LESSON FIVE

FERTILITY LEVELS AND TRENDS

Aynalem Adugna, July 2014
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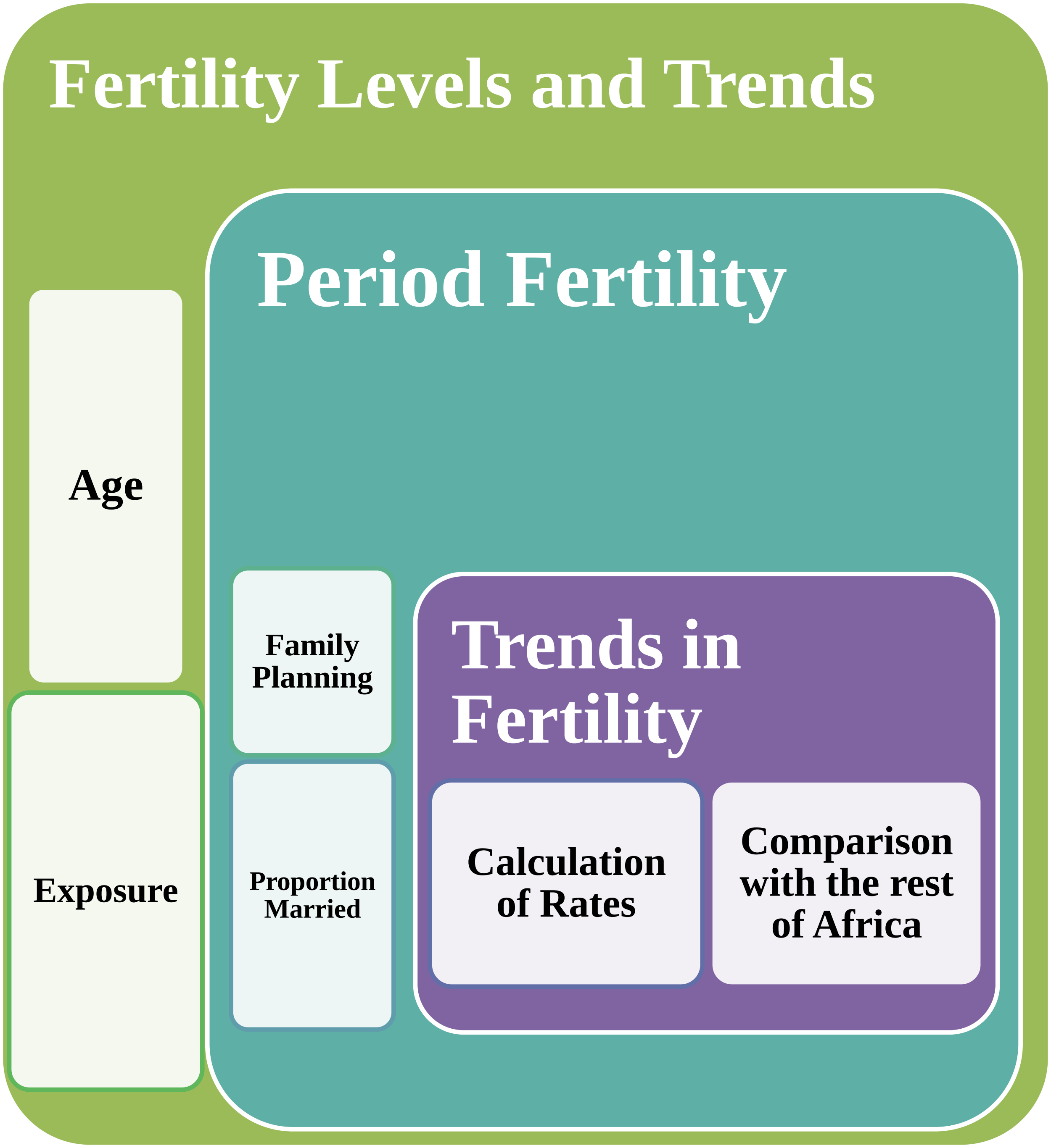
Learning Objectives:



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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 three DHS surveys (in 2000, 2005 and 2011). Fertility statistics for the pre-2000 years come mainly from 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 - 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 21 years covered in these surveys (1990 - 2011). 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. Ethnic diversity was the assumed driver of such a trend:

> "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]

However, their detailed analyses using the entropy index showed that ethnic diversity in Ethiopia (and the presumed competition for influence through sheer numbers0 did not condemn the country a perpetually high fertility regime. One of their conclusions regarding SNNPR was:

