1. Introduction & Crude Death Rate

Welcome to the series of E-learning modules on Measurement of Mortality – Crude, Specific and Standardized Death Rates, Infant Mortality Rate.

By the end of this session, you will be able to:

- Explain the measurement of Mortality such as:
  - Crude Death Rate
  - Specific Death Rate
  - Standardized Death Rate
  - Infant Mortality Rate

Let us start with an introduction.

The word "mortality" came from the Latin word "mors" (death). Mortality rate is the death rate. Mortality rate is a measure of the number of deaths (in general, or due to a specific cause) in a population, scaled to the size of that population, per unit of time.
Mortality rate is typically expressed in units of deaths per 1000 individuals per year.

There are a number of different types of mortality rates, examples are as following:

- The fetal mortality rate: The ratio of fetal deaths to the sum of the births (that is, the live births + the fetal deaths) in that year
- The infant mortality rate: The number of children dying under a year of age divided by the number of live births that year
- The maternal mortality rate: The number of maternal deaths related to childbearing divided by the number of live births (or by the number of live births + fetal deaths) in that year

The following are the principal rates used in measuring mortality,

- Crude Death rate (CDR)
- Specific Death Rate (SDR)
- Age Specific Death Rate (Age-SDR)
- Infant Mortality Rate (IMR)
- Standardized Death Rates (STDR)

Let us discuss about crude death rate:

The crude death rate is the total number of deaths per year per 1000 people.
The crude death rate depends on the age and gender specific mortality rates and the age and gender distribution of the population.
The number of deaths per 1000 people can be higher for developed nations than in less-developed countries, despite life expectancy being higher in developed countries due to standards of health being better.

The Crude death rate is the simplest of all the indices of mortality and is defined as the number of deaths per k-persons in the populations in the given region or community during a given period.
Thus, in particular, the annual crude death rate denoted by 'm' for any region or community.

It is given that, 'm' is equal to Annual deaths divided by Annual mean population into 'k', where 'k' is equal to thousand usually.
The crude death rate for any period gives the rate at which the population is depleted through deaths over the course for the period.

It includes following merits:

i. It is simple to understand and calculate
ii. It is perhaps the most widely used of any vital statistical rates
iii. It is an index of mortality used in numerous demographic and public health problems
iv. It is a probability rate giving the probability that a person belonging to a given population will die in the given period as the entire population of the region is exposed to the risk of mortality

Following are the demerits:

- The most crucial drawback of the crude death rate is that it completely ignores the age and sex distribution of the population
    - Experience shows that mortality is different in different segments of the population
    - The older generation are exposed to higher risk of mortality as compared to younger people
- Moreover mortality rate is also different for females irrespective of age groups than their male counterparts
- Crude death rate is not suitable for comparing the mortality in two places or same place into periods unless ,
    i. The population of the places being compared have more or less the same age and sex distribution or
    ii. Two periods are too distant since in a stable large community age-sex structure of the population shows very little change

It is to be noted that the crude death rate for males and females can be calculated separately.

The crude death rate for males in a given region for a given period is calculated using the formula Crude death rate for Males is equal to Male deaths(^{m}D) divided by Male population (^{m}P) into thousand.

Similarly, Crude death rate for Females is equal to female deaths (^{f}D) divided by female population (^{f}P) into thousand.

Crude death rate usually lies between Eight and Thirty per thousand.
Female death rate is generally less than Male death rate.

2. Specific Death Rate

Let us now discuss about specific death rates.

In order to arrive at a more useful figure than the crude death rate, we must take into account the fact that the mortality pattern is different from different segments of the population. The various segments generally considered are Age, Sex, Occupation, Religion, Community, Social status etc.

For example,

The people engaged in Infant and child welfare work would be interested to know the mortality conditions in the age group below 1 year, 1 to 4 years, 5 to 9 years, etc.

Those engaged in maternal health programs would like to know the number of deaths occurring amongst women in reproductive period (usually 15-49 years)

i. Insurance authorities would be interested in the mortality pattern at different ages of the population

ii. Investment banks might be interested in the mortality pattern of people belonging to a certain age group with a certain social standing or in a specific community

Death rate computed for a particular period specific to the section of the population is termed as specific death rate.
Specific death rate for a given geographical regions during a given period is calculated as, specific death rate is equal to Total number of deaths in the specified section of the population in the given period divided by the Total population of the specified section of the given period into ‘k’ .
Where, ‘k’ is equal to thousand.

