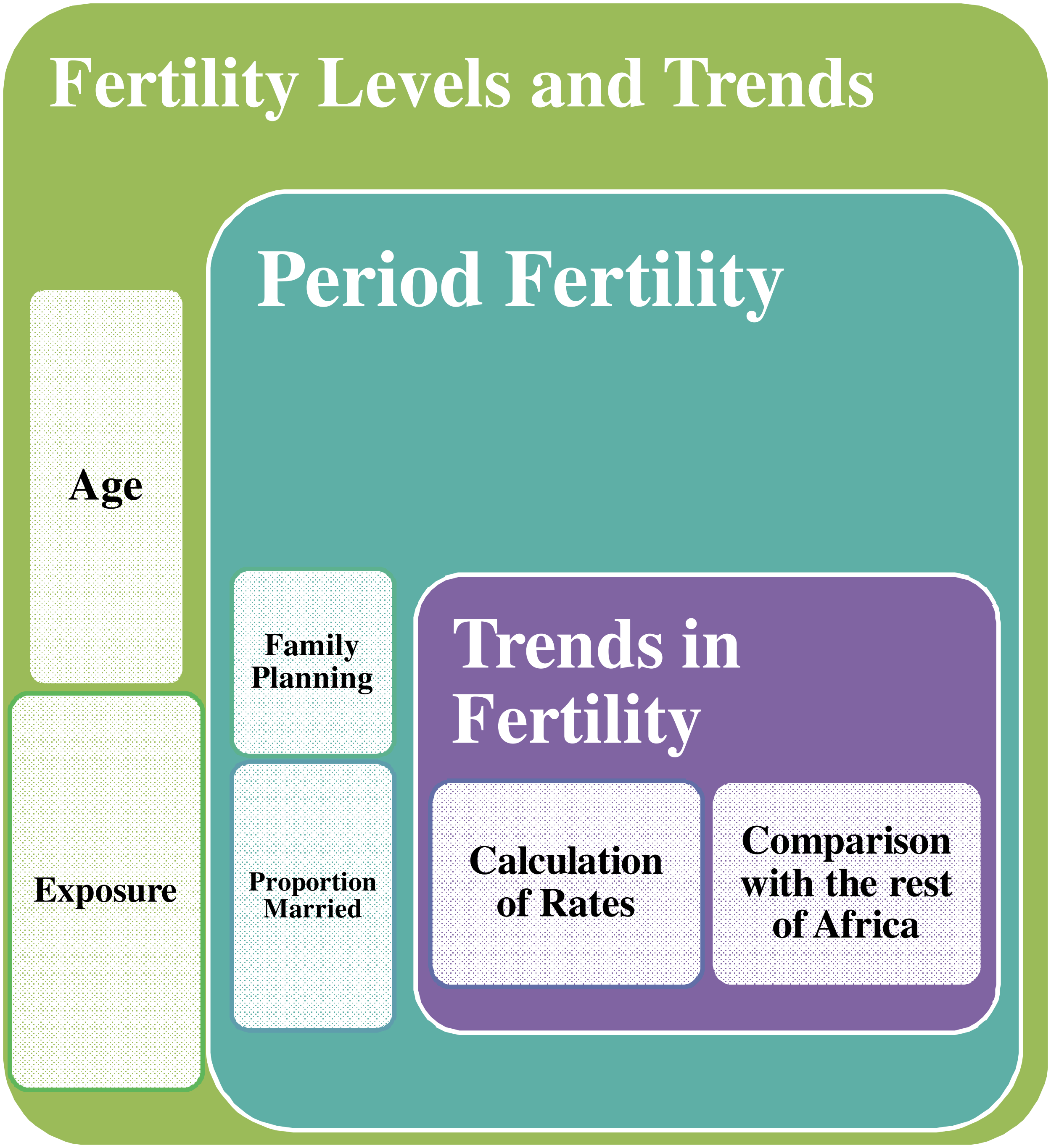
LESSON FIVE

FERTILITY LEVELS AND TRENDS

Aynalem Adugna

Learning Objectives:



Introduction

Accurate data on fertility in Ethiopia had been hard to come-by until the start of the 1990 National Family and Fertility Survey (FFS), and the Demographic and Health surveys (DHS). There have been two DHS surveys, one in 2000 and the other in 2005. Fertility statistics for the pre-2000 years come mainly from the general-purpose (not fertility-specific) national sample surveys and two censuses. At a sub-national level, the 1995 Fertility Survey of Urban Addis Ababa, and the 1997 Community and Family Survey (CFS) in SNNPR - a collaboration between the Demographic Training and Research Center (DTRC) of Addis Ababa University and the Population Studies and Training Center (PSTC) of Brown University - can be mentioned.

> "The 1990 National Family and Fertility Survey (NFFS) was the first nationally representative survey that incorporated wider information on fertility, family planning, contraceptive use and other related topics. In addition to the topics covered by the NFFS, the 2000 EDHS collected information on maternal and child health, nutrition and breastfeeding practices, HIV and other sexually transmitted diseases." [1]

One might wonder what the fertility trends had been over the stated period of 15 years (1990 to 2005) covered in these surveys. The researchers in the SNNPR fertility study partly tested the hypothesis of a possible continuation, into the future, of a high fertility regime in Ethiopia due to its ethnic diversity:

> "As in many African counties, ethnic groups in Ethiopia have remained quite distinct for a long period. This long period of exclusiveness, compounded by ethnic competition for political power, resulted in increased intensity of ethnic affiliation. Ethnic commitments in Ethiopia intensified after the new government came to power in May 1991. Since then an increasing number of ethnic-based political parties have been formed and new federal regions have been demarcated along ethnic lines. This in turn has led to a greater ethnic sentiment and increasing variety in its social institutions, and the issue of numerical strength has gained salience, especially among minority ethnic groups. Given this increasing pattern of ethnic intensity, any differences in fertility and fertility-related behaviors will have important social, economic, and political consequences for the future of the nation." [2]

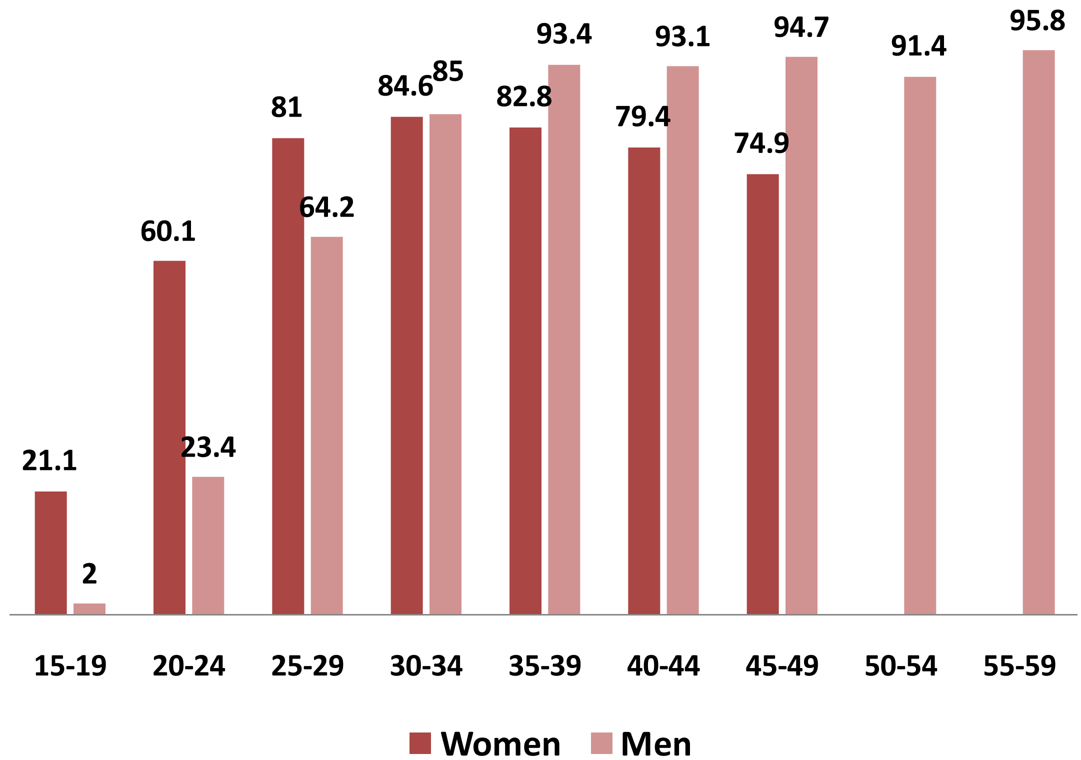
Their detailed analyses of data using the entropy index showed that ethnic diversity in Ethiopia and possible competition for influence through sheer numbers did not condemn the country to perpetually high fertility rates. One of their conclusions regarding SNNPR is that, " …neither ethnoreligious group dominance, religiosity, nor community diversity is an obstacle for efforts to promote fertility limitation practices in the SNNPR. Moreover, community diversity, rather than being an inhibiting factor, appears to be strongly associated with key ingredients for reproductive preferences, attitudes, and behavior that will lead to lowered fertility." [2]

