CHAPTER

8 VITAL STATISTICS AND OFFICIAL STATISTICS

William Farr

William Farr (1807–1883) was a British Epidemiologist, regarded as one of the founders of Medical Statistics. Farr, systematically collected and analyzed Britain's Vital Statistics, is known as "the father of Modern Vital Statistics and surveillance." Farr's name features on the wall painting of the London School of Hygiene and Tropical Medicine (LSHTM) in recognition of his work. Twenty three names of public health and tropical medicine pioneers were chosen to appear on the School building in Keppel Street when it was constructed in 1926.

P.C. Mahalanobis

P.C. Mahalanobis (1893-1972) took initiatives for establishment of the Official Statistical System in India. He was the first Honorary Statistical Advisor to the Government of India. He was instrumental for establishing the present Central Statistical Office and National Sample Survey Office. He is the founder of the internationally renowned Indian Statistical Institute (ISI) at Kolkata, which has centres located at various parts of the country. ISI also concentrates on other disciplines of study which include Geology, Sociology, Computer Science and Theoretical Physics.

LEARNING OBJECTIVES

The students will be able to understand

- the importance of Vital Statistics
- various mortality rates
- different fertility rates
- different components of Life Table
- construction of Life Table for a given community
- evolvement of Statistical System in India
- the role of Official Statistics
- the establishment and roles of different divisions of CSO and NSSO.
- the present Statistical System in India

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8.1 VITAL STATISTICS

Introduction

Demography is a term, generally, concerned with human population and it is also concerned with the social implications of periodical variations taking place in the population with reference to geographical location(s).

Vital Statistics is a branch of Demography, which is the science applied to the analysis and interpretation of numerical facts regarding vital events occurring in human population such as births, deaths, marriages, divorces, migration *etc*.

The following are some of the important definitions of Vital Statistics:

"The whole study of mankind by heredity or environment in so far as the results of their study can be arithmetically stated"

–Arthur Newsholme

"Vital Statistics are conventional numerical records of marriages, births, sickness and deaths by which the health and growth of a community may be studied".

–Benjamin

Vital Statistics is the science of numbers applied to the life history of communities or regions.

8.1.1 Importance of Vital Statistics

Vital Statistics are quantitative measurements on live births, deaths, foetal deaths, infant deaths, fertility and so on.

- Vital Statistics are essential for conducting demographic studies on human community during specific time period.
- Vital Statistics play an important role in the development of a country especially in heath care.
- They are of great use in planning and evaluation of socio-economic and public health development of a country.
- They help to identify factors relating to fluctuations in mortality and fertility rates.
- Maternal and infant mortality are important indications of nation's health, thereby influencing the government to develop policies, funding of programs to maintain quality of health care. Timely documentation of births and deaths is essential to maintain high quality indices.
- They are also of great use for comparison of health indicators at national and international levels.
- They are useful in medical and demographical, actuarial studies and research.
- They are of great use to the government to assess the impact of various family welfare programmes implemented in a country.

- Vital Statistics reflect the changing pattern of the population of any region, community or country in terms of vital events.
- Vital Statistics help to compare two different regions or communities or countries with respect to public health based on vital events.

8.1.2 Collection of Vital Statistics

The following are the five methods normally adopted for collecting data related to various vital events:

(i) Civil Registration System
(ii) Census or Complete Enumeration method
(iii) Survey method
(iv) Sample Registration System
(v) Analytical method

(i) Civil Registration System

Civil Registration System is the most common method of collecting information on vital events. It is an administrative procedure followed by governments, to record various vital events occurring in their population.

In this method, occurrence of the vital events such as births, deaths, marriages, migration *etc*., are registered. Many countries adopt this system. Registration is done with the Authorities appointed by the respective government. In India, registration of births and deaths are made compulsory by legislation, through an act *viz*., "The Registration of Births and Deaths Act, 1969". It came into force throughout the country through a gazette notification published in 1970.

(ii) Census or Complete Enumeration Method

Census presents a comprehensive profile of the country's population. Census is conducted in most countries at intervals of ten years. The complete enumeration method normally covers data regarding age, sex, marital status, educational level, occupation, religion and other factors needed for computing Vital Statistics. However, all these information are available for the census year only.

(iii) Survey method

Ad hoc surveys are conducted in areas where the recording of births and deaths has not been done properly and periodically, particularly in those areas where registration offices have not been established. However, survey records help to provide Vital Statistics for that region only.

(iv) Sample Registration System

Vital rates are required to monitor population growth, especially for the purpose of evaluation of family planning programmes in terms of their ultimate objective of controlling fertility.

Sample Registration System is adopted at both national and state levels in India to collect the following information:

National Level

(a) Infant mortality

(b) Age specific mortality rates in rural areas

(c) Sampling variability of vital rates

State Level

(a) Differences in birth rates with respect to education, religion, parity

(b) Sex ratio

(a) Seasonality in birth and death rates

(v) Analytical Method

It is generally not possible to conduct *ad hoc* surveys to assess the population at any specific period between two consecutive census years. Population estimates of any vital event at a given time can be obtained without *ad hoc* surveys applying analytical methods which use mathematical formulae.

Calculation of Vital Rates

Generally, rate of a vital event is calculated using the formula

$$\textbf{Rate of a vital event} = \frac{Number\ of\ occurrences\ of\ the\ event\ during\ the\ specified\ period}{Size\ of\ the\ population\ exposed\ to\ the\ risk\ of\ the\ event} \times 1000$$

Rates of vital events are usually expressed '*per thousand*'.

8.1.3 Mortality and Its Measurements

Mortality refers to the deaths, which occur in the population/community/region due to sickness, accidents, etc.

Several rates are used for measuring mortality. We will discuss the following primary mortality rates.

(i) Crude Death Rate

(ii) Specific Death Rate

(iii) Infant Mortality Rate

(i) Crude Death Rate

Crude Death Rate (*CDR*) is the simplest type of death rate, which relates the number of deaths in a specific community or region to the population size of the community in a given

period, preferably on yearly basis. The formula used to calculate this mortality rate for a given period is

$$CDR = \frac{D}{P} \times 1000$$

where

D: Number of deaths in the population or community during the given period, and

P: Number of persons in the population or community during the given period.

Example 8.1

There were 15,000 persons living in a village during a period and the number of persons dead during the same period was 98.

Then, the *CDR* of the village can be calculated from

$$CDR = \frac{D}{P} \times 1000$$

as

$$CDR = \frac{98}{15000} \times 1000 = 6.53 \text{ } \textit{per thousand}.$$

In some cases, information about the population may be provided in such a manner that people in the population are grouped according to their age into mutually exclusive and exhaustive age groups. The *CDR* can also be calculated based on such kind of information.

Example 8.2

People living in a town are grouped according to their age into five groups. The number of persons lived during a calendar year and the number of deaths recorded during the same period are as follows:

Age Group (in years)	0-10	10-30	30-50	50-70	70 and above
No. of Persons	5,000	10,000	15,000	10,000	2,000
No. of Deaths	125	30	30	200	1,000

Calculate crude death rate of the town.

Solution:

The total number of deaths occurred in the town, irrespective of the age, is 1385 and the population size is 42,000. Therefore, the *CDR* of the town can be calculated as

$$CDR = \frac{1385}{42000} \times 1000 = 32.98$$

Thus, the Crude Death Rate of the town is 32.98 *per thousand*.

CDR is the widely used mortality measure. It is popular, because it is very easy to compute. However, it is only a crude measure of mortality, which does not take into account of the age and sex, on the whole, of the population/community/region. The probability of death may not be same at all ages. Hence, if the age distribution of two different communities are not similar, then comparing the communities based on their *CDR* can mislead. Also, use of *CDR* may again be misleading, since the probability of death may vary over gender, though they are at the same age.

(ii) Specific Death Rate

Mortality pattern may differ in different sections/segments of the population such as age, gender, occupation *etc*.

Specific Death Rate (*SDR*) can be calculated exclusively for a section of the population. The *SDR* can be calculated for a group of persons, who are distinguished by age or gender or occupational class or marital status. The formula to calculate *SDR* is

$$SDR = \frac{D_S}{P_S} \times 1000,$$

where

D_S refers to the number of deaths in a specific section of population during the given period, and

P_S refers to the total number of persons in the specific section of population during the given period.

