Module: 23

Basic Measures of Fertility

23.1 Introduction:

This module is to provide various measures of fertility and to introduce the concepts and definitions of the measures which are generally used in the structure of fertility.

23.2 Learning objectives:

- Period measures
- Cohort measures
- Crude Birth Rate (CBR)
- General fertility rate (GFR)
- General Marital Fertility Rate (GMFR)
- Age-Specific Fertility Rate (ASFR) and Age-Specific Marital Fertility Rate (ASMFR)

23.3 Types of Fertility Measure:

There are two broad types of measures of fertility:

The analysis of fertility is basically carried out in two ways: one is in a period perspective and the other in a cohort perspective. The events that occur in a given period of time (calendar years) are studied in relation to the durations of exposure of the population during that period. In cohort the events and duration of exposure are studied for well-defined cohorts as they move over time. The term "cohort" indicates a group of people who have a similar experience at the same time. Two types of cohorts are generally used in demography – Birth cohorts and marriage cohorts.

- ***Period measures***
  They are related to a period and based on data on the number of births in that period. These include Crude Birth Rate (CBR) General fertility rate (GFR), and Child Women Ratio (CWR).

- ***Cohort measures***
  In any sample fertility survey, a question is usually asked about number of children ever born (CEB) to women up to a time in the reproductive age groups. Using this approach, fertility is estimated indirectly on the basis of age and sex distribution of the population. These include Total Fertility Rate (TFR), Gross Reproduction Rate (GRR), and Net Reproduction Rate (NRR).

Second categorization of measures of fertility is:

- ***Direct Measures of Fertility:***
- ***Indirect Measures of Fertility*:**

23.4 Direct Measures of Fertility:

In these methods, data on live births are directly used. Some Direct Measures of Fertility are described below:

23.4.1 Crude Birth rate (CBR):

It is defined as the ratio of total births in a year in a specified area divided by total mid-year population of the same specific area in the same year multiplied by a constant K.

CBR= B/P*1000

Where B= the total number of live births in a year

P = the total population in the middle of the year and

K= is constant, usually 1000.

Example : $\mathbf{CBR} = \frac{\mathbf{539427}}{\mathbf{31841374}}$ **X 1000 = 16.9**

Advantages and Disadvantages of CBR

CBR is an important measure of fertility, for it directly links fertility to the growth rate of population. Computation of CBR is easy and quick, and requires minimum data. CBR also indicates the level of fertility in a population. A major weakness of CBR is that it is not very sensitive to small fertility changes; in fact it tends to minimize them. CBR is affected by many factors: age, sex, and marital status. It is also influenced by age structure of the population, and by level of fertility and age pattern of fertility.

23.4.2 General fertility rate (GFR)

The relative frequency of childbirth varies significantly with the age of parents. The age at which maximum fertility occurs may be different for the males and females. Further, fertility is highest among couples who have established some type of cohabitation (legal marriage, or common law marriage) than among persons not in such a union (single). Conversely, specific fertility rates are given separately for female parents and male parents.

Usually, children are born to women between the ages of 15 and 45 years, which is known as the reproductive age group. The fertility rate for this group, called the "General Fertility Rate" (GFR), is calculated as the ratio of total number of yearly births to the total number of females (mid-year population) of child bearing ages (15-44 or 15-49 years).

$$\mathbf{GFR} = \frac{\mathbf{No\ of\ Births\ during\ a\ year}}{\mathbf{Mid-year\ female\ population\ aged\ 15-49}}\ \mathbf{X\ 1000}$$

Where B is the total number of births that occur during a calendar year and $F_{15\text{-}44}$ is the female population of child bearing ages (15-44 or 15-49 years) in the middle of the calendar year. K is a constant, usually taken as 1000. The purpose of having a GFR is to restrict the denominator to potential mothers, but too not restrictive for analysis.

23.4.3 General Marital Fertility Rate (GMFR)

Besides age, marital status is an important factor in fertility. In almost all societies in the world, birth is allowed only in a marital bond. Therefore, it may be more appropriate to consider only currently married women, and not all women, in the reproductive ages.