How about the rest of Ethiopia? Is fertility rising or falling? More than politics or ethnic loyalties the answer would lie in whether or not there have been, or will be, changes in proximate determinants (age at marriage, proportion of married women, contraceptive prevalence, and lactational amenorrhea). Another question would be whether or not differentials and trends in these variables, say between urban and rural, or between the Guraghe and Sidama, will lead to differences in fertility levels and trends. Proximate determinants are discussed in detail in the next lesson but we will take a brief look at just two of them here– proportion married and percentage using contraceptives. The 2005 DHS shows clear urban-rural differentials, but since breakdowns by ethnicity are not available in published reports the differences between region, say between Oromiya and Amhara, can be thought of as crude indicators, even though there are ethnic diversities within Oromiya and Amahara.

Proportion Married

Nearly two thirds of women are already married by the time they reach age 25. More than a fifth are already married by age 15 but Fig. 4.1 confirms that they are not married to males in their own age group. Only 2% of males in the 15-19 group are married. The CSA reported a population of over 4 million women in the 15-19 age group [4] of whom, it appears, about 800,000 are already married. The highest proportion of married women is in the 30-34 age groups after which the percentages decline somewhat due to the combined effects of divorce, separation, and widowhood. It is not our intention here to try and tease out the contributions of each of these forces.

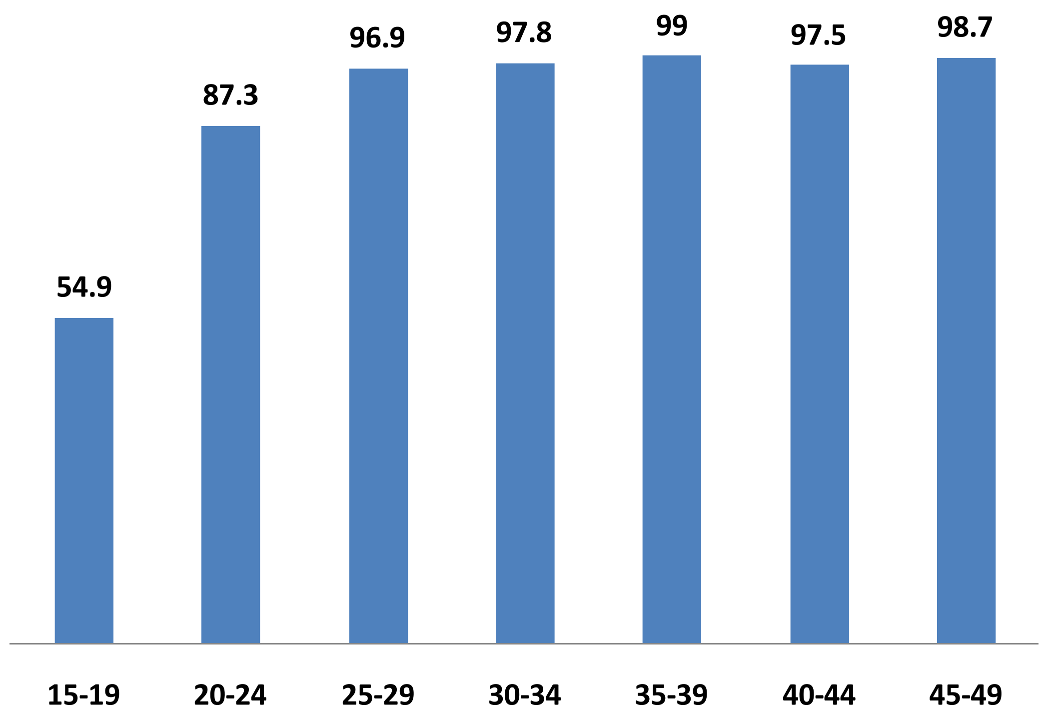
Fig. 5.1 Proportion of married Men and Women by Age Group (Ethiopia 2005)



Source: [1]

Figure 5.2 shows that nearly 55 percent of married women in the 15-19 age category are already mothers. In a country with nearly 80 million people and over 4 million young women in this age group (with 800,000 already married) and 400,000 women currently nursing a baby, it is obvious that child bearing starts early in Ethiopia with very young women making substantial contributions.

Fig. 5.2 Percentage of Married Women who are already Mothers

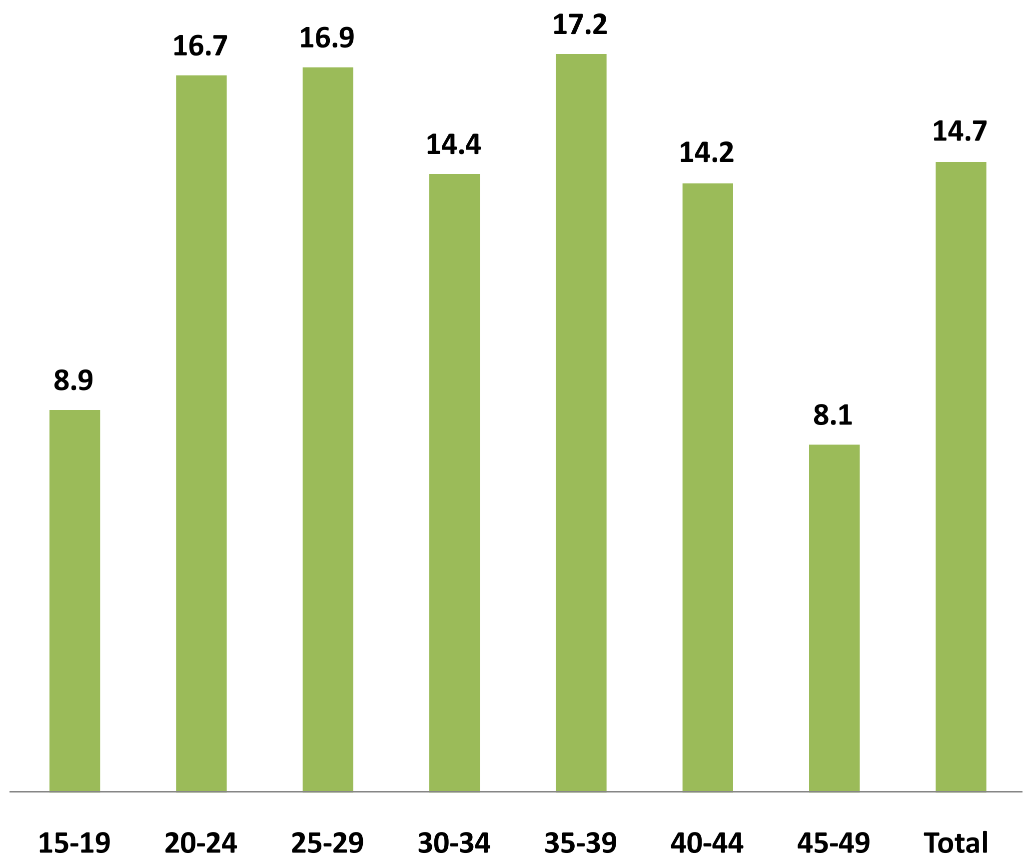


Source: [1]

Family Planning

About one in seven (14.7%) of currently married Ethiopian women are using modern contraception. This is a sign of great progress given the very low base line rate of 4.8 % documented in the 1990 NFFS and 8.1% in the 2000 DHS [1]. At 0.9% the proportion of married women using traditional methods of birth control is extremely low. The breakdown by age groups reveals the same facts. There is a preponderance of reliance on modern methods both among young and older women to a near exclusion of traditional (natural) family planning techniques.

