and ratios involved in the study of mortality, such as the maternal mortality rate and the maternal mortality ratio, and also noted is the difference between the two in a basic way. Further, examples have been given to depict how these concepts are used in application with some data. The content in this module should enable further reading for other modules in this paper, as well as for more further reading into these concepts.

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