*SDR*s can be calculated for any age group, gender, religion, caste or community. If the death rates are calculated for different age groups, say, 0-5 years, 5-15 years, 50-60 years, they are called age specific death rates (*ASDR*s). In the age group $(x,x+n)$, all the persons in the population or in its section, who have attained the age of x years and the persons with age less than $x+n$ years, are included in the age group.

If

$D(x,n)$ denotes the number of deaths in the age group $(x,x+n)$ recorded in a given region during a given period, and

$P(x,n)$ denotes the number of persons in the age group $(x,x+n)$ in the region during the same period, then

ASDR for the age group $(x,x+n)$ for the given region during the period is given by

$$ASDR(x,n) = \frac{D(x,n)}{P(x,n)} \times 1000.$$

The death rates, calculated for persons belonging to different gender, is called as gender specific death rate. The *SDR* can also be used to compare the death rates due to different kinds of seasonal diseases such as *dengue*, *chikungunya*, *swine flu*.

The *SDR* helps to measure the death rates for different sections/segments of the population unlike *CDR*. *ASDR* and *SDR* for gender can be used to compare the death rates of the respective sections of the given population in different regions.

Example 8.3

Number of deaths recorded in various age groups in two areas, *viz.*, Area I and Area II and the population size in each age group are given in the following table.

Age Group (in years)	Area I		Area II	
	Population	No. of Deaths	Population	No. of Deaths
0-10	3000	55	7500	300
10-25	4500	30	6000	50
25-45	6000	40	8000	40
45 and over	1000	15	2000	64

Find the crude death rates and age specific death rates of Area I and Area II.

Solution:

Age Specific Death Rate can be calculated for each age group using the formula

$$ASDR(x,n) = \frac{D(x,n)}{P(x,n)} \times 1000$$

Calculation of the *ASDR* for both the areas in each age group is presented in the following table:

Age Group (x)	Area I			Area II		
	$P(x,n)$	$D(x,n)$	ASDR(x,n) (per thousand)	$P(x,n)$	$D(x,n)$	ASDR(x,n) (per thousand)
0-10	3000	55	$\frac{55}{3000} \times 1000 = 18.33$	7500	300	$\frac{300}{7500} \times 1000 = 40.00$
10-25	4500	30	$\frac{30}{4500} \times 1000 = 6.67$	6000	50	$\frac{50}{6000} \times 1000 = 8.33$
25-45	6000	40	$\frac{40}{6000} \times 1000 = 6.67$	8000	40	$\frac{40}{8000} \times 1000 = 5.00$
45 and over	1000	15	$\frac{15}{1000} \times 1000 = 15.00$	2000	64	$\frac{64}{2000} \times 1000 = 32.00$
Total	14500	140		23500	454	

$$CDR \text{ of Area I} = \frac{140}{14500} \times 1000 = 9.66 \textit{ per thousand}$$

$$CDR \text{ of Area II} = \frac{454}{23500} \times 1000 = 19.32 \textit{ per thousand}$$

Example 8.4

The following are the information about the number of persons who are affected by Diabetes and Lung Cancer and the number of persons died due to each cause of death during a calendar year in two different districts:

Cause of Death	District A		District B	
	No. of Persons		No. of Persons	
	Affected	Died	Affected	Died
Diabetes	20,000	325	22,000	400
Lung Cancer	19500	300	21,225	380

Find the Illness specific death rates for the two districts. Also, compare health conditions of both the districts with reference to these two causes of death. Assume that a person affected by Diabetes is not affected by Lung Cancer and *vice-versa*.

Solution:

The *SDR* due to the two causes of death are calculated as follows:

SDR of District A

$$SDR_{Diabetes} = \frac{D_{Diabetes}}{P_{Diabetes}} \times 1000$$

$$= \frac{325}{20000} \times 1000$$

$$SDR_{Diabetes} = 16.25 \text{ per thousand}$$

$$SDR_{Lung\ Cancer} = \frac{D_{Lung\ Cancer}}{P_{Lung\ Cancer}} \times 1000$$

$$= \frac{300}{19500} \times 1000$$

$$SDR_{Lung\ Cancer} = 15.38 \text{ per thousand}$$

SDR of District B

$$SDR_{Diabetes} = \frac{400}{22000} \times 1000$$

$$SDR_{Diabetes} = 18.18 \text{ per thousand}$$

$$SDR_{Lung\ Cancer} = \frac{380}{21225} \times 1000$$

$$SDR_{Lung\ Cnacer} = 17.90 \text{ per thousand}$$

In both the districts, death rates are more due to Diabetes in comparison with Lung Cancer. Among the two districts, District B has relatively more death rate due to both Diabetes and Lung Cancer.

The *SDR* can be calculated with respect to gender also. For example, *SDR* for males in a given region during a given period can be calculated as

$$SDR_{Male} = \frac{D_{Male}}{P_{Male}} \times 1000 .$$

Here, D_{Male} is the number of male deaths in the region during the specified period, and P_{Male} is the male population size in the region during the specified period.

(iii) Infant Mortality Rate

'Infant' means a baby of age less than a year. **Infant Mortality Rate** (*IMR*) is defined as the number of infant deaths *per thousand* live births in a period or children die before they attain age of one year. The following formula is used to calculate infant mortality rate

$$IMR = \frac{D_{Infant}}{P_{Infant}} \times 1000$$

where

D_{Infant} denotes the number of deaths of infants in a population during a period, and

P_{Infant} denotes the number of live births in the population during the period.

Child Mortality Rate: Child mortality is the death of a child before the child's fifth birth day, measured as the under 5 child mortality rate (*U5MR*).

Example 8.5

The number of live births recorded and the number of infants died in a town during a given period are respectively 400 and 25. Calculate, from these information, the infant mortality rate of the town for the period.

Solution:

The *IMR* of the town is given by

$$IMR = \frac{25}{400} \times 1000$$

$IMR = 62.50$ *per thousand.*

8.1.4 Life Table and Its Applications

A **Life Table** is a presentation of summary of the mortality experiences of a community during a given period in the form of a table. The Life Table exhibits the number of persons living and dying at each age, on the basis of the experience of a ***cohort***. It also gives the probability of dying and living separately. The Life Table tells the life history of a ***cohort***.

Cohort is a group of individuals who born at the same time and experienced the same mortality conditions.

Uses of Life Table

- Actuaries compute rate of premiums for persons of different age groups using Life Table.
- It helps to assess the accuracy of census figures, death and birth registrations.
- It helps to evaluate the impact of family planning on population growth.
- It enables to assess the increase in the life span due to new scientific inventions, sophisticated medical treatments and improved living conditions.
- Estimates of migration can be made from Life Table.

Construction of Life Table

Construction of Life Table begins with a ***cohort*** population. The following are the standard set of components of a Life Table:

(i) Age (x)
(ii) Survivorship function
(iii) Number of deaths in the age interval (x, x+1)
(iv) Probability for a person surviving at the age x to die before x+1 years
(v) Probability for a person aged x years to survive upto x+1 years
(vi) Number of persons lived in aggregate in the age interval (x,x+1)
(vii) Number of years lived by the ***cohort*** at and above the age x years
(viii) Expectation of life.

These components are described below with their respective notations and formula required to compute each of them.

(i) x : Age, in years

(ii) $l(x)$: Number of survivors at the exact age of x years.

For instance, $l(25)$ denotes the number of persons who survive to the moment of attaining age 25 years. Hence, $l(x)$ is a decreasing function of x.

$l(0)$ is called **radix** of the Life Table or ***cohort***, which is conventionally taken as 1,00,000.

(iii) $d(x)$: Number of persons among $l(x)$ persons who die before reaching the age x years.

i.e., $d(x) = l(x) - l(x+1)$

(iv) $q(x)$: Probability for a person surviving at the age x will die before x+1 years.

i.e., $q(x) = \frac{d(x)}{l(x)}$

It is the proportion of persons dying between the ages of x and x +1 to the number of persons surviving at the age of x years, *i.e.*, at the beginning of the corresponding age interval.