Fig. 5.3 Percentage of Currently Married Women using Modern Method of Contraception by Age Group (Ethiopia, 2005)



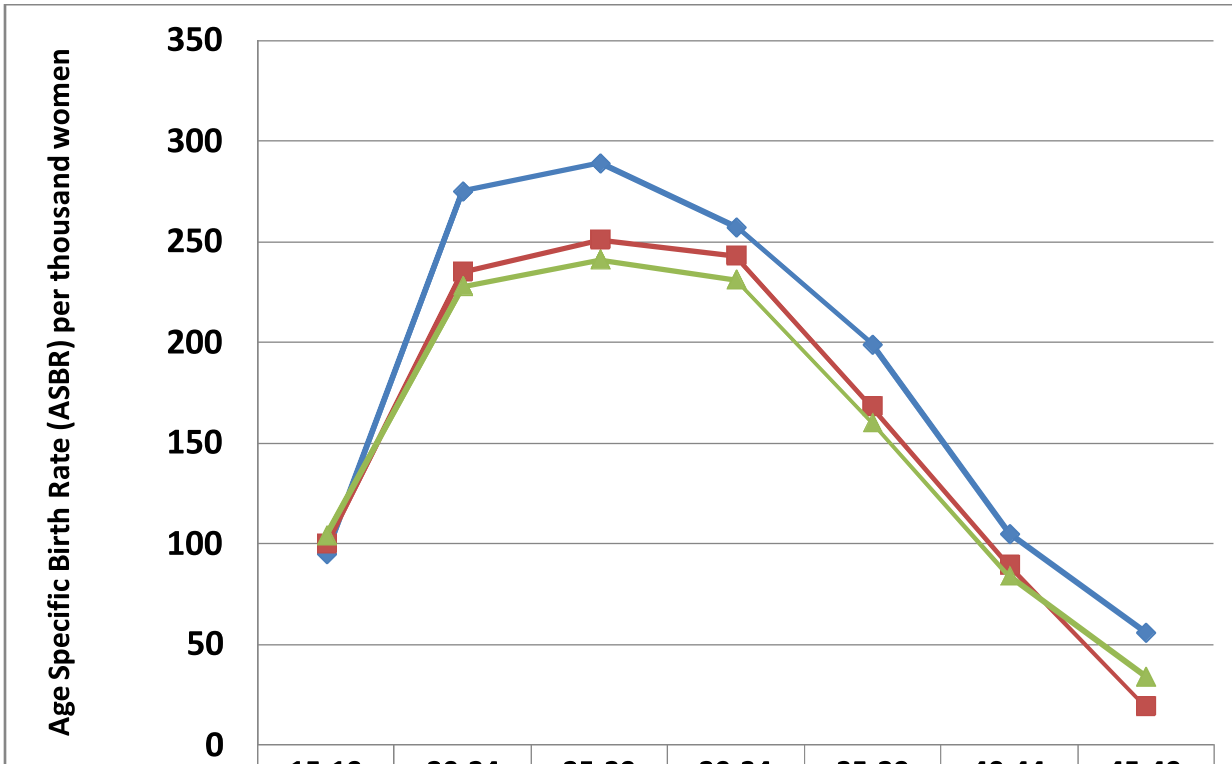
Source: [1]

One would expect a much larger percentage of young women, (those in the 15-19 and 20-24 age group, for instance) than older women to know about, accept, and use modern contraceptives. However, Fig. 5.3 shows a different reality whereby less than 9% of women in the 15-19 age group and 16.9 percent in the 20-24 age group use contraceptives.

Fertility Trends 1990 to 2005

Fertility is on a decline in Ethiopia, and this is one of the rare good news from the demography front. A 2005 survey data showed the total fertility rate in Ethiopia (the average number of children born to an Ethiopian woman between the ages of 15 and 49), to be 5.4 [‘1]. This is a ***period rate*** based on a 2005 survey response and does not necessarily reflect what the average fertility has been in the years before, or will be in the future when the cohorts of women involved actually complete their reproductive performance.. The 5.4 figure (above) represents a drop by one child per woman from the 1990 level [Fig. 4.5). This, if sustained, represents a major decline, and heralds the dawn of a new low fertility regime early in the new century. “Fertility has declined in both rural and urban areas, in all regions, at all educational levels, and for all wealth quintiles” [1].

Fig. 5.4. Age-Specific Fertility (per thousand) Trends in Ethiopia 1990 to 2005



	15-19	20-24	25-29	30-34	35-39	40-44	45-49
NFFS1990	95	275	289	257	199	105	56
EDHS2000	100	235	251	243	168	89	19
EDHS2005	104	228	241	231	160	84	34

Source based on [1]

NFFS : National Family and Fertility Survey
EDHS : Ethiopian Demographic and Health Survey

Figure 5.5 reveals that women in the 20-24 and 25-29 age groups experienced the sharpest fertility decline, nearly 20%, in the fifteen-year period. The apparent rise in ASBR in the 45-49 age group between the years 2000 and 2005 could be data error resulting from low numbers of respondents in the samples.

Summary results for the year 2005 [1]:

- ***According to the results of the 2005 Ethiopian Demographic and Health Survey (EDHS) which covered a total of 14,070 married women respondents in the 15 – 49 age group, and 6033 men in the 15 – 59 age group regionally, fertility varied from an average of 1.4 children per woman in Addis Ababa to 6.2 in Oromiya.***

- ***Child bearing starts early for Ethiopian women because they marry early; both the mean age at marriage and first intercourse are 16. Two thirds of the children ever born to a woman have already been born by the time she is 35.***

- ***Due to amenorrhea, post-partum insensitivity, and abstinence, the interval between births is rather long with close to half of succeeding births taking place at least 3 years after the previous birth.***

- ***With a respective proportion of 88 and 15 percent (of married women 15 – 49) who know about contraception, and actually use it, there is a clear disconnect between knowledge of birth control methods, and actual current use. However, the figure of 15 percent for current use is a significant improvement over the 1990 levels when the proportion of married women 15 – 49 using contraception was only 5 percent. The percentage of current users doubled in just five years between 2000 and 2005 the most preferred method being the use of injectables.***

- ***The proportion of married women desiring more children dropped from 44 to 18 percent between year 2000 and 2005 indicating a marked rise in the proportion now eager to access family planning services or the unmet need for family planning. Moreover, the proportion of married women seeking to space births is larger than those trying to limit births – 20 and 14 percent respectively.***

- ***The radio is the single most important medium of access by women to family planning information with 29 percent of women acquiring knowledge about contraception from this source.***

Fertility Measures

Period Fertility Rates

Samuel Preston et.al [3] define fertility as "… the increment process by which living members of a population produce live births, that is, new living members of the population". They also define reproductivity:

> "Although often associated with fertility, the term "reproduction" in demographic parlance refers to the process by which new members of a population replace outgoing members, a process that may comprise mortality as well as fertility. [3].