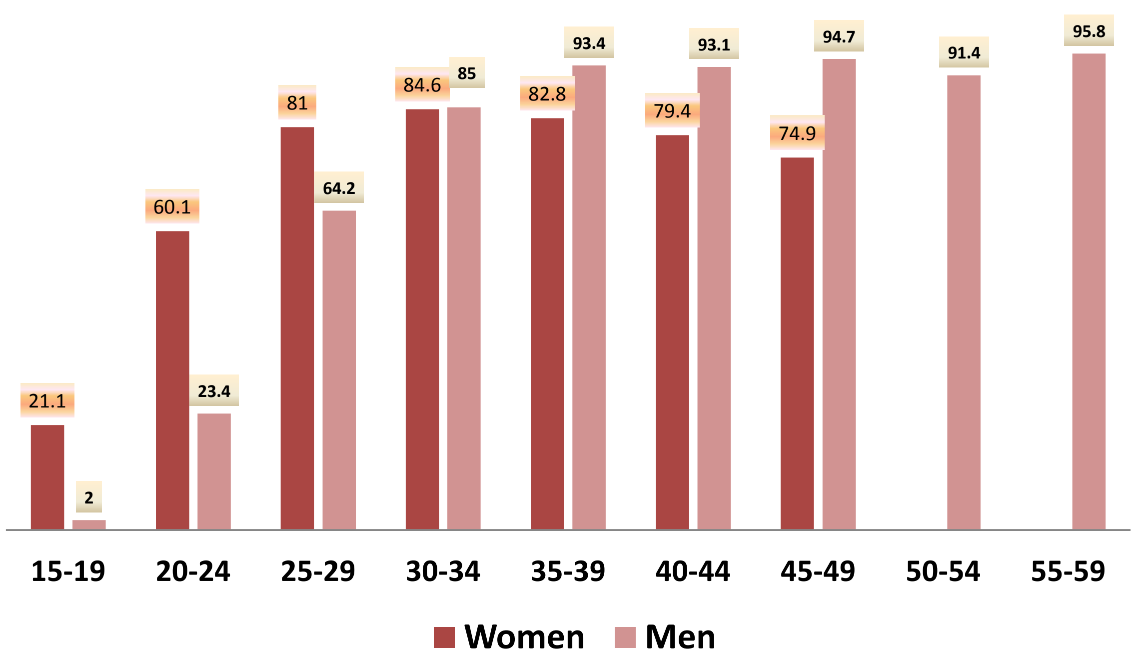
> "…neither ethnoreligious group dominance, religiosity, nor community diversity is an obstacle for efforts to promote fertility limitation practices in the SNNPR. Moreover, community diversity, rather than being an inhibiting factor, appears to be strongly associated with key ingredients for reproductive preferences, attitudes, and behavior that will lead to lowered fertility." [2]

How about the rest of Ethiopia? Has fertility been rising or falling? More than politics or ethnic loyalties the answer could be found 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 areas, 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 a clear urban-rural difference, but since breakdowns by ethnicity are not available in published reports differences between regions, can be thought of as crude indicators, even though there are ethnic diversities within the regions themselves.

Proportion Married

Nearly two thirds of Ethiopian women are already married by the time they reach age 25 and more than a fifth are married by age 15. However Fig. 4.1 confirms that the latter did not marry men who were in their own age; only 2% of males in the 15-19 group were married at the time of the 2005 Demographic and Health Survey (DHS). The CSA reported a population of over 4 million women in the 15-19 age groups [4] of whom about 800,000 were already married. The highest proportion of married women was in the 30-34 age groups after which the percentages declined 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 factors.

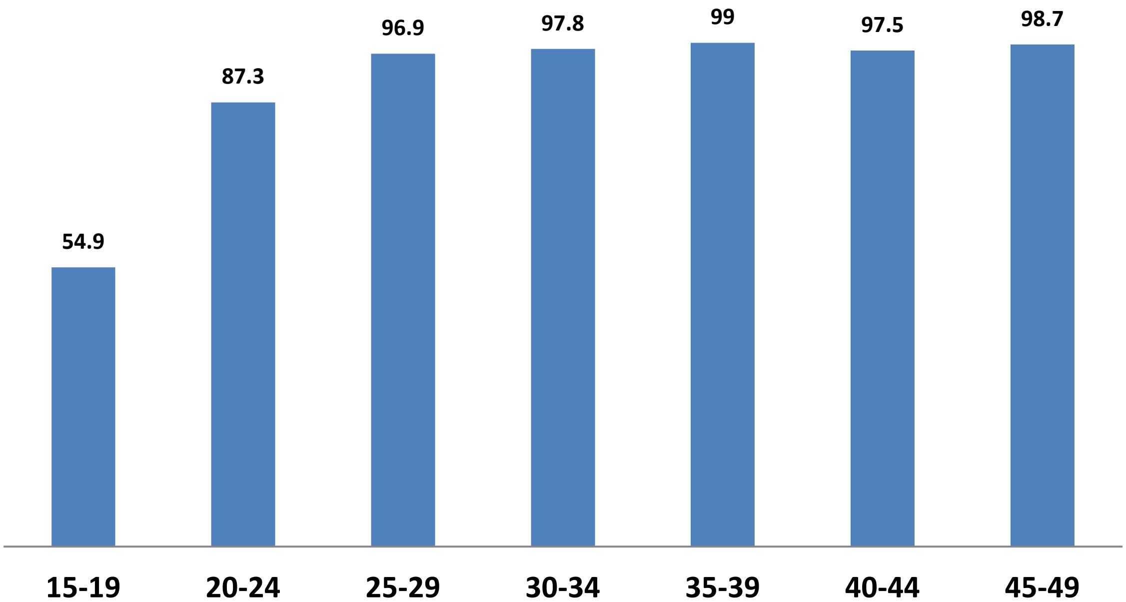
Fig. 5.1 Proportion of married Men and Women by Age Group (Ethiopia 2005)