(v) $p(x)$: Probability for a person aged x years to survive up to x+1 years

i.e., $p(x) = 1 - q(x)$, or equivalently, $p(x) = \frac{l(x+1)}{l(x)}$

It is the proportion of persons surviving up to (x + 1) years to the number of persons at the age of x years.

(vi) $L(x)$: Number of persons lived in aggregate in the age interval $(x,x+1)$

$$i.e.,\ L(x) = \frac{l(x)+l(x+1)}{2}$$

or equivalently

$$L(x) = l(x) - \frac{1}{2}d(x)$$

(vii) $T(x)$: Number of years lived by the ***cohort*** at and above the age x

$i.e.,\ T(x) = L(x)+L(x+1)+L(x+2)+ \ldots$

or equivalently

$T(x+1) = T(x) - L(x)$.

Total number of years lived by the ***cohort*** after x years of age.

(viii) $e^0(x)$: Expectation of life

$$e^0(x) = \frac{T(x)}{l(x)}$$

It gives the average number of years a person of age x years is expected to survive under the existing mortality conditions.

Assumptions of Life Table

The following assumptions are made while constructing a Life Table.

(i) There is no effect of immigration and emigration on the ***cohort***. It means that the reduction in the number of the initial ***cohorts*** is merely due to deaths.

(ii) The size of ***cohort*** begins with a convenient figure, it is conventionally 1,00,000.

(iii) Deaths are uniformly distributed over each age interval.

Example 8.6

A Life Table was constructed for a ***cohort***. The following is a section of the table, wherein some of the entries are not available. Find the estimates of missing values and complete the Life Table.

Age (in years)	$l(x)$	$d(x)$	$p(x)$	$q(x)$	$L(x)$	$T(x)$	$e^0(x)$
40	10, 645	-	-	-	-	1, 93, 820	-
41	10, 543	169	-	-	-	-	-

Solution:

The Life Table can be completed using the relationship among missing terms and other terms.

The number of persons who die before reaching age 40 years is calculated as

$$d(40) = l(40) - l(41)$$
$$= 10645 - 10543$$

Therefore, $d(40) = 102$.

Values of $q(x)$ are estimated as

$$q(40) = \frac{d(40)}{l(40)}$$

$$= \frac{102}{10645}$$

$$= 0.0095.$$

$$q(41) = \frac{d(41)}{l(41)}$$

$$= \frac{169}{10543}$$

$$= 0.0160.$$

Values of $p(x)$ are estimated from the corresponding values of $q(x)$ as

$$p(40) = 1 - q(40)$$

$$= 1 - 0.0095 = 0.9905$$

$$p(41) = 1 - q(41)$$

$$= 1 - 0.0160 = 0.9840$$

Values of $L(x)$ are estimated using its relationship with $l(x)$ and $d(x)$ as follows:

$$L(40) = \frac{l(40) + l(41)}{2}$$

$$= \frac{10645 + 10543}{2}$$

$$= 10{,}594$$

$$L(41) = l(41) - \frac{1}{2}d(41)$$

$$= 10{,}543 - \frac{1}{2} \times 169 = 10{,}458.5$$

$$= 10{,}459 \ (Approx.)$$

The value of $T(41)$ is estimated from the given value of $T(40)$ and the estimated value of $L(40)$ from the relationship

$$T(41) = T(40) - L(40)$$

as $T(41) = 193820 - 10594$

$$= 1{,}83{,}226.$$

The life expectancy of the ***cohort*** at the age $x = 40$ and 41 years can be estimated using the relationship

$$e^0(x) = \frac{T(x)}{l(x)}$$

as

$$e^0(40) = \frac{1{,}93{,}820}{10{,}645} = 18.20$$

$$e^0(41) = \frac{1,83,226}{10,543} = 17.37$$

Now, the completed Life Table becomes as

x	$l(x)$	$d(x)$	$p(x)$	$q(x)$	$L(x)$	$T(x)$	$e^0(x)$
40	10, 645	102	0.9905	0.0095	10,594	1, 93, 820	18.20
41	10, 543	169	0.9840	0.0160	10,459	1,83,226	17.37

Example 8.7

The following is a part of the Life Table constructed for a population, where the contents are incomplete. Evaluate the missing values using the given data and complete the Life Table.

x	$l(x)$	$d(x)$	$p(x)$	$q(x)$	$L(x)$	$T(x)$	$e^0(x)$
83	3560	-	-	0.16	-	-	
84	-	508	-	0.17	-	11975	

Solution:

Values of the missing entries can be estimated from the given data applying the respective formulae as follows:

The number of persons who die before reaching age of 83 years is calculated as

$d(83) = l(83) \times q(83)$

$= 3560 \times 0.16$

$= 569.6 = 570$

The value of the survivorship function $l(x)$ at $x = 84$ years is estimated as

$l(84) = l(83) - d(83)$

$= 3560 - 570$

$= 2990$

Values of $p(x)$ are estimated from the corresponding values of $q(x)$ as

$p(83) = 1 - q(83)$

$= 1 - 0.16 = 0.84$

$p(84) = 1 - q(84)$

$= 1 - 0.17 = 0.83$

Values of $L(x)$ are estimated using its relationship with $l(x)$ and $d(x)$ as follows:

$$L(83) = \frac{l(83) + l(84)}{2}$$

$$= \frac{3560 + 2990}{2}$$

$$= 3{,}275$$

$$L(84) = l(84) - \frac{1}{2} d(84)$$

$$2990 - \frac{508}{2}$$

$L(84) = 2736.$

The value of $T(83)$ can be estimated from the given value of $T(84)$ and the estimated value of $L(83)$ from the relationship

$T(84) = T(83) - L(83)$

$T(83) = L(83) + T(84)$

as

$T(83) = 3{,}275 + 11975 = 15{,}250$

The life expectancy of the ***cohort*** at the age x = 83 and 84 years is estimated using the relationship $e^0(x) = \frac{T(x)}{l(x)}$

as

$$e^0(83) = \frac{15250}{3560} = 4.28$$

$$e^0(84) = \frac{11975}{2990} = 4.01$$

Now, the completed Life Table is as follows:

x	$l(x)$	$d(x)$	$p(x)$	$q(x)$	$L(x)$	$T(x)$	$e^0(x)$
83	3560	570	0.84	0.16	3275	15250	4.28
84	2990	508	0.83	0.17	2736	11975	4.01

Example 8.8

A part of the Life Table of a population is given hereunder with incomplete information. Find those information from the given data and complete the Life Table.

Age (in years)	$l(x)$	$d(x)$	$p(x)$	$q(x)$	$L(x)$	$T(x)$	$e^0(x)$
72	4412	-	-	-	-	-	-
73	3724	-	-	-	-	-	-
74	3201	642	-	-	-	26567	-

Solution:

Values of the missing entries can be calculated from the given data applying the respective formulae as follows:

The number of persons who die before reaching age x = 72 and 73 years can be calculated as

$$d(72) = l(72) - l(73)$$

$$= 4412 - 3724$$

$$= 688$$

$$d(73) = l(73) - l(74)$$

$$= 3724 - 3201$$

$$d(73) = 523.$$

Values of $q(x)$ are estimated as

$$q(72) = \frac{d(72)}{l(72)}$$

$$= \frac{688}{4412}$$

$$= 0.1559$$

$$q(73) = \frac{d(73)}{l(73)}$$

$$= \frac{523}{3724}$$

$$q(73) = 0.1404$$

$$q(74) = \frac{d(74)}{l(74)}$$

$$= \frac{642}{3201}$$

$$= 0.2006.$$

Values of $p(x)$ are estimated from the corresponding values of $q(x)$ as

$$p(72) = 1 - q(72)$$

$$= 1 - 0.1559 = 0.8441$$

$p(73) = 1 - q(73)$

$= 1 - 0.1404 = 0.8596$

$p(74) = 1 - q(74)$

$= 1 - 0.2006 = 0.7994.$

Values of $L(x)$ are estimated using its relationship with $l(x)$ and $d(x)$ as follows:

$$L(72) = \frac{l(72)+l(73)}{2}$$

$$= \frac{4412+3724}{2}$$

$$= 4{,}068$$

$$L(73) = \frac{l(73)+l(74)}{2}$$

$$= \frac{3724+3201}{2}$$

$$L(74) = l(74) - \frac{d(74)}{2}$$

$$= 3201 - \frac{642}{2}$$

$$= 2880.$$

The value of $T(x)$ is estimated for x = 72 and 73 from the given value of $T(74)$ and the estimated values of $L(72)$ and $L(73)$ as

$$T(73) = L(73) + T(74)$$

$$= 3463 + 26567 = 30{,}030.$$

$$T(72) = L(72) + T(73)$$

$$= 4068 + 30030 = 34{,}098.$$

The life expectancy of the ***cohort*** at the age x = 72, 73 and 74 years is estimated using the relationship

$$e^0(x) = \frac{T(x)}{l(x)}$$

as

$$e^0(72) = \frac{34098}{4412} = 7.73$$

$$e^0(73) = \frac{30030}{3724} = 8.06$$

$$e^0(74) = \frac{26567}{3201} = 8.30$$

The completed Life Table is as follows:

x	$l(x)$	$d(x)$	$p(x)$	$q(x)$	$L(x)$	$T(x)$	$e^0(x)$
72	4412	688	0.8441	0.1559	4,068	34,098	7.73
73	3724	523	0.8596	0.1404	3,463	30,030	8.06
74	3201	642	0.7994	0.2006	2,880	26,567	8.30

Example 8.9

Find the missing values in the following Life Table:

Age (in years)	$l(x)$	$d(x)$	$p(x)$	$q(x)$	$L(x)$	$T(x)$	$e^0(x)$
4	95,000	500	-	-	-	48,50,300	-
5	-	400	-	-	-	-	-

Solution:

Value of the survivorship function $l(x)$ at $x = 5$ years can be estimated as

$$l(5) = l(4) - d(4)$$

$$= 95000 - 500$$

$$= 94500$$

Values of $q(x)$ are estimated as

$$q(4) = \frac{d(4)}{l(4)}$$

$$= \frac{500}{95000}$$

$$= 0.005$$

$$q(5) = \frac{d(5)}{l(5)}$$

$$= \frac{400}{94500}$$

$$= 0.004.$$

Values of $p(x)$ are estimated from the corresponding values of $q(x)$ as

$$p(4) = 1 - q(4)$$

$$= 1 - 0.005 = 0.995$$

$$p(5) = 1 - q(5)$$

$$= 1 - 0.004 = 0.996.$$

Values of $L(x)$ are estimated using its relationship with $l(x)$ and $d(x)$ as follows:

$$L(4) = \frac{l(4)+l(5)}{2}$$

$$= \frac{95000+94500}{2}$$

$$= 94{,}750$$

$$L(5) = l(5) - \frac{d(5)}{2}$$

$$= 94500 - \frac{400}{2}$$

$$= 94{,}300.$$

The value of $T(5)$ is estimated from the given value of $T(4)$ and the estimate of $L(4)$ as

$T(5) = T(4) - L(4)$

$T(5) = 4850300 - 94750 = 47{,}55{,}550.$

The life expectancy of the ***cohort*** at the age $x = 4$ and 5 years is estimated using the relationship

$$e^0(x) = \frac{T(x)}{l(x)}$$

as

$$e^0(4) = \frac{4850300}{95000} = 51.06$$

$$e^0(5) = \frac{4755550}{94500} = 50.32$$

The completed Life Table is

x	$l(x)$	$d(x)$	$p(x)$	$q(x)$	$L(x)$	$T(x)$	$e^0(x)$
4	95,000	500	0.995	0.005	94,750	48,50,300	51.06
5	94,500	400	0.996	0.004	94,300	47,55,550	50.32

8.1.5 Fertility and its Measurements

Fertility refers to births occurring to the women who are at child bearing age. A woman at child bearing age is defined as the age of the female who can give birth to a child. In other words, it is the reproductive age of woman.

Fertility rates are the quantitative characteristics, which are used to measure the rate of growth of the population due to births during a specified period, usually a year. The fertility rates are expressed *per thousand* women who are at child bearing age.

As like mortality rates, there are several fertility rates. Among them, the following are the basic fertility rates discussed here

(i) Crude Birth Rate

(ii) Specific Fertility Rate

(iii) General Fertility Rate

(i) Crude Birth Rate

Crude Birth Rate (*CBR*) of a region or a community relates the number of live births to size of the population of the region or the community. This quantity can be computed using the formula

$$CBR = \frac{B_t}{P_t} \times 1000$$

where

B_t denotes the number of live births occurred in a given region/community during the period t, and

P_t denotes the population size of the given region/community during the period t.

Example 8.10

The number of children born in a city during a period was 15,628 and the total population of the city in that period was 80,00,000. Find the crude birth rate of the city.

Solution:

The Crude Birth Rate can be calculated using the formula

$$CBR = \frac{B_t}{P_t} \times 1000$$

The *CBR* of the city is

$$CBR = \frac{15628}{8000000} \times 1000$$

= 1.95 per thousand.

Example 8.11

People living in a town are grouped according to their age into nine groups. Details about the number of live birts are also grouped according to the age group of women. These information are presented in the following table:

Age Group (in years)	Less than 15	15-20	20-25	25-30	30-35	35-40	40-45	45-49	49 and above
No. of Persons	20,000	15,000	19,000	21,000	25,000	20,000	18,000	16,000	35,000
No. of Live Births	0	30	200	1,000	1500	800	500	100	0

Calculate crude birth rate of the town.

Solution:

The total number of persons in the town during the specified period can be calculated from the given information as

P_t = 1,89,000

and the total number of live births as

B_t = 4,130.

Hence, the Crude Birth Rate of the town is

$$CBR = \frac{4130}{189000} \times 1000$$

= 21.85 per thousand.

CBR is the simplest fertility rate, which provides a comprehensive idea about the population growth of any region/community. It is easy to compute for any given region.

However, *CBR* does not take into account of the age and gender distribution of the population or specifically the number of women at the child bearing age. This is a crude measure, since it includes the sections of the population who are not in the reproductive age group. It means that P_t includes the sections of the population who are not exposed to the risk of producing children, in particular, male and also the female beyond the reproductive age. *CBR* also assumes that all the women at child bearing age have the same reproductive capacity irrespective of their age, which is totally unrealistic.

(ii) General Fertility Rate

General Fertility Rate (*GFR*) of a region or a community relates the number of live births to the number of women in the reproductive age.

i.e.,
$$GFR = \frac{Number\ of\ \ live\ births}{Number\ of\ women\ at\ child\ bearing\ age} \times 1000$$

This quantity can be computed using the formula

$$GFR = \frac{B_t}{\sum_{i=a_1}^{a_2} P_t^i} \times 1000$$

where

P_t^i denotes the number of women in the reproductive age i years in the given region/community during the period t, $i = a_1$ to a_2.

In India, generally, a_1 = 15 years and a_2 = 49 years.

GFR overcomes the disadvantage of *CBR* considering only the women population at the child bearing age group, since the denominator in the above formula represents the entire women population at the reproductive age group. *GFR* expresses the increase in the women population at the child bearing age through live births.

However, *GFR* does not express the age composition of women population at the reproductive age group. Hence, two different regions/communities cannot be compared with respect to age of women using *GFR*.

Example 8.12

Women, at child bearing age, of a district are grouped into seven age groups. The number of women lived during a calendar year in the district and the number of live births recorded during the same period are as follows:

Age Group (in years)	15-20	20-25	25-30	30-35	35-40	40-45	45-49
No. of Persons	20,000	22,000	28,000	32,000	29,000	24,000	8,000
No. of Live Births	50	1500	1700	2,000	1800	500	80

Calculate the general fertility rate of the district.