Usually specific death rate is computed to specific age and sex. Age specific death rates mathematically formulated as number of deaths amongst the persons with age ‘x’ or more but less than ‘x’ plus ‘n’ in a given region during a given period‘t’.

The total population of the Age group ‘x’ to ‘x plus n’ is denoted by $({}_nP_x)$.

Then, the age specific death rates for the age group ‘x’ to ‘x plus n’ is denoted by $({}_nm_x)$ and is calculated by Number of deaths in the age group ‘x’ to ‘x plus n’ divided by Total population of the age group ‘x’ to ‘x plus n’ into thousand.

Taking ‘n’ is equal to 1, we get the annual age specific death rate as Age specific rate is equal to the Deaths in the age group ‘x’ to ‘x plus n’ by population of the age group ‘x’ to ‘x plus n’ into thousand.

To be more specific, the age specific death rate for males is given by the formula, age specific death rate of males for the age group ‘x’ to ‘x plus n’ is equal to Male deaths in the age group ‘x’ to ‘x plus n’ divided by Total male population of the age group ‘x’ to ‘x plus n’ into Thousand.

Similarly, the age specific death rate for females is given by the formula; female age specific death rate is equal to the Number of Female deaths in the age group ‘x’ to ‘x plus n’ divided by Total Female population in the age group ‘x’ to ‘x plus n’ into Thousand.

Both these formulas give the death rates specific to age and sex.

Specific death rates reveal more facts about various segments of the population than the crude death rate, that is, if the death rate is high in a specific age group than old age, preventive measure can be taken depending on the situations, thus, specific death rates are extremely helpful in planning and research.

It includes following merits:

i. The Age specific death rate has overcome the drawbacks of the crude death rate since they are computed by taking into consideration the Age and Sex composition of the population
ii. It eliminates the variations in the death rates due to Age-Sex distribution of the population and provides a more appropriate measures of the relative mortality situations of the region
iii. The Age specific death rates is one of the most important and widely applicable type of death rates
iv. It also supplies one of the essential components required for computation of Net reproduction rates and construction of life table

Following are the demerits:

- However, specific death rates are not of much use for overall comparison of mortality conditions prevailing in two regions A and B
- It will not be possible to draw general conclusions regarding the overall mortality pattern in region A as compared to region B
- In order to draw valid conclusions the different age or sex specific death rates must be combined to give a single figure which will reflect the true picture of the mortality of the region
- In addition to age and sex, distribution of the population, social, occupational and topographical factors come into operations causing what is called Differential Mortality and specific death rates completely ignores these factors

3. Infant Mortality Rate

Let us discuss about the infant Mortality Rate.

The Infant mortality rate is defined as the chance of dying of a newly born infant within a year under a given mortality conditions.

The infant mortality rate during the calendar year 'z' is calculated by Considering the number of deaths among the children between the age group zero to one divided by the Total number of live births denoted in the same region within the same calendar year.

Where,
I of z of n=The infant mortality rate during the calendar year 'z'.
D of z of n=Number of deaths among the children between age group 0 -1 .
B of z of zero =Total number of live births within the same calender year z.

Points to be noted are.

The infant mortality rate and age specific death rate for Age zero (0) have the same numerator.
However, the denominated in the age specific death rate at Age Zero includes all the infants up to the age below 1 year.

It includes following merits:

- The infant mortality rate is regarded as a more useful measure of Infant mortality as compared to Age specific death rate for Age Zero
- The other advantage of Infant mortality rate is that it does not require the data of population census or estimates
- The Infant mortality rate can be obtained for any population, any region provided that the data for infant deaths or live births for that period are available
- The infant mortality rate is regarded as a very sensitive index of the health condition of a community or country and reflects any changes in its health standards since the infant mortality rate is very responsive to any improvements made in the environment and medical conditions

Following are the demerits:

i. The Infant mortality rate has a serious drawback due to the under registration of live births
ii. As the definition of Live births and still births vary from country to country and for the same country from time to time. It is difficult to define Infant Mortality Rate
iii. Quite often infants who are born alive but die immediately after birth are recorded as dead. This results in under registration of live births and over registration of infant deaths leading to an overstatement of Infant Mortality Rate than its actual value
iv. Thus, by improving the Birth registration system we can lower the Infant Mortality Rate without saving a single life

In the last 15-20 years, we have seen a steady decline in the infant mortality rates due to improvement in environmental and medical conditions.

In addition to education of mothers, increasing the general awareness of child care, health and hygiene play an important role in reducing the IMR.