All of the following discussions and the formulae used rely on this source.

Fertility is a much more complex subject to study than mortality. Firstly, unlike mortality, it involves two individuals of opposite sex. Secondly, unlike, mortality the "risk" of producing an offspring is not universal or identical for all females. Thirdly, unlike death, giving birth is a repeatable event. Fourthly, giving birth is an avoidable event, and can be timed or delayed.

For easy of analysis, it has been customary to relate births to mothers only (to the exclusion of fathers) and study fertility rates by linking numbers of babies born to the numbers of women in their reproductive ages. A related concept is that of ***fecundity*** which refers to a woman's biological potential to reproduce. The difference between fertility and fecundity is in the fact that fertility relates to actual numbers of births per individual women whereas fecundity related to their biological potential to reproduce.

Crude Birth Rate

The term ***period*** in period fertility refers to the compilation of data and reporting of results pertaining only to a very specific point in time. It shows a snap-shot of the demographic event under consideration as observed at the time of the survey. For instance, the rates for Ethiopia obtained from the 2005 Demographic and Health Survey relate only to the year 2005, and any projection into the future assumes that the observed rate will remain the same into the future date. "A period rate for a population is constructed by limiting the count of occurrences and exposure times to those pertaining to members of the population during a specified period of time" [3]

$$\textbf{\textit{Rate}}\ [0,T] = \frac{\textbf{\textit{Number of Occurrences between time 0 and T}}}{\textbf{\textit{Person-years lived in the population between times 0 ad T}}}$$

The crude birth rate (**CBR**) between time 0 and T:

$$CBR\ [0,T] = \frac{\textit{Number of births in a population between time } 0 \textit{ and } T}{\textit{Person-years lived in the population between times } 0 \textit{ ad } T}$$

The CBR is the most frequently used fertility measure, and is often expressed per thousand inhabitants. Thus:

$$CBR\ [0,T] = \frac{\textit{Number of births in a population between time } 0 \textit{ and } T}{\textit{Person-years lived in the population between times } 0 \textit{ ad } T} \times 1000$$

The CBR for Ethiopia for the year 2007 was 40 [5] but marked spatial variations are observed with significant differences between urban and rural CBRs. A comparison with other African countries gives the following picture:

Table 5.1 African Countries* with CBR higher than, or similar to Ethiopia's (2007)**

CBR higher than in Ethiopia		CBR about the same as Ethiopia	
Country	**CBR**	**Country**	**CBR**
Liberia	50	Zambia	41
Guinea-Bissau	50	Mozambique	41
Congo, Dem. Rep. Of	50	Eritrea	40
Angola	49	Kenya	40
Uganda	48	Madagaskar	40
Siera Leone	48	Equatorial Guinea	40
Niger	48	Tanzania	40
Mali	48	Ethiopia	40
Malawi	46	Senegal	39
Burundi	46		
Somalia	46		
Burkina Faso	45		
Rwanda	43		
Nigeria	43		
Benin	42		
Ghana	42		

Source: *Estimates for the other African countries is from PRB [7]
**Source CSA [4]

The CBR figures above show the number of births per thousand. The rate of 40 per thousand in Ethiopia translates into a total of 3,080,000 births per year. This is the number of babies born in Ethiopia yearly when calculated on the basis of the CBR and total population estimates for the year 2007

The main drawback of the CBR as a measure of fertility is that the denominator is the entire population much of which is "non-relevant" to the reproduction process. For example, males don't give birth, and neither do children, but they are included. Thus, "the CBR only loosely approximates an occurrence/exposure fertility rate because only women in their reproductive ages can actually give birth….The refinement of exposure gives rise to the General Fertility Rate (GFR)" [3].

$$GFR\,[0,T] = \frac{\textit{Number of births in a population between time } \mathbf{0} \textit{ and } \mathbf{T}}{\textit{Person-years lived between times } \mathbf{0} \textit{ ad } \mathbf{T} \textit{ by women aged 15 and 50}} \times 1000$$

In the case of Ethiopia, the numerator is the calculated number of births (above) and the denominator (2007) is the population of women in the reproductive ages shown below:

Table 5.2 Numbers of Ethiopian Women in the Reproductive Age Group 15 – 19, July 2008

Age Group	Population of women
15 to 19	4032325
20 to 24	3664510
25 to 29	3177429
30 to 34	2660634
35 to 39	2181807
40 to 44	1783644
45 to 49	1435124
Total	**18935473**

Source: CSA 2008 [4]

The table shows a population total of 3,539,945 for Ethiopian females in the 15 to 49 age group. The GFR for Ethiopia is calculated as follows:

$$GFR = \frac{3,168,840}{18,935473} \times 1000 = 167.3$$

The two calculations above can be summed up as follows:

- ***Forty babies are born each year in a community numbering 1000.***
- ***Roughly 167.3 babies are born each year per 1000 Ethiopian females in the reproductive age group.***

One of the main drawbacks of this measure as applied to traditional societies like Ethiopia lies in the distortions resulting from the small but not insignificant number of births given by young women below the age of 15 as having been born to those aged 15 and above.

A crude birth rate can also be calculated based on GFR values as follows:

$$CBR\,[0,T] = GFR[0,T] \times {}_{35}C_{15}^{F}\,[0,T]$$

Whereas: ${}_{35}C_{15}^{F}\,[0,T]$

"….is the proportion of person-years lived in the population that is lived by females between the exact age 15 and 50" [3]

The calculation for Ethiopia is as follow:

Person-years lived by Ethiopian females between exact age 15 and 50 = 0.0459

167.3 x (**18935473** ÷79221000) = 40

Comparative studies frequently show a slight mismatch in rankings of countries when based on CBR and GFR. That is to say, a county ranked top or bottom on the basis of its CBR isn't necessarily ranked top or bottom on the basis of the GFR measure. This shows that, even though both CBR and GFR are crude measures of fertility, the stories they tell are slightly different. For instance, a certain population (A) with a larger percentage of women in the reproductive age groups due, say, to new in-migration could end up having the same annual numbers of births and the same CBR as another population (B) of a similar size, but with a lower GFR, because all of the new migrants would be included in the numerator even though greater percentages of them, than the native-born women, failed to have births during the year in question.

Age Specific Rates

Age is the single most important determinant of fertility, and there are great variations in the fertility of women in their late teens, late twenties or late thirties. A single measure like GFR, which encompasses the entire reproductive period, is, therefore, inadequate to reveal real fertility differences by age. Neither is it effective in showing real fertility differences spatially between women of identical age, or those in smaller age groups, say five-year age groups. A further refinement of the GFR produces the Age Specific Birth Rates (ASBR), denoted in the formula below as $_nF_x$.

$$_nF_x[0,T] = \frac{\textit{Births in the period } 0 \textit{ to } T \textit{ to women aged } x \textit{ to } x+n}{\textit{Person-years lived in the period } 0 \textit{ to } T \textit{ by women aged } x \textit{ to } x+n}$$

Age specific fertility rates are often expressed per 1000. Normally, seven rates are calculated one for each age group 15-19, 20-24…45-49, but calculations of single-year rates are also common. It is necessary to have birth classifications by age of the mother, but data on age is often lacking. The problem of age misreporting also complicates matters. For example, a birth to a woman whose true age is twenty-nine will fall in the 25-29 age category if she reported her true age. However, such births are often entered in the next age category if the woman reported herself to be 30. This is called rounding (by respondents) and is a common practice.