Solution:

The total number of women, at child bearing age in the district during the study period can be calculated from the given information as

$$\sum_{i=15}^{49} P_t^i = 1{,}63{,}000$$

and the total number of live births as

$B_t = 7{,}630.$

Hence, the general fertility rate of the district is

$$GFR = \frac{7630}{163000} \times 1000$$

$= 46.81$ *per thousand.*

(iii) Specific Fertility Rate (SFR)

It is a well known fact that fertility is affected by several factors such as age, marriage, migration, region *etc*. But, both *CBR* and *GFR* do not take into account of this fact. In this respect, **Specific Fertility Rate** (*SFR*) is defined as

$$SFR = \frac{\text{Number of live births to the women population in the reproductive age groups of specific section in a given period}}{\text{Total number of women in the reproductive age groups of the specific section in the given period}} \times 1000$$

SFR can be calculated separately for various age groups of females who are at child bearing age such as 15-20, 20-25, and so on. The *SFR* computed with respect to different reproductive age of women is known as the **Age Specific Fertility Rate** (*ASFR*), which can be calculated using the formula

$$ASFR(x, x+n) = \frac{B_t(x, x+n)}{P_t(x, x+n)} \times 1000$$

where

$B_t(x, x+n)$ denotes the number of live births to the women in the reproductive age group $(x,x+n)$ during the period t in the given region, and

$P_t(x, x+n)$ denotes the number of women in the reproductive age group $(x,x+n)$ during the period t in the given region.

Grouping of women with respect to their age is essential, since capacity of women to give birth to child varies over the age of women. Thus, *ASFR* enables to compare the fertility rates of two or more different regions with respect to specific age groups. Moreover, *ASFR* can be considered as a probability value.

Example 8.13

The female population, at reproductive age, of a country is grouped into six age groups. The number of women in each group and the number of live births given by them are given the following table.

Age Group (in years)	No. of Women	No. of Live Births
15-20	1,16,610	10,668
20-25	1,13,810	17,183
25-30	1,03,130	12,722
30-35	93,500	7,283
35-40	74,120	3,656
40-45	62,900	1,340

Calculate the general fertility rate and the age specific fertility rates of the country.

Solution:

Total number of women in the country at reproductive age during the period of 't' is

$$\sum_{i=15}^{44} P_t^i = 5{,}64{,}070$$

and the total number of live births of the country during the same period is

$$B_t = 52{,}852$$

Therefore, the general fertility rate of the country is

$$GFR = \frac{52852}{564070} \times 1000$$

$$= 93.69 \textit{ per thousand.}$$

The age specific fertility rates of the country can be calculated for each age group using the formula

$$ASFR(x, x+n) = \frac{B_t(x, x+n)}{P_t(x, x+n)} \times 1000$$

where

$B_t(x, x+n)$ denotes the number of live births to the women in the reproductive age group $(x,x+n)$ during the period t in the given region, and

$P_t(x, x+n)$ denotes the number of women in the reproductive age group $(x,x+n)$ during the period t in the given region.

The *ASFRs* are calculated from the given information and are presented in the following table:

Age Group	*ASFR*
15-20	$\frac{10668}{116610}\times 1000 = 91.48$
20-25	$\frac{17183}{113810}\times 1000 = 150.98$
25-30	$\frac{12722}{103130}\times 1000 = 123.36$
30-35	$\frac{7283}{93500}\times 1000 = 77.89$
35-40	$\frac{3656}{74120}\times 1000 = 49.33$
40-45	$\frac{1340}{62900}\times 1000 = 21.30$

It is can be observed, with respect to *ASFRs*, that the women in the country falling in the age group of 20-25 years have given relatively more live births. The women at the age of 40-45 years have reproduced less number of live births.

Example 8.14

The following is the data regarding the size of female population in a country at reproductive age and the live births during a period.

Age Group (yrs)	Female Population	No. of Live Births
15–20	2,16,410	20,468
20–25	2,13,610	26,983
25–30	2,02,930	22,522
30–35	1,93,300	17,083
35–40	1,73,920	13,456
40–45	1,62,870	11,140

Calculate the general fertility rate and the age specific fertility rates of the country.

Solution:

Size of the women population of the country at reproductive age during the period '*t*', is

$$\sum_{i=15}^{44} P_t^i = 11,63,040$$

and the total number of live births occurred during the same period in the country is

$B_t = 1,11,652.$

Hence, the general fertility rate of the country during the period is

$$GFR = \frac{111652}{1163040} \times 1000 = 96.00$$

The age specific fertility rate of the country during the same period is calculated for each reproductive age group and the rates are presented in the following table:

Age Group (in years)	*ASFR*
15 – 20	$\frac{20468}{216410} \times 1000 = 94.58$
20 – 25	$\frac{26983}{213610} \times 1000 = 126.32$
25 – 30	$\frac{22522}{202930} \times 1000 = 110.98$
30 – 35	$\frac{17083}{193300} \times 1000 = 88.38$
35 – 40	$\frac{13456}{173920} \times 1000 = 77.37$
40 – 45	$\frac{11140}{162870} \times 1000 = 68.40$

It can be observed, with respect to *ASFR*, that the women population of the country falling in the age group of 20-25 years have given relatively more live births. The women at the age of 40-45 years have reproduced less number of live births.

8.1.6 Measurement of Population Growth

Every human population, normally, may have a change in its size over a period of time. Each change in the population size may be an increase or decrease in magnitude. Sometimes, the population size may remain without any change. Such a population is known as stable population. The tendency to increase in the population size may be called as **population growth**. Every government requires information about the rate of growth of its population.

If many new born babies in a population are female, the corresponding population size may increase. If gender of the infant deaths is female, change in the population size may be downward. Hence, fertility and mortality rates, individually, do not provide knowledge on population growth.

Quantitative ideas about the growth of a population can be obtained from several measurements. Among them,

(i) Crude Rate of Natural Increase, and

(ii) Pearl's Vital Index

may be considered as the basic indicators of population growth. These two measures can be calculated using the following formulae

$$\textit{Crude Rate of Natural Increase} = CBR - CDR$$

$$\textit{Pearl's Vital Index} = \frac{CBR}{CDR} \times 100$$

Positive values of Crude Rate of Natural Increase indicate the net increase in the population. Similarly, negative values of Crude Rate of Natural Increase indicate the net decrease in the population.

If Pearl's Vital Index is greater than 100, then it can be regarded as the population is growing. On the other hand, if this index is less than 100, it can be regarded as the population is not growing. The above formula shows that the Vital Index can also provide knowledge on birth-death ratio of the population.

These two measures are simple and easy to calculate. They indicate whether the number of births exceeds the number of deaths. However, these two measures suffer from the limitations of *CBR* and *CDR*. They cannot be used for comparing two different populations. Also, information regarding whether the population has a tendency to increase or decrease cannot be obtained from these two measures.

8.2 OFFICIAL STATISTICS

Official statistics are the statistical information published by government agencies or other public bodies, which are collected and compiled on various aspects for administrative purposes. Official Statistics are collected in a systematic manner through a well-established Statistical System. These information include quantitative and qualitative information on all major areas of citizens' lives, such as economic and social development, living conditions, health, education and environment. Official statistics should be objective and easily accessible, produced on a continual basis so that measurement of change is possible. The following may be considered as the main functions of the Statistical System:

(i) collection, validation, compilation of data

(ii) publication/dissemination of the statistical information

(iii) maintenance of statistical standards such as definitions, classification, statistical methodology, comparability *etc*.

(iv) coordination of statistical activities

(v) training statistical personnel

(vi) independence and integrity of its functioning

(vii) international coordination

8.2.1 Early History of Statistical System in India

Statistical data collection and compilation began in India during 321-298 *BC* and are documented in Kautilya's *Arthasastra*. Later, during the Moghul's period, the details of Official Statistics can be found in *Ain-i-Akbari* written by Abul Fazal in Emperor Akbar's rule during 1590 *AD*. It contains Official Statistics of various characteristics including land classification, crop yields, measurement system, revenue *etc*.