4. Standardized Death Rate

Let us now discuss the standardized death rate.

In the Crude death rate and Age specific death rate, there are certain draw backs in the formulation of the calculations since the age distributions of the populations between two regions are not identical.
To remove this draw back it was suggested to use the same set of weights for computing the weighted average of the age related Specific Death Rate. Such an adjusted death rate is known as Standardised death rate.

For example, the crude death rates in terms of age specific death rates of two regions A and B are given,

Age specific male death rates for region A is calculated by age specific death rates for region A divided by age specific population rate for region A into thousand
That is, Age specific male death rates for region A is calculated by summation of age specific male death rates for region A in the age group x to x+n into age specific population rate for region A in the age group x to x+n divided by Summation of age specific population rate for region A in the age group x to x+n .

Similarly, Age specific male death rates for region B is calculated by age specific death rates for region B divided by age specific population rate for region B into thousand

These expressions are the weighted arithmetic means of the age-SDR, the weights being the corresponding populations in the age groups.

Standardisation of death rates can be done in multiple ways but we focus on the following two methods that are popular and lead to reasonable accurate results. Direct method of Standardisation and Indirect method of Standardisation.

Let us discuss about direct method of standardisation.

In any standardization method weighting of age specific death rates is done using the corresponding population of the area to which they refer.
However, the Direct Method consists of weighting the age specific death rates by the population distribution of another region chosen as a standard.

Thus, if P_x to the power s is the number of persons in the age group ‘x’ to ‘x+1’ in the standard population, then, the standardized death rates for the regions A and B are given respectively by,

Standardized death rates for the regions A is equal to summation of age specific male death rates for region A in the age group x to x+n into number of persons in the age group x to x+n divided by Summation of number of persons in the age group x to x+n.
Standardized death rates for the regions B is equal to summation of age specific male death rates for region B in the age group x to x+n into number of persons in the age group x to x+n

divided by Summation of number of persons in the age group x to x+n.

If you notice, age adjusted death rates for both the regions A and B are the Crude death rates that would be observed in the standard population if it were subject to the age specific death rates of the region A and B.

Note: The death rate may similarly be adjusted for other factors like sex, rate, etc. and interpreted accordingly.

It includes following merits:

- Standardised death rates are easily understandable and easy to calculate
- Age adjusted death rates are comparable since they eliminate the differences caused by the different distributions of the age specific population for regions A and B. Differences in these death rates gives a true picture of the differences in mortality in the two regions

Following are the demerits:

i. The choice of standard population concept is a major drawback as it affects the magnitude of the resulting adjusted rates and might change the relative positions with respect to each other
ii. However, in the calculations, if we take the standard population as the actual population for the larger region of which the two said regions A and B used in the calculations are a sub set, the above drawback can be removed

Let us now discuss about indirect standardisation.

In normal calculation of standardized death rates we need to know the numbers of persons and age-specific death rates for different age groups.
However, in reality though we might have the population count classified by age, total number of death and crude death rate but the actual age related specific death rate might not be known or available. In such cases we use the Indirect Standardisation method.

The Indirect Standardisation method which consists of:

Multiply the Crude death rate of a region A by the adjustment factor C where ‘C’ is the measure of the ‘relative mortality’ that the population is prone to in that region.

Crude death rate is equal to summation of age specific male death rates for region A in the age group x to x+n into age specific population rate for region A in the age group x to x+n divided by Summation of age specific population rate for region A in the age group x to x+n.

Standardized death rates for the regions A is equal to summation of age specific male death rates for region A in the age group x to x+n into number of persons in the age group x to x+n divided by Summation of number of persons in the age group x to x+n.

Therefore, C is equal to summation of age specific male death rates for region A in the age group x to x+n into number of persons in the age group x to x+n divided by Summation of number of persons in the age group x to x+n divided by summation of age specific male death

rates for region A in the age group x to x+n into age specific population rate for region A in the age group x to x+n divided by Summation of age specific population rate for region A in the age group x to x+n.

Since, m_x to the power a data values are not known, we obtain an approximate value of C by replacing m_x to the power a by m_x to the power s.

Thus, the Standardised Death rate using Indirect standardization method can be arrived at as, C cap is equal to summation of number of male death person in the age group x to x+n into number of persons in the age group x to x+n divided by summation of number of persons in the age group x to x+n which is whole divided by summation of number of male death person in the age group x to x+n into age specific population rate for region A in the age group x to x+n divided by age specific population rate for region A in the age group x to x+n .