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 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

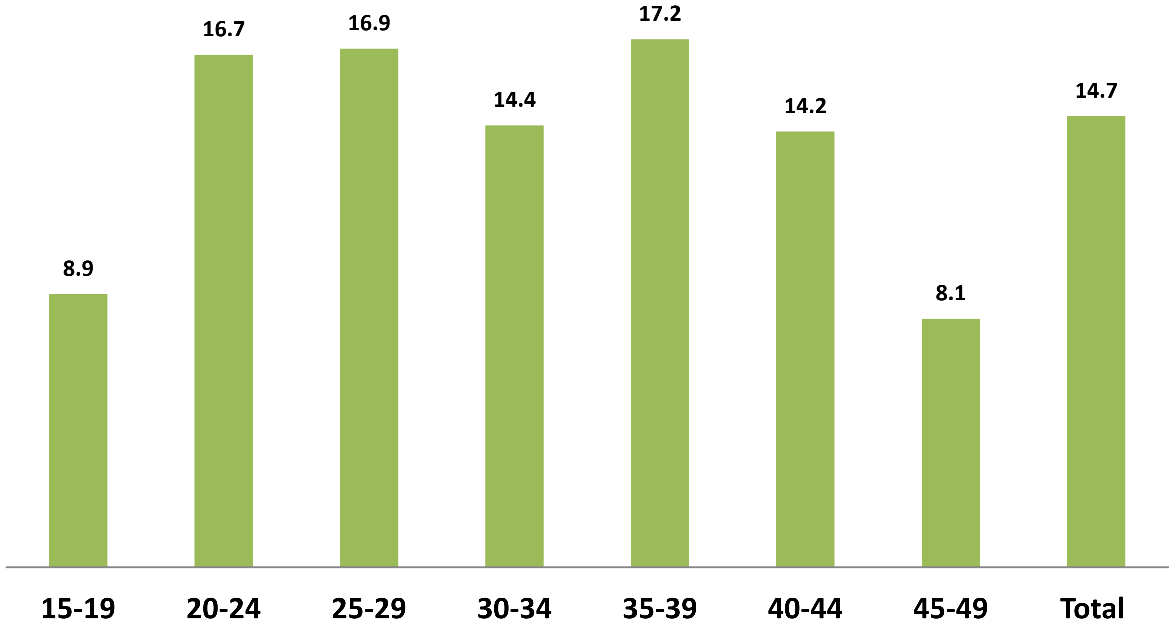


Source: [1]

Family Planning

About one in seven (14.7%) of currently married Ethiopian women are using modern contraception. This is 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 very 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)