Table 5.3 Calculation of Age Specific Birth Rates All Women (2008)

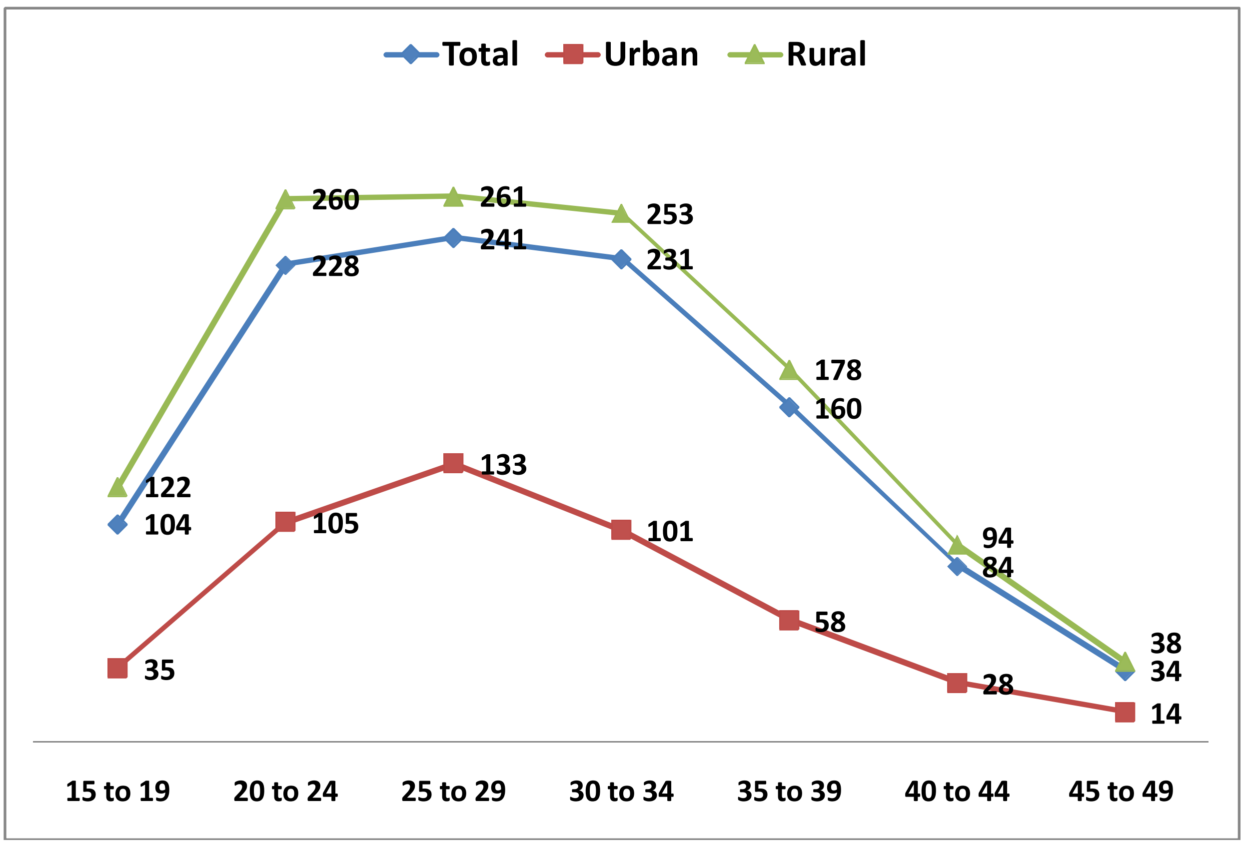
Age Group	Population of women *	Number of babies born**	Age-specific birth rate, 2008 (per 1000)***
15 to 19	4032325	419362	104
20 to 24	3664510	835508	228
25 to 29	3177429	765760	241
30 to 34	2660634	614606	231
35 to 39	2181807	349089	160
40 to 44	1783644	15006	84
45 to 49	1435124	48794	34
Total	**18935473**	**3048126**	**TFR = 5.4**

*CSA estimate for July 2008 [4]
**Calculated on the basis of age-specific birth rates in the 2005 DHS
*** From DHS 2005 [1]

The numbers in column 4 show births per 1000 women in that age group. For example, 104 for the 15 – 19 age group, 228 for the 20 – 24 age group, 241 for the 25 – 29 age group, etc. The figure of 241 represents a peak age of reproductivity.

Age specific birth rates can be graphed. Fig 5.5 shows a typical shape of an ASBR curve, reflecting a rapid rise at first, a peak in the early or mid twenties, and a gradual decline to very low levels after age 40. As has been observed by Newell [6] "these regularities make [ASBRs] amenable to mathematical modeling". One such model is Brass's (1981) Relational Gompertz Model (RGM).

Fig. 5.5 Age Specific Birth Rate per Thousand (2008) by Urban-rural Residence, and for All Women.



Source: [1]

It is important to note that births to women less than 15 years of age are customarily added to the births in the 15-19 age group. Likewise, births to women reporting themselves as older than 50 are entered in the 45-49 group, with the assumption that they are overstating their age.

Age-specific fertility is much higher in rural Ethiopia (for all age groups) than in rural Ethiopia. The widest and narrowest gaps are in the 15-19 and 25-29 age groups respectively. See the table below:

Rural Age-Specific Fertility is Higher than Urban Fertility by a Factor of:

Age Group	Factor
15-19	3.5
20-24	2.5
25-29	2.0
30-34	2.5
35-39	3.0
40-44	3.4
45-49	2.7

The main disadvantage of the age specific fertility rates in Table 5.3 and Figure 5.5 is simply that there are a lot of numbers to look at. "This makes comparisons complex and tedious" [6]. In Fig 5.5 for instance, there are a set of seven numbers corresponding to the seven age groups. Fortunately, demographers have devised a technique to allow for the computation of a single number to represent the level of completed fertility. The measure is known as the total fertility rate (TFR). The ease of interpretation as well as the possibility of comparing several populations on the basis of a simple period fertility rate, has made the TFR the most widely used measure of fertility.

Total Fertility Rate

The table below presents the data needed for the calculation of age specific birth rates (ASBR) and total fertility rate (TFR). The 1994 census data for rural women in the Tigray has been selected.

$$\boldsymbol{TFR}[0,T] = n\,x \sum_{x=\alpha}^{\beta-n} nFx\,[0,T]$$

where α and β are the minimum and maximum ages at childbearing.
n is the age interval which, usually, is 5 years.
$_nF_x$ [0,T) has been defined before, as the age specific birth rate (ASBR).

The total fertility rate shows the total number of children a woman would bear if she were to experience at each age, the observed age specific fertility rates, and survive to the end of her reproductive span. "These rates may pertain either to birth cohorts of women passing through life, or more commonly, to the set of age specific fertility rates of a particular period" (Preston, 2000 p. 94). For Ethiopia, this could refer to a cohort of women born in the entire country on the 1st of January 1971 (this gives a cohort rate); or all Ethiopian women aged 15 to 49 alive between January 1st and December 31st of 2007 (a period rate). The total fertility rate TFR is, simply the sum total of values in col. 4 of Table 5.3, which equals 1.187, multiplied by 5. We multiply by 5 because the individual rates refer to five-year age groups denoted by ***n*** in the formula. Multiplying by 5 gives the true rate over the five-year interval used in the Table. This has been shown as the last row of values in Table 5.3. The product 5.4 represents the total number of children rural Ethiopian women would have at the end of their reproductive years if the 2005 ASBRs (col. 4) remained unchanged throughout their reproductive period. Note that there is no need to multiply the sum of ASBRs by five if single-year intervals are used, and that is why the TFR equation does not specify multiplication by five.