The point to be noted are:

i. We should not be comparing the Direct and Indirect method of standardization
ii. The two methods are equivalent if the age specific death rate for a given population is proportional to the Specific Death rate of the standard population
iii. The Indirect method is used as an approximation of the Standard method only when data for the direct standardisation is not available or unknown

- Both Direct and Indirect methods of standardization have their own pitfalls and disadvantages
- Both methods do not account properly for the mortality index obtained based on the age-sex composition of the standard population used.
- They also do not account for the gains (or losses) in mortality reduction obtained at younger or older age

5. Example

Let us take an example to understand the measurement of mortality. In this example, let us compute the crude and standardized death rates of the two populations A and B, regarding A as standard population from the data.

Figure 1

Age groups (yrs)	A		B	
	Population	Deaths	Population	Death
Under 10	20,000	600	12,000	372
10 -20	12,000	240	30,000	660
20 - 40	50,000	1250	62,000	1612
40 – 60	30,000	1050	15,000	525
Above 60	10,000	500	3,000	180

In the table,
The first column represents the age group ‘x’.
The second column represents the population of A for age ‘x’.
The third column represents the deaths in population A at age ‘x’.
The fourth column represents the population of B for age ‘x’.
The fifth column represents the deaths in population B for age ‘x’.

Solution is as follows:

Let us calculate the Crude Death Rate and the Standard Death Rate for the given data for which we prepare the table.

Figure 2

Age groups (yrs)	A			B			
	Population (P_x^a)	Deaths (D_x^a)	Death Rate Per 1000 (m_x^a)	Population (P_x^b)	Death (D_x^b)	Death Rate Per 1000 (m_x^b)	(m_x^b) (P_x^a)
Under 10	20,000	600	**30**	12,000	372	**31**	**6,20,000**
10 -20	12,000	240	**20**	30,000	660	**22**	**2,64,000**
20 - 40	50,000	1250	**25**	62,000	1612	**26**	**13,00,000**
40 – 60	30,000	1050	**35**	15,000	525	**35**	**10,50,000**
Above 60	10,000	500	**50**	3,000	180	**60**	**6,00,000**
Total	**1,22,000**	**3,640**		**1,22,000**	**3,349**		**38,34,000**

In the table, the first column represents the age group ‘x’ ,the second column represents the population of A for age ‘x’, the third column represents the deaths of population A at age ‘x’, in the fourth column we will calculate the death rate per 1000 which is equal to 30, 20, 25, 35, and 50.

The fifth column represents the population of B for age ‘x’, the sixth column represents the deaths in population B for age ‘x’ the seventh column represents the death rate of population B per 1000 which is equal to 31, 22, 26, 35, 60.

And in the last column, we will take the product of the death rate of the population B and the population A for age ‘x’ we will get 6,20,000, 2,64,000, 13,00,000, 10,50,000 and 6,00,000 with a total of 38,34,000.

In the next step, let us calculate the Crude Death Rate and the Standard Death Rate.
The Crude Death Rate is equal for population A is equal to summation x death rate of population a divided by summation x population of A into 1000 is equal to 3 thousand 640 divided by 1 lakh 22 thousand into 1000 is equal to 29.8.

Similarly, for population B we calculate the Crude Death Rate by considering summation x of deaths of population B divided by summation x of population B into 1000 is equal to 3 thousand 349 divided by 1 lakh 22 thousand into 1000 is equal to 27.4.

Next we will calculate the Standard Death rates for both the population.
The Standard Death rates for population A is equal to Crude Death Rate of population A which is equal to 29.8.
(Since population A is taken as standard population) the Standard Death rates of population b is equal to summation of the product of the death rate of the population B and the population A for age ‘x’ divided by summation of population A which is equal to 38 lakh 34 thousand divided by 1 lakh22 thousand is equal to 31.4.

Look at this table for comparison.

Figure 3

Particulars	Population A	Population B
Crude Death Rate	29.8	27.4
Standard Death Rate	29.8	31.4

The Crude Death Rate of population A is 29.8 and population B is 27.4 whereas the Standard Death Rate of population A is 29.8 and population B is 31.4
Thus, we can conclude that the death rate in population B is greater than population A.

Here’s a summary of our learning in this session, where we have understood:

- The Measurement of Mortality such as,
    - Crude Death Rate
    - Specific Death Rate
    - Standardized Death Rate
    - Infant Mortality Rate