Fertility calculated in this manner is termed as General Marital Fertility Rate (GMFR), and is calculated from the following expression:

$$\mathbf{GMFR} = \frac{\mathbf{Live\ births\ in\ a\ year}}{\mathbf{Married\ women\ aged\ 15-49}}\ \mathbf{X\ 1000}$$

GFMR = (53942 / 6497495) *1000 = 83

GMFR = $(B/W^{m}_{15.44})$ K (8.3), where $W^{m}_{15.44}$ is the mid-year number of married women in the reproductive ages. Although it is a refinement over CBR, GFR also suffers from certain limitations. The measure considers the entire female population in the reproductive ages as a homogeneous group, whereas the fecundity of women is not uniform during the period. Thus, GMFR must also be considered as a crude rate.

23.4.4 Age-Specific Fertility Rate

The age-Specific Fertility Rate (ASFR) addresses the limitations of GMFR. AFSR is calculated in the following manner:

$$\mathrm{ASFR} = \frac{\text{Births to women aged } (x, x+n) \text{ in a year in a year}}{\text{Mid-year female population aged } (X, X+n)}\ \mathrm{X}\ 1000$$

The reproductive age interval 15-49 can be either divided into single or five year or wider intervals and rates could be made specific for each age group. Because of the wide variations in fertility by age, age specific fertility rates have been found to be very useful. Generally five year age groups of women are used for calculating the ASFR, resulting in seven numbers, one for each age group -15-19, 20-24,----, 45-49. For the calculation of this measure, it is necessary to have births classified by the age of the mother as well as all women by the same age group. The ASFR obtained for the women in the age group 20-24 is given below.

ASFR (20-24) = (223656 / 1543523) x1000 = 144.9

Similarly one can calculate ASFR for all age groups (see table 23.1).

Table 23.1: Age Specific Fertility Rate

Age group	No. of births	Female population	ASFR/1000
15-19	36748	1499920	24.5
20-24	223656	1543523	144.9
25-29	198224	1489290	133.1
30-34	63738	1330656	47.9
35-39	15083	1311576	11.5
40-44	1685	990887	1.7
45-49	292	974123	0.3
Total	539427	9139975	
Total population		31841374	

The general pattern of the ASFR is the rate increases to a maximum between ages 20-29 and then decreases slowly to reach zero by age 50. The curve depicting the age pattern of fertility, called fertility curve appears to have a standard pattern (see Fig: 23.1). The modal value of the curve depends to a certain extent on the age at marriage of women of the population. Fertility curve based on ASFR calculated in the above table is given in Figure 23.1.

