4.2 Measures of Fertility

The demographic studies of fertility deal with certain phenomena connected with hu reproduction (Multilingual Demographic Dictionary). The basic notion of fertility is an a level of performance in a population, based on the numbers of births that occur. Me scientists frequently use fertility and fecundity interchangeably. Distinction should be between these two terminologies. Fecundity is the physiological capacity of a female to children whereas fertility is the actual outcome of conception. There are many terminol being used for fertility study which should be known to demographers, particularly dealing medical side.

Fertility is one of the most important components of population which can bring changes age and sex structures. A country where fertility is very high has broad base popu consisting of large proportion of children causing issues relating to literacy, schooling, cr of jobs etc.

4.2.2 Crude Birth Rate

Crude birth rate (CBR) is an important indicator of fertility defined as number of births per thousand mid year population in a year. It is easier to compute and amenable to statistical analysis for drawing meaningful conclusions. However, it is a crude measure of fertility as population (P_{mid}) used as denominator for computation is not exposed to the risk of events (B) here births, being used as numerator. Moreover it may mislead while comparing fertility levels of two or more regions or countries if these have different age structures.

In mathematical notations it is defined as

$$CBR = \frac{B}{P_{mid}} \times 1000$$

Where B is the number of births in a year and P_{mid} is the mid year population in the same year.

Example: According to Pakistan Demographic Survey (PDS), 1999 the estimated mid 1999 year population of Pakistan (excluding FATA, military restricted areas and protected area of NWFP) was 126449843 and births from 1st January to 31st December of same areas and year were 3876658, thus:

$$CBR = \frac{B}{P_{mid}} \times 1000 = \frac{3876658}{126449843} \times 1000 = 30.66 \text{ births per thousand persons.}$$

4.2.3 General Fertility Rate

General fertility rate (GFR) is a bit refined rate as compared to CBR but slightly difficult to compute and the segment of population used as denominator is still not exposed to the risk of births or child bearing. It is defined as the number of births in a year per 1000 women of child bearing ages that is between ages 15 and 44 years or 49. GFRs of two areas, regions or countries can not be compared for differential study of fertility because of difference in the age structure of their female populations. In mathematical terminologies GFR is represented as:

$$GFR = \frac{B}{F_{(15-49)}} \times 1000$$

Example: According to PDS, 1999 the total female population aged 15-49 was 29066897 1999 and births equal 3876658, thus:

$$GFR = \frac{B}{F_{(15-49)}} \times 1000 = \frac{3876658}{29066897} \times 1000$$

= 133.37 births per thousand females of ages between 15 and 49 years.

Age Specific fertility Rates (ASFRs):

ASFR can be worked out by dividing number of births (Bi) by Women of any specific age group in a year with corresponding number of females (Fi) of same age group.

It is expressed as birth per 1000 women of a specified age.

$$ASFR = \frac{Bi}{Fi} \times 1000$$

Advantages

→ It is not affected by age & structure
→ amenable to statistical analysis.
→ It draw meaningful conclusion
→ It is more refined indicators than crude birth rate (CBR) and General fertility rate (GFR).
→ It is useful for projection of population by ages.
→ Comparison of such rates of regions, areas or countries is possible.

Disadvantages

→ It is difficult to compute.
→ It can't give result in a single figure which can easily compare fertility levels of two populations.

Example:

Number of females and births by ages of females are given then we can find ASFR:

Age(i)	Females(F_i)	Births(B_i)	ASFR $\left(\frac{B_i}{F_i} \times 1000\right)$
15-19	6973888	246174	$\frac{246174}{6973888} \times 1000 = 35.3$
20-24	5638319	1132745	200.9
25-29	4488987	1124297	250.5
30-34	3744430	748191	199.8
35-39	3436735	403298	117.3
40-44	2685988	166686	59.8
45-49	2398548	61268	25.5

ASFR increases sharply from theryl low of 35.3 births per thousand women of age 15-19 to 200.9 by age 20-24 and touch to its peak on age 25-29 that is 250.5 births per thousand women. then start declining and reached minimum level at the end of reproductive age/ Period.

(4) Total Fertility Rate (TFR)

TFR can be interpreted as number of children born to a women by the age she reaches to 50 years assuming that she followed the pre-set schedule of ASFRs.

TFR is computed as the sum of ASFRs weighted by the number of years in each age group.

$$TFR = a \cdot \sum_{i=15-19}^{45-49} ASFRs/1000 \Rightarrow \text{If } ASFR = \frac{B_i}{F_i} \times 1000$$

$$TFR = a \cdot \sum_{i=15-19}^{45-49} ASFRs \Rightarrow \text{If } ASFR = \frac{B_i}{F_i}$$

where

a = number of years in each age group.