In British India, a statistical survey was conducted, in the year 1807 by Dr.Francis Buchanan, Governor-in-Council of *East India Company*. Information were collected regarding topographical account of each district, conditions of the inhabitants, their religion and customs, details of fisheries, mines and forests, farm sizes, vegetables grown, commerce, list of useful plants and seeds. An **Official Statistical System** was established in India by *Col*. Sykes during 1847 with a Department of Statistics in *India House*. The **first Census Report of India** was published in 1848. The second Census Report was published in 1881 and since then Census was conducted every 10 years.

8.2.2 Post-Independence Indian Official Statistical System

After Independence, the need for a statistical system for monitoring socio-economic development of the country was felt by the Government of India. In 1949, Shri.P.C.Mahalanobis was appointed by the Government of India as the Honorary Statistical Advisor to the government. In the same year, he established the Central Statistical Unit. This Unit was renamed, in 1951, as Central Statistical Organization, which coordinated various statistical activities in the country. It also defined and maintained statistical standards in the country.

During the same period, National Income Committee was established in 1949 to estimate the National Income of the country. The Committee recommended the use of sampling methods for collecting information in order to fill the large gaps in the statistical information required for estimation of the National Income. Sample surveys were conducted at national level for this purpose. The first round of National Sample Survey was conducted in October 1950. Later, a separate organization under the government set-up for conducting sample surveys was formed in the name of National Sample Survey Organization.

The Central Statistical Organization and National Sample Survey Organization are now called respectively as Central Statistics Office (CSO) and National Sample Survey Office (NSSO).

The Ministry of Statistics and Programme Implementation (MoS&PI), a ministry with independent charge in the Government of India, was formed on October 15, 1999 with two wings, *viz*., National Statistical Office (NSO) and Programme Implementation.

The Government of India set up a Commission in the year 2000 under the headship of Shri.C.Rangarajan to address the growing statistical needs of the country. Based on the recommendations of the Commission, a permanent and statutory apex body, called **National Statistical Commission** (NSC), was set up in NSO on July 12, 2006. The NSC was formed to evolve policies, priorities and to maintain quality standards in statistical matters.

The NSC is constituted with an eminent statistician or a social-scientist as its Chairperson and four members - one each from the areas of Economic Statistics; Social and Environmental Statistics; Census Operations, Surveys and Statistical Information System; and National Accounts. The Chief Statistician of India is the Secretary of the Commission and the Chief Executive Officer of NITI Aayog of Planning Commission of India is an *ex-officio* member of NSC. The Chief Statistician of India is the Head of National Statistical Office and Secretary of the MoS&PI. NSC, in addition to the above responsibilities, also performs the functions of Governing Council of the NSSO since August 30, 2006.

Presently, the main sections of NSO are NSC, CSO, NSSO and a Computer Center.

8.2.2.1 Central Statistics Office

The **Central Statistics Office** is responsible for coordination of statistical activities in the country, and evolving and maintaining statistical standards. CSO is headed by a Director General, who is assisted by five Additional Director Generals. The CSO has five main divisions. The divisions and their responsibilities are presented below:

(i) National Accounts Division

This division is responsible for

- preparation of national accounts including Gross Domestic Product
- preparation of quarterly estimates of Gross Domestic Product
- estimation of Capital Stock and Consumption of fixed capital
- estimation of State-wise Gross Value Added and Gross Fixed Capital Formation
- preparation of Input-Output Transaction Tables, and
- preparation of comparable estimates of State Domestic Product.

(ii) Social Statistics Division

This division is responsible for

- statistical monitoring of the Millennium Development goals
- preparation and maintaining environmental economic accounting
- grant-in-aid for research, workshop/seminars/conferences in Official/Applied Statistics
- national/international awards for statisticians
- preparation of National Data Bank on socio-religious categories
- basic statistics for Local Level Development Pilot scheme
- conduct of time-use surveys and release of regular and *ad hoc* publications.

National Statistics Day and World Statistics Day

The Government of India declared 29th June, the birthday of Prof. P.C. Mahalanobis, as the National Statistics Day to honour his contribution to the establishment of Official Statistical System in India. As a part of the celebration of this day, essay writing competitions are conducted nationwide among postgraduate students of Statistics. The winners are honoured with awards during the celebration at New Delhi. The first National Statistics Day was celebrated on June 29, 2007.

United Nations Statistical Commission declared October 20 as the World Statistics Day. It is celebrated every five years in almost all the countries focussing on specific theme. The first World Statistics Day was celebrated all over the world on October 20, 2010. The second World Statistics Day was celebrated on October 20, 2015 on the theme *Better Data, Better Lives* to emphasize the important role of high quality official statistical information in decision-making.

All the government departments, educational departments and others dealing with Statistics take part in celebration of National Statistics Day as well as World Statistics Day.

The year 2013 was observed as the International Year of Statistics.

The State and Central Governments recruit professionals, who are trained in applications of statistical methods, for appointment as Statistical Investigators, Assistant Directors. Most of the statisticians in CSO, NSSO and in ministries now qualify Indian Statistical Service (ISS) examination conducted by Union Public Service Commission. They are trained by the National Statistical Systems Training Academy.

The first Economic Census was conducted in 1977.

The Second Five Year Plan of India followed the model developed by Prof. P.C. Mahalanobis, which focused on public sector development and rapid industrialization. The Government of India honoured him with one of the highest civilian awards *Padma Vibhushan*. The Government of India released a stamp on June 29, 1993 in commemoration of his 100th birthday. Recently, the Government of India released a commemorative coin on June 29, 2018 during the celebration of his 125*th* birthday.

(iii) Economic Statistics Division

This division is responsible for

- conducting Economic Census and Annual Survey of Industries
- compiling All India Index of Industrial Production
- collecting and compiling Energy Statistics and Infrastructure Statistics
- developing classifications like, National Industrial Classification and National Product Classification.

(iv) Training Division

This division is responsible for

- training manpower in theoretical and applied statistics to deal with the challenges of data collection, compilation, analysis and dissemination of information for policy making, planning, monitoring and evaluation
- looking after the National Statistical Systems Training Academy, which is a premier institute for developing human resource to deal with Official Statistics in India as well as at international level.

(v) Coordination and Publications Division

This division is responsible for

- coordinating the works related to statistical matters within CSO and the Ministries of Central Government and State/UT Governments
- organizing Conferences of Central and State Statistical Organizations
- celebration of National Statistics Day every year

- preparation of Results Framework Document, Citizens' Charter, Annual Action Plan and Outcome Budget of the MoS&PI
- implementation of Capacity Development Scheme and Support for Statistical Strengthening with an aim of improving the Capacity and Infrastructure of the State Statistical System for collection, compilation and dissemination of reliable Official Statistics for policy making
- coordinating implementation of recommendations of NSC
- administrative works related to Indian Statistical Institute.

8.2.2.2 National Sample Survey Office

National Sample Survey Office (NSSO), headed by a Director General, is responsible for conduct of national level large scale sample surveys in diverse fields. Primarily, data are collected through nation-wide household surveys on various socio-economic subjects. Besides these surveys, NSSO collects data on rural and urban prices and plays a significant role in the improvement of crop statistics through monitoring the area enumeration and crop estimation surveys of the State agencies. It also maintains a sampling frame of urban area units for conducting sample surveys in urban areas.

NSSO has four divisions. The divisions and their responsibilities are listed below:

(i) Survey Design and Research Division

This division, located at Kolkata, is responsible for

- technical planning of surveys
- formulation of concepts and definitions
- preparation of sampling design
- designing of inquiry schedules
- drawing up of tabulation plan
- analysing and presenting survey results.

(ii) Field Operations Division

The headquarters of this division is at Delhi. This division has a network of 6 Zonal Offices, 49 Regional Offices and 118 Sub-Regional Offices spread throughout the country. This division is responsible for collection of primary data for the surveys undertaken by NSSO.

(iii) Data Processing Division

The Division, with its headquarters at Kolkata and 6 Data Processing Centers at various places, is responsible for

- selection of sample subjects
- developing relevant software
- processing, validation and tabulation of the data collected through surveys.

(iv) Coordination and Publications Division

This Division, located at New Delhi, is responsible for

- coordinating all the activities of different Divisions of NSSO
- publishing the bi-annual journal of NSSO, titled "Sarvekshana"
- organizing National Seminars on the results of various socio-economic surveys undertaken by NSSO.