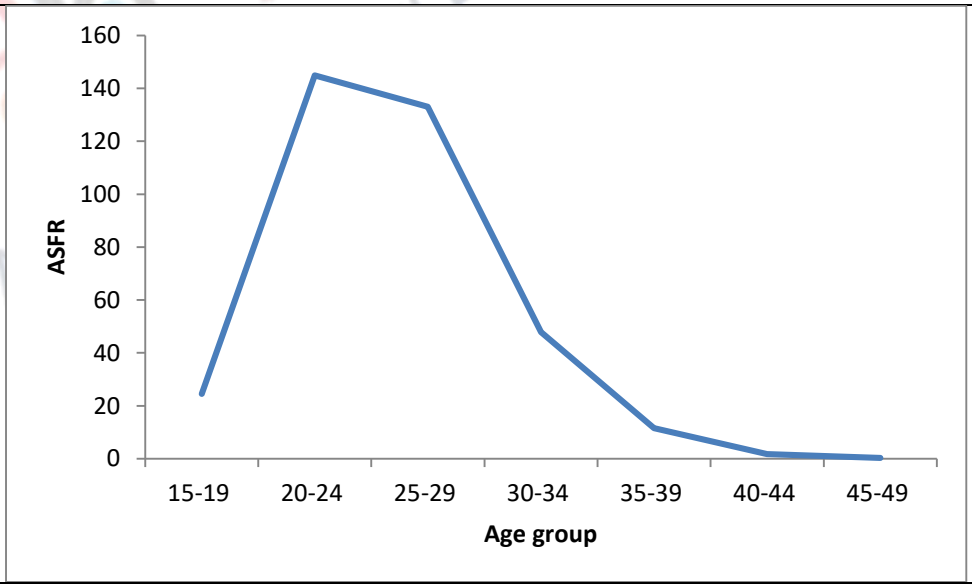

Figure 23.1- Fertility curve based on ASFR calculated in the table 23.1

Source: Data from table 23.1

23.4.5 Age-Specific Marital Fertility Rate (ASMFR)

One must note that the measure ASFR can be used with reference to only currently married women in an age group. Thus, it becomes necessary to introduce an Age-Specific Marital Fertility Rate (ASMFR), which can be expressed as:

$$\text{ASMFR} = \frac{(x, x+n) \text{ in a year}}{\text{Mid} - \text{year population of married women aged } (x, x+n)} \text{ X } 1000$$

Since there is a possibility of greater incidence of unmarried women in the early age groups, and divorced, separated and widowed women in the older age brackets of the reproductive age span, ASMFR provides a more realistic picture of fertility levels in a population.
It is also possible to compute the total marital fertility rate (TMFR), which is equivalent to the TFR for a married woman.

Table 23.2: Age Specific Marital Fertility Rates

Age group	No. of births	Married Women	ASMFR/1000
15-19	36748	195900	176.1
20-24	223656	886143	252.4
25-29	198224	1264506	156.8
30-34	63738	1201449	53.1
35-39	15083	1176174	12.8
40-44	1685	857050	2.0
45-49	292	796018	0.4
Total	539427	6390073	
Total population		31841374	

The TMFR obtained using above example (Table:23.2) is,

TMFR =[(176.1+252.4+156.8+53.1+12.8+2.0+0.4)x5/1000]=3.3

23.4.6 Total Fertility Rate

ASFR can be calculated from a single year's age data as well as for broader age groups. Usually, the reproductive age span is divided into age groups in five-year intervals. Thus, there would be six or seven groups, depending on the upper limit of the reproductive age span. This makes comparison between two or more populations a cumbersome exercise. Thus, we use the Total Fertility Rate (TFR), a summary measure of ASFR, to facilitate comparison. TFR is obtained by multiplying the sum of ASFR by the width of the age group, and then dividing the product by the value of radix (i.e., 1,000). Consider the following:
TFR = {(∑ ASFR) n}. 1/K, where 'n' is the width of the age group and 'K' is the value of the radix. Thus, TFR refers to the total number of children a woman will produce during her childbearing age span if she is subjected to a fertility schedule as prescribed by the age-specific fertility rates. TFR, together with ASFR, can be further used to construct several useful measures for the study of fertility changes (Rama kumar, 1986:89).

23.4.7 Sex Age Adjusted Birth Rate (SAABR)

Another measure that reduces the effects of age structure to a minimum and hence, facilitating comparison of the fertility levels of two or more populations is Sex Age Adjusted Birth Rate (SAABR). The United Nations defines it as "the number of births per 1,000 of a weighted sum of the number of women in various five-year age groups from 15 to 44" (UN, 1956:42)[1].

The UN recommends a standard set of weights (1, 7, 7, 6, 4 and 1) corresponding to the six five-year age groups in the reproductive age span from 15 to 44 years. These weights are roughly proportional to the typical relative fertility rates of various age groups. These weights were derived based on a study of 52 nations having varying levels of fertility.
SAABR is calculated from the expression:

SAABR = B/[(1xW1) + (7xW2) + (7xW3) + (6xW4) + (4xW5) + (1xW6)].
'B' is the number of live births in a calendar year and W1, W2…. W6 are the number of women in the six five-year age groups in the reproductive age span. In the calculation of TFR , if only female births are considered, the resultant measure will be known as *Gross* Reproduction Rate (GRR).

