# Module 6: Demography

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# Overview

- **Vital Statistics**
- **Uses of Vital Statistics**
- **Mortality Rates**
- **Birth or Fertility Rates**
- **Population Growth Rates**

- **Vital Statistics:** Vital statistics means data or methods of studying vital events such as births, deaths in a population. By vital (important) events we mean important events such as birth, death, marriage, divorce, illness occurring in human life.

- **Sources of obtaining Vital Statistics**

  There are three methods of obtaining vital statistics.

  1. Registration Method.
  2. Census Method.
  3. Sample Survey Method.

- 1. **Registration Method:** The registration method is the most important method of obtaining vital statistics. In most of the countries vital statistics are registered and maintained by the government. It is compulsory to register the birth, death and marriage.

**2. Census Enumeration :** In almost all countries in the world census is carried in every 10 years. Various information of an individual regarding like age, sex, education, marital status, occupation, religion etc is collected during census depending.

**3. Sample Surveys:** When up-to-date information is required or where registration of death and births is not reliable, sample surveys are conducted. In a sample survey, a part of the population selected is studied. From the sample using proper statistical methods, we can estimate the characteristics of the population. National sample survey conducts such surveys.

- **Population Measurements:** Then the population at any time *t* is given by

$$P_t = P_e + (B - D) + (I - E)$$

Where, $P_0$ = Total population at last census

B = Total births during last census to time t

D = Total deaths during last census to time t

I = Total immigrants during last census to time t

E = Total emigrants during last census to time t.

- **Measurement of Mortality:**

**(a) Crude Death Rate (C.D.R.):** The annual Crude Death Rate is defined as the ratio of number of deaths in a given period to the total population.

$$C..D.R. = \frac{Total\ annual\ deaths}{Total\ Population} x1000$$

C.D.R. generally lies between 3 to 23 per thousand.

The C.D.R. does not take into account the age group or the sex. Generally, the proportion of deaths in the age group 0 to 10 and above 60 *i.e.* child death and old age death is much larger in comparison to the proportion of deaths in the remaining age group *i.e.* in the age group 10 to 60.

The Crude Death Rate can be used to compare the mortality at the same place at different times if the periods are not separated far away.

- **(b) Specific Death Rates (S.D.R.):** Crude Death Rate gives us a general picture of mortality situation at a given place in a given year. If we want more information about mortality such as mortality in a specific age group or sex or locality, Specific Death Rates are calculated.

$$S.D.R = \frac{Total\ number\ of\ deaths\ in\ specified\ section\ of\ population\ in\ given\ period}{Total\ Population\ in\ specified\ section\ in\ given\ period} x1000$$

Of all the Specific Death Rates Age Specific Death Rates are highly useful and more commonly used. They are very important for life insurance companies for fixing the premiums.

$$Age\ S.D.R. = \frac{Total\ number\ of\ deaths\ in specified\ age\ group\ in given\ period}{Total\ Population\ in\ specified\ age\ group\ in given\ period} x1000$$

We observe that the A.S.D.R. is very high in the first year of the child, then it slowly decreases as age increases, reaches a minimum, remains more or less steady for some period say upto the age of 45 and then it again increases.

**(c) Infant Mortality Rate (1.M.R):** Infant mortality rate *i.e.* the Age Specific Death Rate of babies before completing the first year is defined as

$$I.M.R. = \frac{Total\ number\ of\ deaths\ before\ completing\ one\ year}{Total\ number\ of\ live\ births\ during\ the\ year} x1000$$

**(d) Standardized Death Rate :** Age SDR is useful for age-wise comparisons of mortality of two populations or years. But it may happen that ASDR for one population is higher in some age group than that of other age group. Thus we need a unique representative value of all SDR's. This can be obtained using weighted average of SDR's. Here to compare two SDR's a 3rd population is taken as a standard population.

There are two methods of calculating Standardized Death Rates. They are (i) Direct Method, (ii) Indirect Method.

**(i) Direct Method:** Let $P_i^s$ = Standard Population of $i^{th}$ age-group

$m_i^a$ = Age SDR of $i^{th}$ age-group of Population A

$m_i^b$ = Age SDR of $i^{th}$ age-group of Population B

then Standardized Death Rate (STDR) of population A is given by

$$STDR_A = \frac{\sum m_i^a P_i^s}{\sum P_i^s}$$

and (STDR) of population B is given by

$$STDR_B = \frac{\sum m_i^b P_i^s}{\sum P_i^s}$$

**(ii) Indirect Method:** If the Age Specific Death Rates of the population are not available, Standardized Death Rate (S.T.D.R.) cannot be calculated. In such cases, under certain assumptions approximate value of S.T.D.R. can be obtained by multiplying C.D.R. by an "adjustment factor" defined as follows

$$C = \frac{\sum m_i^a P_i^s}{\sum P_i^s} / \frac{\sum m_i^a P_i^a}{\sum P_i^a}$$

Thus STDR = C * $CDR_{(A)}$

But generally $m_i^a$ are unknown & hence we replace $m_i^a$ by $m_i^s$ and estimate the value of C & denote it by $\hat{C}$

$$\hat{C} = \frac{\sum m_i^s P_i^s}{\sum P_i^s} \Big/ \frac{\sum m_i^s P_i^a}{\sum P_i^a}$$