8.2.3 Present Statistical System in India

In addition to the role played by CSO and NSSO, most of the Central Ministries collect statistical information on the subjects related to the respective ministries. The statistical information are collected as by-products of administration of the ministries or for monitoring the progress of specific programmes implemented by the respective ministries. Some Ministries in Government of India, like Agriculture, Water Resources, Health, Finance, Commerce, Labour, and Industrial Development have separate statistical divisions, while most others have nucleus cells.

The Statistical System in the States is similar to the system at the Central Government. A Directorate of Economics and Statistics, functioning in each State under a decentralized system, is a nodal agency, which is responsible for the coordination of statistical activities in the State. The Directorates have statistical offices at the headquarters in each district. The district level offices collect statistical information related to all sections of economy of the respective district. The Directorates compile and publish such information as Statistical Hand Books every year. The Hand Books contain several information including estimates of area, production and yield of principal crops. In Tamil Nadu, the Directorate is functioning with the nomenclature "**Department of Economics and Statistics**". This department, with headquarters at Chennai, is headed by a Commissioner, who is assisted by a Director, 3 Additional Directors and 2 Joint Directors, in addition to Assistant Directors and supportive officials.

Generally, flow of statistical information in Indian Statistical System is upwards from village → block → district → State Government Departments → corresponding Ministries at the Centre.

In addition to CSO, NSSO and the Ministries, there are other public and private organizations in India, which also deal with collection of Official Statistics on various characteristics. Reserve Bank of India is one such organization, which collects, compiles and publishes, every year, the statistical information related to economy of the country as the "**Hand Book of Indian Economy**".

POINTS TO REMEMBER

- Vital Statistics are quantitative measurements on live births, deaths, foetal deaths, infant deaths, fertility and so on.
- Data on vital events are collected adopting the five methods - Civil Registration System, Census or Complete Enumeration method, Survey method, Sample Registration System and Analytical method.
- Census method normally covers data regarding age, sex, marital status, educational level, occupation, religion and other factors needed for computing vital statistics. Census is conducted in most countries at intervals of ten years.
- Rates of vital events are usually expressed '*per thousand*'.
- Crude Death Rate =

$$\frac{\text{No. of deaths in the population or community during the given period}}{\text{Total number of persons in the population or community during the given period}} \times 1000$$

- Specific Death Rate =

$$\frac{\text{No. of deaths in a specific section of the population during the given period}}{\text{Total number of persons in the specific section of the population during the given period}} \times 1000$$

- Infant Mortality Rate =

$$\frac{\text{No. of infant deaths in a population during the given period}}{\text{Number of live births in the population during the given period}} \times 1000$$

- ***Cohort*** is a group of individuals who born at the same time and experienced the same mortality conditions.
- A Life Table exhibits the number of persons living and dying at each age, on the basis of the experience of a ***cohort***, which also gives the life expectancy of the population.
- Radix of a Life Table refers to the number of survivors at the beginning of the table.
- Crude Birth Rate =

$$\frac{\text{No. of live births in the population during the given period}}{\text{Total number of persons in the population during the given period}} \times 1000$$

- General Fertility Rate =

$$\frac{\text{No. of live births occurred in the population during the given period}}{\text{Total number of women at the reproductive age in the population during the given period}} \times 1000$$

- Specific Fertility Rate = $\frac{\text{Number of live births to the women population in the reproductive age groups of specific section in a given period}}{\text{Total number of women in the reproductive age groups of the specific section in the given period}} \times 1000$
- Crude Rate of Natural Increase = Crude Birth Rate – Crude Death Rate
- Pearl's Vital Index $= \frac{\text{Crude Birth Rate}}{\text{Crude Death Rate}} \times 100$
- Official statistics are the statistical information collected and compiled on various aspects including all major areas of citizens' lives, such as economic and social development, living conditions, health, education and environment.
- An Official Statistical System was established in India by *Col*. Sykes during 1847 with a Department of Statistics in *India House*. The first Census Report of India was published in 1848.
- The Central Statistics Office is responsible for coordination of statistical activities in the country, and evolving and maintaining statistical standards, which has five main divisions.
- National Sample Survey Office (NSSO), headed by a Director General, is responsible for conduct of national level large scale sample surveys in diverse fields, which has four divisions.

EXERCISE 8

I. Choose the best answer.

1. One of the branches of Demography is
   (a) Economic Statistics (b) Vital Statistics
   (c) Official Statistics (d) Agricultural Statistics

2. When there is no proper system of recording births and deaths, Vital Statistics are collected through
   (a) Registration Method (b) Census Method
   (c) Survey Method (d) Analytical Method

3. Compulsory registration of births and deaths was implemented in India, during the year
   (a) 1947 (b) 1951 (c) 1969 (d) 1970

4. Rates of vital events are usually measured as
   (a) *per* ten lakh (b) *per* ten thousand
   (c) *per* thousand (d) *per* hundred

5. Death of a child before the child's fifth birth day is measured by
   (a) crude death rate (b) specific death rate
   (c) infant mortality rate (d) child mortality rate

6. Death rates due to different kinds of diseases can be calculated using
   (a) crude death rate (b) infant mortality rate
   (c) specific death rate (d) vital index

7. History of a *cohort* can be understood from
   (a) mortality rates (b) life table
   (c) fertility rates (d) population growth

8. Total number of women at child bearing age group is used to calculate
   (a) crude birth rate (b) general fertility rate
   (c) age specific fertility rate (d) population growth

9. Population growth can be measured using
   (a) crude birth rate, specific death rate
   (b) general fertility rate, infant mortality rate
   (c) specific fertility rate, specific death rate
   (d) crude birth rate, crude death rate

10. Vital Index measures
    (a) birth-death ratio (b) rate of vital event
    (c) infant mortality rate (d) general fertility rate

11. The first census Report of India was published in
    (a) 1858 (b) 1848 (c) 1948 (d) 1958

12. Department of Statistics in India House was established in India by Col. Sykes during
    (a) 1847 (b) 1947 (c) 1857 (d) 1887

13. The first Honorary Statistical Advisor to Government of India is
    (a) P.C. Mahalanobias (b) *Col*. Sykes
    (c) C. Rangarajan (d) Dr. Francis Buchanan

14. Ministry of Statistics and Programme Implementation was formed on
    (a) October 2, 1959 (b) October 15, 1999
    (c) November 13, 1969 (d) November 15, 1999

15. Secretary to MoS&PI and Head of NSO is
    (a) Chairman, Planning Commission (b) Director, NSSTA
    (c) Chief Statistician of India (d) CEO, NITI Aayog

16. National Statistical Commission was formed on
    (a) January 12, 2006 (b) April 12, 2006
    (c) June 12, 2006 (d) July 12, 2006

17. Celebration of National Statistics Day is one of the responsibilities of _____ Division of CSO.
    (a) Coordination and Publications (b) Training
    (c) Social Statistics (d) Economic Statistics

18. Collection of primary data for the surveys undertaken by NSSO is one of the responsibilities of _____ Division.
    (a) Survey Design and Research (b) Field Operations
    (c) Data Processing (d) Coordination and Publications

19. NSSO publishes the bi-annual journal
    (a) Sarvekshana (b) Sankhya (c) Pramana (d) Yojana

20. "Hand Book of Indian Economy" is published periodically by
    (a) State Bank of India (b) Reserve Bank of India
    (c) NSO (d) Ministry of Economics

II. Give very short answer to the following questions.

21. What is Registration method?
22. Define rate of vital event.
23. Mention the purpose of Analytical method in collecting Vital Statistics.
24. What is meant by mortality?
25. What is known as fertility?
26. What is *cohort*?
27. What is called radix of Life Table?
28. How will you calculate expectation of life?
29. Write down the formula to compute crude death rate.
30. What is the formula used to compute infant mortality rate?
31. Define crude birth rate.
32. What is specific fertility rate?
33. Write down the formula to compute general fertility rate.
34. Define vital index.
35. Specify the difference between crude birth rate and general fertility rate.
36. What are known as Official Statistics?
37. What were the Official Statistics collected by East India Company?
38. What were the earlier attempts made in India before British rule for collection of Official Statistics?
39. What are the wings of MoS & PI?
40. What are the divisions of CSO?
41. List the divisions of NSSO:
42. Which Ministries of Government of India have separate statistical divisions?