"The total fertility rate is recommended as an easy-to-compute and effective measure of age-sex-adjusted fertility for year-to-year or area-to-area comparisons" [8]. Moreover, the TFR is of great value in controlling differences in fertility caused by variations in the age structure of the population, as opposed to actual variations in the reproductive performance of, say, educated women and uneducated women in the Amhara region. In comparison, "the GFR only partially controls for age structure, and the CBR does not at all" [6]

Table 5.4 Calculation of Total Fertility Rates for Ethiopia 1990, 2000, 2005 from Age Specific Birth Rates (ASBR)

Age Group	ASBR 1990	ASBR 2000	ASBR 2005
15-19	0.095	0.1	0.104
20-24	0.275	0.235	0.228
25-29	0.289	0.251	0.241
30-34	0.257	0.243	0.231
35-39	0.199	0.168	0.16
40-44	0.105	0.089	0.084
45-49	0.056	0.019	0.034
Sum	1.276	1.105	1.082
TFR = Sum x 5	6.380	5.525	5.410

Source: [1]

As with most other rates in population studies, the usefulness of calculated TFR values like that shown in Table 5.4 depends on the quality of the underlying data. Moreover, great swings in coverage, or differences in completeness of data over time, as well as differences in the truthfulness of reported rates from one place to another, will result in spurious, but noticeable (or even dramatic) changes in fertility levels from one year to another, and over geographic regions.

Regional and Educational Differentials: Brief summary

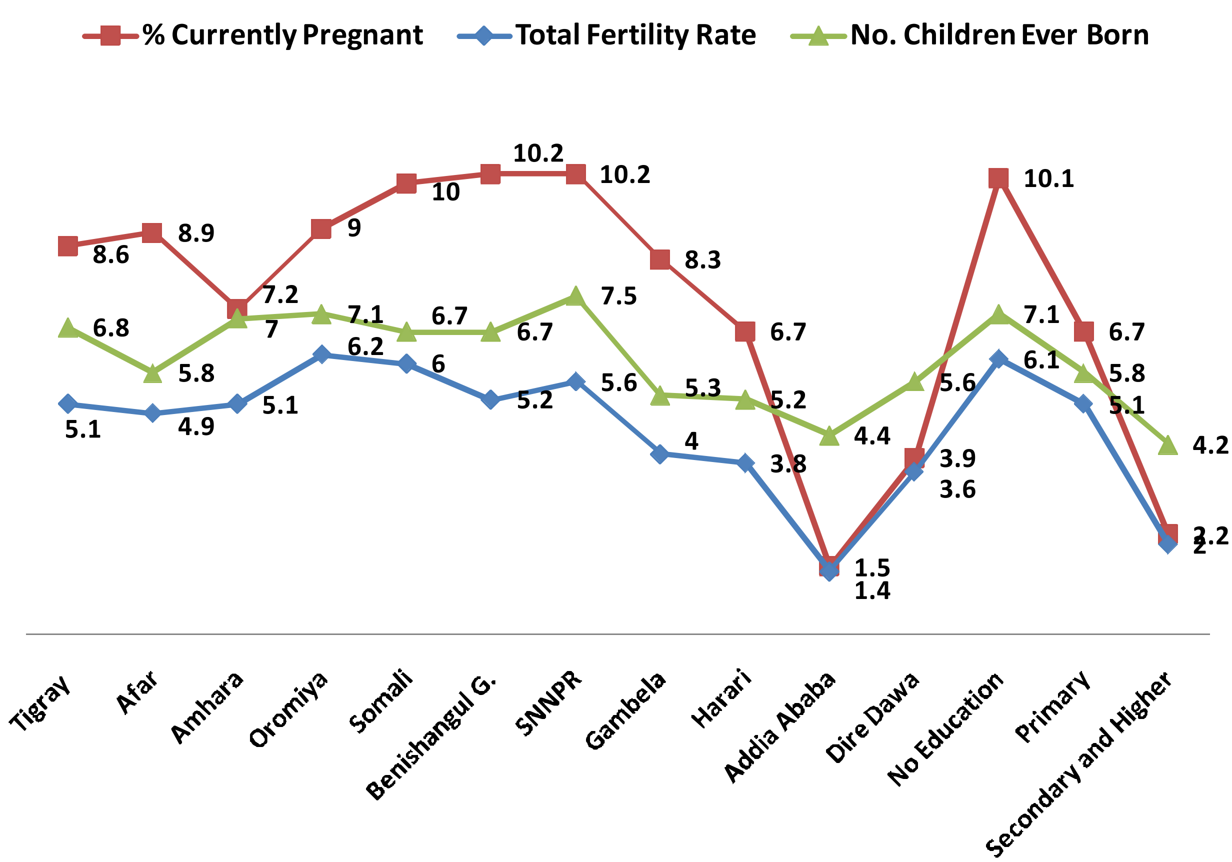
Excluding the predominantly urban regions of Addis Ababa, Dire Dawa and Harari, total fertility in Ethiopia ranges from 4 in Gambella to 6.0 in Somalia and 6.2 in Oromiya. In other words, given current rates, women in the latter two regions will have 2 more children each than those in Gambela by the time they complete their reproductive life. Women in Tigray, Afar, Amhara, and Benishangul-Gumuz will have about 5 children each. With a TFR of 5.6, women in SNNPR fall mid-way between the highest and intermediate fertility regions.

Fig. 5.6 includes percentages of married women currently pregnant. For the non-urban regions named above, this varies from a high of at least 10 percent in Somali, Benishangul-Gumuz, and SNNPR to a low of 7.2 in Amhara. There is a curious mismatch for Gambella in that, whereas the region has the lowest total fertility rate (TFR) there are greater percentages of currently pregnant women here than in the Amhara region. Could the explanation be higher miscarriage or abortion or still-birth rates in Gambella, or underreporting of live births? A follow-up study might reveal the true reasons behind the odd observation.

The middle curve relates to the reported number of children ever born to individual married women. Expectedly, the numbers mirror, more or less, the observation of TFR variations by region.

The difference by education is a lot more pronounced than regional differences. Fertility levels are inversely related to women's education, decreasing rapidly from 6.1 children among women with no education to 2.0 children among women with at least some secondary education. Fertility is also associated with wealth status. Women in the lowest wealth quintile have a TFR of 6.6, which is twice as high as that of women in the highest quintile.

Fig 5.6 Fertility Differences by Region and Level of Education, 2005

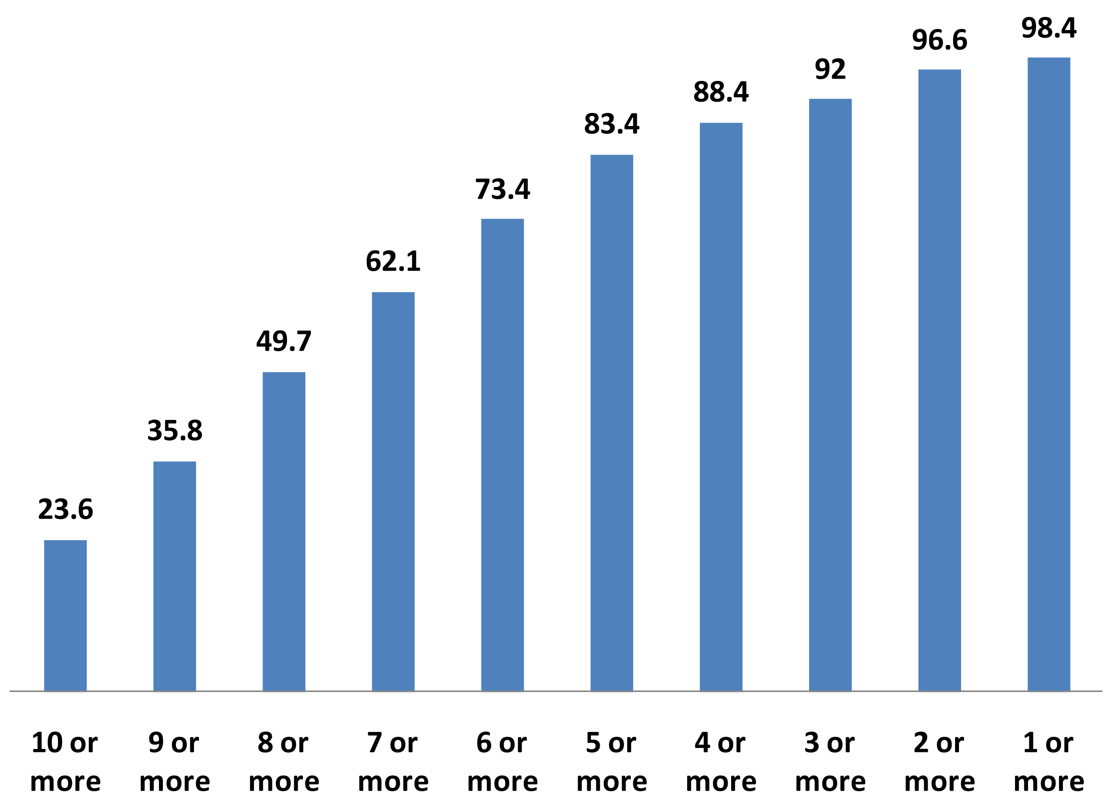


Source: Based on [1]