Example

Age	Females(F_i)	Birth(B_i)	ASFR $\left(\frac{B_i}{F_i}\right)$
15-19	6973888	246174	0.03530
20-24	5639319	1132745	0.20090
25-29	4438987	1124297	0.25046
30-34	3744430	748191	0.19981
35-39	3436736	403298	0.11735
40-44	2685688	160686	0.05982
45-49	2398548	61268	0.02554
Total	29366896	3876659	0.88919

$$TFR = a \cdot \sum_{i=15-19}^{45-49} ASFR_i$$

$$= 5 \times 0.88919$$

$$= 4.44594 \cong 4 \text{ children born per}$$

women by the time she reached to her 50th anniversary.

→ TFR gives results in a single figure which can easily guide about prevailing level of fertility and facilities in comparability.

→ It is amenable to statistical analysis.

→ It is widely used measure of demography.

→ It is useful for projection of population.

(5) Gross reproduction rate (GRR):

Average number of female children born to a woman by the time she attains age of 50 year.

Or in other words, It is the number of female children replacing her mother by the time mother reached to her 50th anniversary provided the mother follows the pre-set schedule of fertility.

$$GRR = TFR \cdot \left(\frac{1}{1+SR}\right) \quad \longrightarrow i)$$

We read before Sex Ratio (SR) is the number of males per 100 females. Here we are discussing fertility so the SR will be number of male births per 100 female births. If we take simple ratio not taking answer in per 100. the $SR_{\text{at Birth}}$ will be.

$$SR = \frac{B_m}{B_f}$$

B_m = Number of male births

B_f = Number of female births.

So the equation (i) will be

$$GRR = TFR \cdot \left(\frac{1}{1 + \frac{Bm}{Bf}}\right)$$

$$= TFR \left(\frac{1}{\frac{Bf + Bm}{Bf}}\right)$$

$$\boxed{GRR = TFR\left(\frac{Bf}{Bt}\right)} \quad \because Bf + Bm = Bt$$

Bt = total number of births

Example: GRR calculation by first formula you can see by notes. And the GRR calculation by 2nd formula is as follows:

In 2013, the TFR was 3.4 and the total live Births in year was 4,964,000 in which 2,670,000 were females.

$$GRR = TFR\left(\frac{Bf}{Bt}\right)$$

$$GRR = (3.4)\left(\frac{2,670,000}{4,964,000}\right)$$

$$= (3.4)(0.54)$$

$$= 1.836 \cong 2 \text{ female children}$$

born per woman by the time she reached to her 50th anniversary.

GRR gives an idea about replacement level but is a rough measure as mortality is not taken into consideration.

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(6) Net Reproduction Rate (NRR):

NRR means average number of female children to a woman and surviving till their end of reproductive period. It reflects the actual replacement level of female population during their reproductive period.

However it is very difficult to calculate and required some knowledge about life table.

Net Reproduction Rate is always lower than GRR, because it takes into account the fact than some women will die before entering and completing their chil-bearing years.

$$\boxed{NRR = GRR \times S} \quad \text{— (i)}$$

S = Survival ratio from birth to age $x+n$ (If data is given in "n" years interval).

$$NRR = GRR \times S$$

we will read this after mean age (Life table)

$$= \frac{TFR}{1+SR} \times \left(\frac{{}_5L_x}{5 \times l_0}\right)$$

$$= \frac{5 \times \sum ASFR_s}{1+SR} \times \frac{{}_5L_x}{5 \times l_0}$$

$$NNR = \frac{\sum ASFR_s}{1+SR} \times \frac{{}_5L_x}{l_0}$$

for each age group it become

$$\boxed{NRR = \sum \left(\frac{ASFR}{1+SR} \times \frac{{}_5L_x}{l_0}\right)}$$

Example: given ASFR, ${}_5L_x/l_0$ in table and also SR = 1.085.

Age	ASFR	${}_5L_x/l_0$	$\frac{ASFR}{1+SR}$	$\frac{ASFR}{1+SR} \times \frac{{}_5L_x}{l_0}$
15-19	0.0353	3.88727	0.01693	0.065813
20-24	0.209	3.79787	0.096355	0.365943
25-29	0.25046	3.68824	0.120125	0.443049
30-34	0.19981	3.57334	0.095832	0.342441
35-39	0.11735	3.45368	0.056283	0.104383
40-44	0.05982	3.32597	0.028691	0.095494
45-49	0.02554	3.1997	0.012249	0.038949

NRR = 1.546003

1.55 female children to a woman ~~and~~ that surviving till their end of reproductive period.

~~It~~ The replacement level of female population during their reproductive period is 1.546003.

(7) Child Woman Ratio (CWR):

It is computed by dividing the number of children under 5 (P_{0-4}) by number of women 15 to 49 (P^{f}_{15-49}) years old. It may be viewed as a proxy of general fertility rate or as a measure of effective fertility, which takes into account child mortality

$$CWR = \frac{P_{0-4}}{P^{f}_{15-49}} \times 1000$$

This measure tells you that how many children (under 5) to per thousand women of age 15-49.