III. Give short answer to the following questions.

43. Write down the definitions of Vital Statistics.
44. Write a brief note on Census Method of collecting Vital Statistics.

45. What are various information collected under Sample Registration System?
46. If the number of deaths occurred is 980 in a town consisting of 1,50,000 persons during a period, quantify the death rate of the town using suitable formula.
47. Population size of a Hamlet in a hill station during a calendar year was 55,000 and the number of deaths recorded in the Hamlet during the same year was 185. What is the crude death rate of the village?
48. The number of women at reproductive age in a district is 70,000. Also, the number of live births and infant deaths registered in the district are respectively 10,000 and 70. Which mortality rate you will calculate? What is its value?
49. A Primary Health Centre located in a village has a record of 135 live births during a year. The number of deaths recorded in the village was 300. Among them, 5 are new born babies of age less than a year. Measure the infant mortality rate of the village.
50. What is specific death rate? What are its uses?
51. List various uses of Life Table.
52. What are the assumptions made in the construction of Life Table?
53. Population size of a District during a calendar year was 1,25,526. Also, the number of live births registered in the district during the same period was 987. Compute appropriate vital rate using this information.
54. The number of women at child bearing age in a tribal village during a year was 2275 and the number of new born babies of age less than a year in the same village was 23. How will you quantify the birth rate of the village? Find its value.
55. Write a brief note on specific fertility rate.

IV. Give detailed answer to the following questions.

56. What are the importance of Vital Statistics?
57. Calculate crude death rate of a population living in a town from the following data:

Age Group (in years)	0-10	10-20	20-40	40-60	60 and above
No. of Persons	6500	12,000	24,000	20,000	8,000
No. of Deaths	25	37	30	90	100

58. The number of deaths registered in a district with respect to age during a year and the population size in each age group are given below. Calculate the crude death rate of the district for the period.

Age Group (in years)	Below 15	15-25	25-40	40-65	65 and above
No. of Persons	40,000	88,000	90,000	60,800	23,000
No. of Deaths	40	62	100	78	20

59. The population of a District during a Census year was grouped into 8 age groups. The data regarding the number of deaths and the population size for each age group are given hereunder.

Age Group (in years)	0-5	5-15	15-25	25-40	40-50	50-60	60-65	65 and above
No. of Persons (in '000)	42,345	19046	93,578	30,724	28,874	62,087	28,473	37,693
No. of Deaths	900	798	512	186	174	213	475	883

Calculate the age specific death rates of the District.

60. Calculate the specific death rates for each age group of a population, whose size and the number of deaths are given in the following table:

Age Group (in years)	Below 10	10-20	20-40	40-60	60 and above
No. of Persons	36,000	28,000	62,000	52,000	18,000
No. of Deaths	682	204	576	878	725

61. What are the different components and their formulae of Life Table?

62. Find the missing entries in the following Life Table.

Age (in years)	$l(x)$	$d(x)$	$p(x)$	$q(x)$	$L(x)$	$T(x)$	$e^0(x)$
25	75818						
26	75445					2722331	
27	75039			0.009			

63. There are missing entries in some of the columns in the following Life Table. Find the values of the missing entries.

Age (in years)	$l(x)$	$d(x)$	$p(x)$	$q(x)$	$L(x)$	$T(x)$	$e^0(x)$
42	64711					1513333	
43	63787						
44	62821				62310		

64. The following is a section of a Life Table with some missing entries. Complete the Life Table.

Age (in years)	$l(x)$	$d(x)$	$p(x)$	$q(x)$	$L(x)$	$T(x)$	$e^0(x)$
36	69818						
37	69032						
38	68212	850				1779254	

65. Calculate crude birth rate from the following data:

Age Group (in years)	15-20	20-25	25-30	30-40	40-49
No. of Perosns	16,000	18,000	14,000	15,000	28,000
No. of Live Births	25	30	38	28	14

66. The women population at reproductive age in a State are grouped and the population size in each group are given hereunder. The number of live births given by the women in each group are also presented. Find the general fertility rate of the State. Also, calculate the age specific fertility rate for each group.

Age Group (in years)	15-20	20-25	25-30	30-35	35-40	40-45	45-49
No. of Women	2,12,724	1,89,237	2,45,367	1,32,109	1,29,645	90,708	34,975
No. of Live Births	20,209	23,655	37,787	12,815	9,723	4,898	874

67. The number of live births occurred in a District during a calendar year are classified according to the age of mother. The female population size at child bearing age are also given.

Age Group (in years)	15-20	20-25	25-30	30-35	35-40	40-45	45-49
No. of Women	4,729	6,236	8,034	9,408	5,907	4,657	2,975
No. of Live Births	356	845	970	1,878	856	608	452

Calculate the general fertility rate of the District. Also, calculate the specific fertility rates for each of the reproductive age group.

68. The following are the information registered about the number of live births and the female population size in a town during a calendar year.

Age Group (in years)	15-20	20-25	25-30	30-35	35-40	40-45	45-49
No. of Women	1,276	3,253	5,628	7,345	6,901	4,253	3,957
No. of Live Births	218	361	693	1,305	1,031	634	390

Calculate from these information the general fertility rate of the town and the age specific fertility rates for the year.

ANSWERS

I. 1. (b) 2. (c) 3. (d) 4. (c) 5. (d)
6. (c) 7. (b) 8. (b) 9. (d) 10. (a)
11. (b) 12. (a) 13. (a) 14. (b) 15. (c)
16. (d) 17. (a) 18. (b) 19. (a) 20. (b)

III. 46. *CDR* = 6.53 47. *CDR* = 3.36 48. *IMR* = 7.00 49. *IMR* = 37.04
53. *CBR* = 7.86 54. *GFR* = 10.11

IV. 57. *CDR* = 4.00 58. *CDR* = 0.99

59.

Age Group (in years)	0-5	5-15	15-25	25-40	40-50	50-60	60-65	65 and above
ASDR	21.25	41.90	5.47	6.05	6.03	3.43	16.68	23.43

60.

Age Group (in years)	Below 10	10-20	20-40	40-60	60 and above
ASDR	18.94	7.29	9.29	16.88	40.28

62.

x	$l(x)$	$d(x)$	$p(x)$	$q(x)$	$L(x)$	$T(x)$	$e^0(x)$
25	75818	373	0.9951	0.0049	75632	27,97,968	36.90
26	75445	406	0.9946	0.0054	75242	27,22,331	36.08
27	75039	675	0.9910	0.0090	74702	26,47,629	35.28

63.

x	$l(x)$	$d(x)$	$p(x)$	$q(x)$	$L(x)$	$T(x)$	$e^0(x)$
42	64711	924	0.9857	0.0143	64249	1513333	23.39
43	63787	966	0.9849	0.0151	63304	1449084	22.72
44	62821	1022	0.9837	0.0163	62310	1385780	22.06

64.

x	$l(x)$	$d(x)$	$p(x)$	$q(x)$	$L(x)$	$T(x)$	$e^0(x)$
36	69818	786	0.9887	0.0113	69425	1917301	27.46
37	69032	820	0.9881	0.0119	68622	1847876	26.77
38	68212	850	0.9875	0.0125	67787	1779254	26.08

65. *CBR* = 1.48

66. *GFR* = 106.27

Age Group (in years)	15-20	20-25	25-30	30-35	35-40	40-45	45-49
ASFR	95.00	125.00	154.00	97.00	75.00	54.00	24.99

67. *GFR* = 142.21

Age Group (in years)	15-20	20-25	25-30	30-35	35-40	40-45	45-49
ASFR	75.28	135.50	120.74	199.62	145.06	130.56	151.93

68. *GFR* = 142.03

Age Group (in years)	15-20	20-25	25-30	30-35	35-40	40-45	45-49
ASFR	170.85	110.97	123.13	177.67	149.40	149.07	98.56

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