Children Ever Born

The graph below shows percentages of married women who have completed their reproductive life (age 45 – 49) at the time of the 2005 Demographic and Health Survey by the number of children ever born (CEB). This first notable observation is the very low level of childlessness in the country (only 1.6 percent). At the other extreme (CBE 10+) emerges a picture of a highly productive generation of women. Almost a quarter of Ethiopian women now completing their reproductive life cycle gave birth to 10 or more children. This observation is tempered, however, by the evidence, in the graph, of reporting errors in which the number 9 may have been avoided by many women in favor, most likely, of the number 10, and to a much lesser extent, the number 8.

Fig. 5.2 Percentage of Ethiopian Women Aged 45 -49 by the Number of Children Ever Born (CEB), 2005.



It is possible that a significant, but unknown percentage of women who had 9 children reported themselves as having had to 10 or more children. It is also evident that some misreporting occurred at the lower parities

Comparison with the rest of Africa

The average total fertility rate for Africa as a whole is 5.3 (5.8 for countries south of the Sahara), which is almost twice the world average of 2.9. The average for Europe, Australia, and North America is 1.4, 1.7 and 2.0 respectively. A total fertility rate of 2 indicates replacement fertility in which the mother and father are replaced by a new generation of mothers and fathers. This assumes immortality of the new generation, however. The magical number for replacement fertility in low mortality countries of Europe, North America, and Asia is often thought to be 2.1. The number after the decimal point representing expected losses to the succeeding generation of mothers and fathers due to the force of mortality. In high mortality countries such in Sub-Saharan Africa, however, a much higher TFR the 2.1 would be required to replace a generation. If we assume that the required rate for Somalia is 3, we are implying a third of the children born to a Somali couple will not survive long enough to replace their parents. This would not be far from the truth for Somalia and many other Sub-Saharan African countries.

A careful look at global values of TFR, confirms the strong inverse relationship between fertility on the one hand and levels of socio-economic development on the other. This is also true for African countries although the country of Gabon where the per capita GNP of US$ 4170 (the highest GNP per capita for any mainland African country) is a notable exception, in that its TFR of 5.4 is among the highest in Africa, rather than the lowest. North African countries such as Egypt, Tunisia, and Morocco, have rates that conform to the inverse relationship model, with a relatively high GNP per capita, and a low TFR. Most of the Sub-Saharan countries where the per capita GNPs are low, and fertility levels very high, also conform to the inverse relationship model.

Table 5.5 presents the total fertility rate for African countries for the year 2007. It shows that only three island countries in Africa – Mauritius, Seychelles, and Reunion – have replacement, or below replacement fertility.

Table 5.5 Total Fertility Rates for Africa (year 2007) by Country in Descending Order.

Niger	7.1	Mozambique	5.4	Swaziland	3.6
Guinea Biss.	7.1	Tanzania	5.4	Namibia	3.6
Somalia	6.8	Chad	5.3	C.Verde	3.5
Angola	6.8	Eritrea	5.3	Lesotho	3.5
Burundi	6.8	Senegal	5.3	Gabon	3.4
D.R. Congo	6.7	Togo	5.1	Congo	3.3
Uganda	6.7	Gambia	5.1	Botswana	3.1
Mali	6.6	Cote d'Ivoire	5	Egypt	3.1
Malawi	6.3	CAR	5	Libya	3
Burkina Faso	6.2	Cameroon	4.9	W. Sahara	2.9
Rwanda	6.1	Kenya	4.9	S. Africa	2.7
Sierra Leone	6.1	Mauritania	4.8	Algeria	2.4
Nigeria	5.9	Sudan	4.5	Morocco	2.4
Benin	5.7	Ghana	4.4	Reunion	2.4
Guinea	5.7	Djibouti	4.2	Tunisia	2
Eq. Guinea	5.6	Sao Tome & P	4.1	Mauritius	1.7
Zambia	5.5	Zimbabwe	3.8		

Source: [7]

Niger and Guinea Bissau have the highest TFR in Africa, and in the world. Their TFR estimate for the year 2007 suggests that a typical woman in those two countries would have the highest number of births in the world (more than seven) at the conclusion of her reproductive years. Given the histories of civil conflict and widespread economic disruptions, and the accompanying deterioration in the standard of living in the countries of Somalia and the Democratic Republic of Congo, it would be hard to accept the very high TFR values as valid. Even though poor countries have higher fertility than their developed counterparts, some measure of peace and stability are required for society's institutional fabrics (e.g. the institution of marriage) to result in normal reproductive activities of its members. Times of war and natural disasters are, more often than not, accompanied by periods of reduced fertility.

The total fertility rate could be refined to only include a subset of women in their reproductive years. One such refinement will produce ***parity-specific (p) fertility rates***. Parity refers to a woman's total number of previous births. For example, the total fertility rate of first-parity women (women giving birth for the first time) could be expressed as the total number of births to previously childless women divided by the total number of previously childless women. In this way, parity-specific rates for the second parity (birth to women with one prior birth), third parity (births to women with two prior births), etc. can be computed. The rates are denoted by (F_P [0,T]), and could be computed using the formula:

$${}_nF_x[0,T] = \frac{\textit{Births in the period } \mathbf{0} \textit{ to } \mathbf{T} \textit{ to women at parity P}}{\textit{Person-years lived in the period } \mathbf{0} \textit{ to } \mathbf{T} \textit{ by women at parity P}}$$

A more commonly used refinement of the total fertility rate recognizes the differences in fertility between married and unmarried women. It is called the total marital fertility rate **(TMFR)**. We obtain the TMFR by combining age and marital specific fertility rates. Age-specific marital fertility rates are defined as:

$${}_nF_x[0,T] = \frac{\textit{Births in the period } \mathbf{0} \textit{ to } \mathbf{T} \textit{ to married women aged } \mathbf{x} \textit{ to } \mathbf{x+n}}{\textit{Person-years lived in the period } \mathbf{0} \textit{ to } \mathbf{T} \textit{ by married women aged } \mathbf{x} \textit{ to } \mathbf{x+n}}$$

Comparison of the TFR and TMFR values reveals the contribution of a given nuptiality (marriage) pattern to observed fertility levels.

> "The ratio, TFR/TMFR, appears as a weighted average of the proportion married in each age interval, the weight being the contribution of an age group to the total marital fertility rate. The ratio is thus a fertility weighted average of proportions married by age. The comparison of fertility rates standardized on two dimensions (age and marital status in the TMFR) and on one of these dimensions (age only in TFR) provides an assessment of the impact of the other dimension (marriage) on fertility. [3].