Thus STDR = $\hat{C}$ * $CDR_{(A)}$

Ex. 1. Obtain STDR for the population A and B by direct method

| | Population A | | Population B | | | | | |
|---|---|---|---|---|---|---|---|---|
| Age-groups | No. of persons (Pi) | Deaths ($D_i^a$) | No. of persons ($P_i^s$) | Deaths ($D_i^a$) | $m_i^a$ | $m_i^a P_i^s$ | $m_i^b$ | $m_i^b P_i^s$ |
| 0-10 | 600 | 18 | 400 | 16 | 18*1000/600 = 30 | 1200 | 40 | 16000 |
| 10-20 | 1000 | 5 | 1500 | 6 | 5*1000/ 1000 = 5 | 7500 | 4 | 6000 |
| 20-60 | 3000 | 24 | 2400 | 24 | 24*1000/ 3000 = 8 | 19200 | 10 | 24000 |
| 60-100 | 400 | 20 | 700 | 21 | 20*1000/ 4000 = 50 | 3500 | 30 | 21000 |
| | 5000 | 67 | 5000 | 67 | | 73700 | | 67000 |

Thus $STDR_A = \frac{\sum m_i^a P_i^s}{\sum P_i^s}$ = 73700/5000 = 14.75

and $STDR_B = \frac{\sum m_i^b P_i^s}{\sum P_i^s}$ = 67000/5000 = 13.4

i.e. $STDR_B < STDR_A$

thus population B is more healthy than population A.

- **Birth rates or Fertility Rates:**

**a) Crude Birth Rate ( CBR):** The annual Birth rate is given by

$$CBR = \frac{\text{Total number of births in a specified year}}{\text{Total population in a specified year}} x1000$$

## b) General Fertility Rate (GFR):

$$GFR = \frac{\text{Total number of live births } (B)}{\text{Total female population in reproductive age}} x1000 = \frac{\sum B_i}{\sum P_i^f} x1000$$

Generally GFR is better than CBR, but it does not take in to account the fact that fertility differs from age groups to age groups. Thus age-specific fertility rates are to be obtained.

## C) Age-Specific Fertility Rates (ASFR):

Let $B_i$ = no. of births to females in $i^{th}$ group.

$P_i^f$ = females population in $i^{th}$ group.

Then ASFR is given by

$$ASFR = \frac{B_i}{P_i^f} x1000$$

Here also ASFR are different for different age-groups. But for comparison purpose we require a single value, which can be obtained by total fertility rate.

**d) Total Fertility Rate (TFR):** If 'C' is the width of an age-group then the total fertility rate for the corresponding group is C*ASFR.

Thus the TFR for all reproductive age groups taken together is given by $\sum$ C x ASFR where C is constant.

**Interpretation:** TFR = 2000 means on an average 1000 females over their complete reproductive period give birth to 2000 off-springs.

**Limitations:** 1) TFR assumes all women will survive till the end of their reproductive age, which is impossible.

2) In TFR we consider entire population of women but we have to consider only married female population.

3) TFR will not consider the effect of infertility factor in females or males.

Ex. 1. Compute CBR, GFR and TFR for the following data.

| Age Groups | No. of Women | No. of Births | ASFR |
|---|---|---|---|
| 15-19 | 24000 | 800 | (800/24000)*1000=33.33 |
| 20-24 | 20000 | 2400 | 120 |
| 25-29 | 15000 | 2000 | 133.33 |
| 30-34 | 12000 | 600 | 50 |
| 35-39 | 6000 | 120 | 20 |
| 40-44 | 4000 | 10 | 2.2 |
| **Totals** | **81000** | **5930** | **359.1666** |

1) CBR = (5930/186300)*1000 = 31.83
2) GFR = (5930/81000)*1000 = 73.21
3) TFR = C*ASFR = 5* 359.1666 = 1795.833

**e) Population Growth Rates:** Generally fertility rates are greater than that of mortality rates of similar kind, which results in increase in population. The average life of an individual, age at marriage, female population in child bearing period etc will directly affects the population growth. Gross reproduction rate & Net reproduction rate are the measures of population growth.

**Gross Reproduction Rate (G.R.R.)** : Gross reproduction rate measures the rate at which new born females would add to the total female population if they would be alive and would have the age Specific Fertility Rate till the end of child bearing period.

$$GRR = \sum \frac{B_i}{P_i} x1000 \; xWidth\ of\ age\ group$$

GRR is interpreted as the average no. of daughters to a women in a child bearing period.

**f) Net Reproduction Rate (N.R.R.)** : Here we consider probable population in every age-group. Which can be done by using survival factor.

If $\pi_i$ $[0 \leq \pi_i \leq 1]$ is a survival factor of female in $i^{th}$ age-group, then we define NRR as

$$NRR = \Sigma \frac{B_i^f}{P_i^f} x \pi_i x 1000 x width\ of\ age - group$$

Note: 1) Since $\pi_i \leq 1$ thus NRR $\leq$ GRR

2) NRR = 1 Shows no. of potential mother remains same

NRR > 1 Shows that population is increasing

NRR < 1 Shows that population is decreasing

# Summary: ( Learning Outcomes)

At the end of this module student must be able to

- **Define Vital Statistics**
- **State the uses of Vital Statistics**
- **Explain Mortality Rates**
- **Explain Fertility Rates**
- **Describe Population Growth Rates**