23.4.8 The Gross Reproductive Rate (GRR):
The total fertility includes all births, both male and female. The GRR shows how many girls babies, potential future mothers, would be born to 1000 women passing through their child bearing years, if the age specific birth rates of a given year remained constant and if no women entering the child bearing period died before reaching menopause. It represents the average number of daughters who would replace their mothers, assuming that the age and sex specific fertility rate for the current period were to continue indefinitely (Woods, R., 1979)[2].

GRR indicates the number of daughters that every woman is likely to bear during her entire childbearing age span, if she is subjected to a fertility schedule as prescribed by given sex and age-specific fertility rates. Also considered as replacement index, this measure is generally used while comparing current fertility in different populations.

Calculation of GRR requires data on the number of live births by sex along with distribution of women in different age groups in the childbearing age span. In case the data is available, GRR can also be worked out by simply multiplying the TFR by feminity ratio (the ratio between the number of female babies born and the total live births in a population). In India, for example, 105 male babies are born for every 100 female babies. Thus, the feminity ratio is 0.4878 (i.e., 100/205).

Then, GRR will be calculated from the following formula:
GRR = TFR X Feminity Ratio
As with TFR, GRR also assumes that women in the reproductive age group will survive till the end of their child-bearing period. GRR, thus, indicates the number of daughters a woman is expected to produce, if there is no attrition in the cohort due to mortality (Bhende and Kanitkar, 2000:262)[1]. This is, however, not a realistic assumption.

23.4.9 Net Reproduction Rate (NRR)
The Net Reproduction Rate (NRR), a refinement over GRR, with a component of mortality built into it, allows for decrease due to deaths among mothers.
Thus, NRR is the number of daughters ever born to a woman, if she gives birth according to the given schedule of age-specific fertility rates, and experiences given age-specific mortality rates up to the end of her reproductive span. NRR measures the extent to which a woman will replace herself by female babies under predetermined schedules of fertility and mortality.

23.5 Indirect Measures

In addition to the direct measures discussed above, there are some indirect measures of fertility, which are useful particularly when data on live births are not readily available, or are not reliable. These measures arrive at estimates of fertility indirectly using data on age-sex structure, and marital status, and cross-classified by age and sex. Child Women Ratio and Female Mean Age at Marriage are most commonly used indirect measures.

23.5.1 Child-Women Ratio
It is a ratio, which a population has between the women and the children. A child is considered to be a baby between the age of 1 to 5 years. It is expressed in terms of number of children below five years of age per thousand females of reproductive age group (15-49 years). P(0-5) Child-women ratio = x 1000 FP(15-49) Where, P(0-5) = number of children under 5 years of age FP(15-49) = female population in child bearing age group (15-49 years) It represents the number of children under 5 years

of age per 1000 women of child bearing age. Figures from census as well as registration office are used to calculate the ratio.

Mathematically, it is expressed as:
CWR= ($P_{0-4}/W_{15-44 \text{ or } 49}$) K.

Where, P_{0-4} is the number of children in the age groups 0-4 years and $W_{15-44 \text{ or } 49}$ is the number of women in the reproductive ages. Here, 'K' is usually taken as 100. As P_{0-4} is the survivors of the children born over the preceding five years, and not the total births, CWR is affected by infant and child mortality. Hence, it is not a very accurate measure of fertility. Nevertheless, it may be used as a relative measure to study the fertility performance of different sections of the same population (Barclay, 1958:172)[1].

23.4.2. Mean Age at marriage

Age at marriage is said to have significant bearing on the fertility performance of women in a population. If age at marriage is low, women start bearing children at an early age. But, when the age at marriage is raised, the reproductive span is reduced, and overall fertility level is low. Mean age at marriage, therefore, is taken as a proximate indicator of fertility levels. Mean age at marriage for women can be worked out using Hajnal's method:

$$\text{Mean Age at Marriage for Women} = \sum_{X=0}^{K} (n.{}_nSx - Sk.K)/1 - Sk$$

Where, ${}_nSx$ is the proportion of single women in the age x to x + n, Sk is the proportion of single women at age K (i.e., 50 years) and n is the age interval.

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