COHORT FERTILITY

Total fertility is a cumulative process that depends on a number of factors. Moreover, a woman's past fertility may affect her future reproductive performance. Preston [3] defines cohort fertility as "the average number of children who would be born to an actual birth cohort of women if they had all survived to the end their reproductive period, and born children at each age at the rate observed for the surviving members of the cohort at each age". Shryock and Siegel [8] define a cohort as follows:

> A cohort consists of a group of individuals who experienced the same significant demographic event during a specified period of time, usually a year, and who may be identified as a group at successive later dates on the basis of this common demographic experience. Examples are a birth cohort, persons born during the same year or years; a

> marriage cohort, persons married during the same year or years; a first parity cohort, women who had a first child in a given year…and a cohort of deceased persons, persons who died in a given year.

The cohort TFR can only be calculated when all living members of a birth cohort, for instance women born in Arsi (currently part of Oromiya) in 1955, have reached the end of their childbearing years. In other words, the total cohort fertility rate **(TCFR)** for the birth cohort of 1959 won't be known until about 2009. If the fertility of the cohort members who died before the end of year 2009 were the same at each age as that of the women who survived, their cohort total fertility rate would be identical to that of the women who survived to the end of the childbearing years. Moreover, if demographic rates at every age remain constant over time with 26 year old women, for instance, having the same age specific fertility as the 26 year olds born in all the years after that, there would be no difference in total fertility computed on the bases of the long-term **(cohort)** approach, and the cross-sectional **(period)** approach shown in Table 5.4. Note, however, that period and cohort values will differ even if cohort fertility has remained constant over time, if the age pattern of fertility is changing overtime. For example, the 1984 drought, which claimed an estimated one million lives in then Tigray and Wello provinces of Ethiopia significantly reduced the period fertility of women in the two provinces in that year. However, Tigyian and Wello women who have experienced "loss" or "misplacement" of births are assumed to have "caught up" by having additional births than they would otherwise have, in the following years, thus ending up with the same number of births, as if no drought-related disruptions have ever occurred. There must have been significant fluctuation, however, in the period rates in the two provinces in the mid 1980's. In other words, cohort fertility rates are, generally, less variable than period fertility rates. A cohort rate avoids the pitfalls of rate variations in response to social changes (such as a rise in marriage age or changes in time-intervals between successive births), or natural vicissitudes of the kind discussed above. The cohort approach is not without its own shortcomings, however.

There are three big problems associated with cohort analysis. The first is that it requires data in the form of a fairly long, consistent time series. Such data are rare, even in highly developed societies. The second is that of a problem known technically as 'censoring'. This refers to the fact that one does not know what will happen in the future. In other words, the later experiences of young or more recent cohorts cannot be known ahead of time. The third is that it is rather difficult to think about cohorts. Our minds are so used to thinking in a cross-sectional ways that it is hard to think in any other way [6].

A related problem is that of telling apart the magnitude of fertility changes resulting from real increase or decrease in the number of births, from changes induced by altered timing such as when couples advance or postpone births. In demography and population geography, a timing change is known as a **'*tempo*'** change whereas real increases or decreases in fertility between successive cohorts is said to be a **'*quantum*'** change. One cannot know if the various variables affecting fertility had a tempo effect or a quantum effect until the cohorts of interest have completed child bearing. For example, the total fertility rate in Kenya reached 8 births per woman in the 1980's giving the appearance that the average Kenyan woman will have a total of eight births at the conclusion of her reproductive years. The rate is now about 4.5; suggesting that the current projection of completed family size for a Kenyan woman is three and a half births less than the projection of the 1980s. The difference between the number of births a Kenyan woman was projected to have at the conclusion of her reproductive life on the basis of the 1980s values, and the real values observed when the women actually complete their reproductive years, is a difference attributable to a quantum change. This shows that something happened in Kenya in the later decades to bring about a real difference in the actual numbers of births Kenyan women ended up having. The difference between the rates in mid-eighties and mid-nineties is an example of a tempo change in fertility. It shows that Kenyan women 'slowed down' a great deal in their run to the finish line (their 50^{th} birthday, to use a cut-off time consistent with the formula for the calculation of the TFR).

PARITY PROGRASSION RATIO

The age of a woman is the single most important determinant of her fertility, and places the ultimate limit on the span of her reproductive lifetime. The changes in her fertility can, therefore, be traced by following her movement from one age to another. Age is not the only variable to trace in the analysis of fertility, however. A woman's **progression from one parity** (the number of children ever born – CEB) **to the next** can also be pursued. The latter can be represented by a measure known in demographic literature as the parity progression ratio **(PPR).** As indicated in previous pages, a woman's parity is the sum total of her live births. The parity progression ratio is a measure of a woman's, or groups of women's, progression from one parity (i) to the next $(i + 1)$. It is a measure of the proportion of a birth cohort of women, say those born in the year 1959 who had at least i live births, and who went on to have at least one additional birth:

$$PPR_{(i,i+1)} = \frac{\text{Number of women at parity } i+1}{\text{Number of women at parity } i \text{ or more}} = \frac{P_{i+1}}{P_i}$$

The PPR simply measures **the probability of having one more child given that a woman has already had a certain number of births**. For, example, if a woman has already given birth to a baby, the PPR would state the probability of her having a second (a_1). Note that a_0 is simply the proportion of women in a birth or marriage cohort who became mothers. Table 5.5 shows the calculation of parity progression ratios for the Tigray region of Ethiopia. The data comes from the 1994 population and housing census [9]. All women between the ages of 45 and 49 are selected regardless of marital status. The $PPR_{(i,i+1)}$ column shows the probability of Tigrian women making a transition from one parity to the next. For example, if the experience of those in the 45-49 year age group at the time of the 1994 census were to remain the same for the foreseeable future, 95.7 percent of Tigrian women "currently" in their reproductive years will become mothers, 96.3 percent will have at least one child, 94.9 percent will have at least two children, etc. The probabilities are computed by dividing the entries in a given row of column 3 (women aged 45-49 with at least the stated number of prior births, labeled here as CEB – children ever born), by an entry in a previous row of the same column. The second column shows the number of women in the stated parity (total number of births)

Table 5.5 Parity Progression Ratios, Women Aged 45 – 49, Tigray, Ethiopia (1994)

Parity	Women Aged 45 - 49	Women 45 -49 With at least CEB	$PPR_{(i,i+1)}$	$PPR_{(0,i)}$
0	2230	52401	0.9574 (a0)	
1	1812	50171	0.9634 (a1)	0.9574
2	2485	48359	0.9486 (a2)	0.9224
3	3522	45874	0.9232(a3)	0.8749
4	4529	43352	0.8931(a4)	0.8078
5	5533	37823	0.8537(a5)	0.7214
6	6588	32290	0.7960(a6)	0.6159
7	6978	25702	0.7285(a7)	0.4902
8	6785	18724	0.6376(a8)	0.3571
9	5183	11939	0.5659(a9)	0.2277
10	3459	6756	0.4880(a10)	0.1289
11+	3297	3297		0.0629
Sum	**52,401**			**6.1666**

All of the columns in Table 5.5, except the last, have been explained above. The $PPR_{(0,i)}$ values are simply the products of two consecutive a_i values. For example, the entry in the second row (0.9224) is the product of a_0 and a_1 (0.9574 x 0.9634). The sum total of all of the entries (6.1666) represents the **total cohort fertility rate** (TFR^C) of women in Tigray, Ethiopia. According to Preston (2000: p. 104) "If we denote as P_i the number of women at parity i or more and *W* as the total number of women, then the number of first births will equal P_1, of second births p_2, etc., and

$$(TFR^C) = \frac{P_1}{W} + \frac{P_2}{W} + \frac{P_3}{W} + \ldots\ldots$$

$$= \frac{P_1}{W} + \frac{P_1}{W} \times \frac{P_2}{P_1} + \frac{P_1}{W} \times \frac{P_2}{P_1} \times \frac{P_3}{P_2} + \ldots\ldots$$

$$= PPR_{(0,1)} + PPR_{(0,1)} + PPR_{(1,2)} + PPR_{(0,1)} + PPR_{(1,2)} + PPR_{(2,3)} + \ldots.$$

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