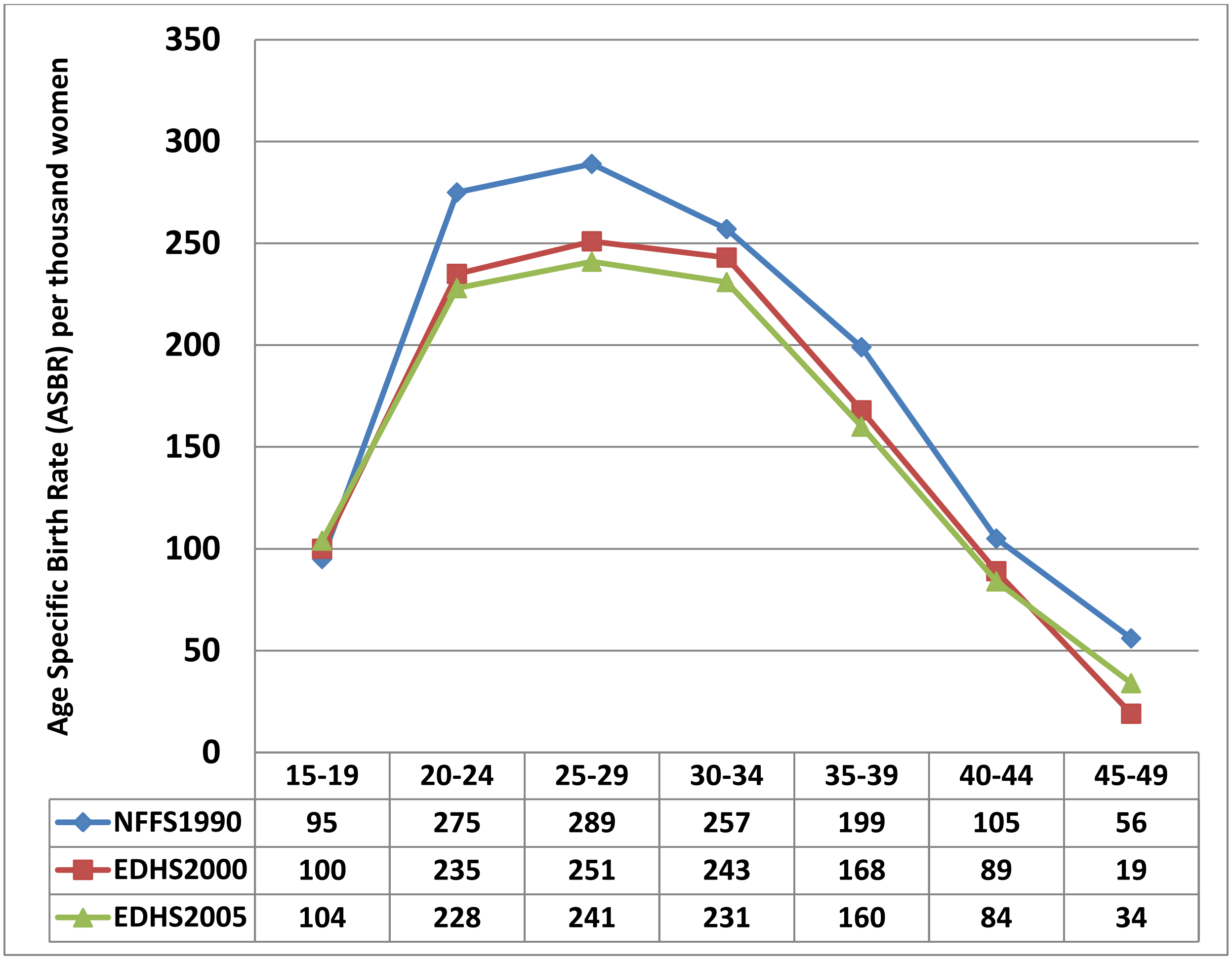
Source: [1]

A reasonable expectation is that larger percentage of young women, (those in the 15-19 and 20-24 age group) than older women would know about, accept, and use modern contraceptives. However, Fig. 5.3 shows a 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; a good news from the demographic front. A 2005 survey data showed the total fertility rate (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***, however, 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 in the study actually complete their reproductive performance. The 5.4 figure (above) represents a drop by one child per woman from the 1990 levels [Fig. 4.5). This, if sustained, represents a major decline. “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 shows 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 age specific fertility rate –ASFR- in the 45-49 age group between the years 2000 and 2005 could be due to data errors.

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 lactational 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 only 15 percent of married women aged 15 – 49 who knew about contraception (88 percent knew) actually using it, there is a clear disconnect between knowledge of birth control methods and 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 injectables.

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

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

Fertility Measures

Period Fertility Rates

Samuel Preston's book entitled "Demography: Measuring and Modeling Population Processes" by Blackwell Publishers (2001) will form the basis of all discussions in lesson five [3]. It defined fertility as "… the increment process by which living members of a population produce live births, that is, new living members of the population". They defined reproductivity as well - a related concept but not identical to fertility:

> "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].

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 calculate 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 that fertility relates to actual numbers of births per individual women whereas fecundity refers 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 that 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]

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

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

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

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

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

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		Madagascar	40
Sierra 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 even though more half of the population (males, females younger than 13 and older than 50) are "non-relevant" to the reproduction process because they don't give birth. 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].

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

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
15-19	4032325
20-24	3664510
25-29	3177429
30-34	2660634
35-39	2181807
40-44	1783644
45-49	1435124
Total	**18,935,473**

Source: CSA 2008 [4]

The number of births was 3,539,945. The GFR for Ethiopia is calculated as follows:

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

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 female members of the community in their reproductive years.

One of the main drawbacks of this measure as applied to traditional societies like Ethiopia lies in the distortions resulting from the addition to the 15-19 age group of a not insignificant number of births to women below the age of 15.

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 GFR. 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, did not have births during the year in question.

Age Specific Rates

Age is the single most important determinant of fertility. 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, both inadequate and incapable of showing real fertility differences by age. A further refinement of the GFR produces the Age Specific Fertility Rates (ASFR), denoted in the formula below as ${}_{n}F_{x}$.

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

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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)

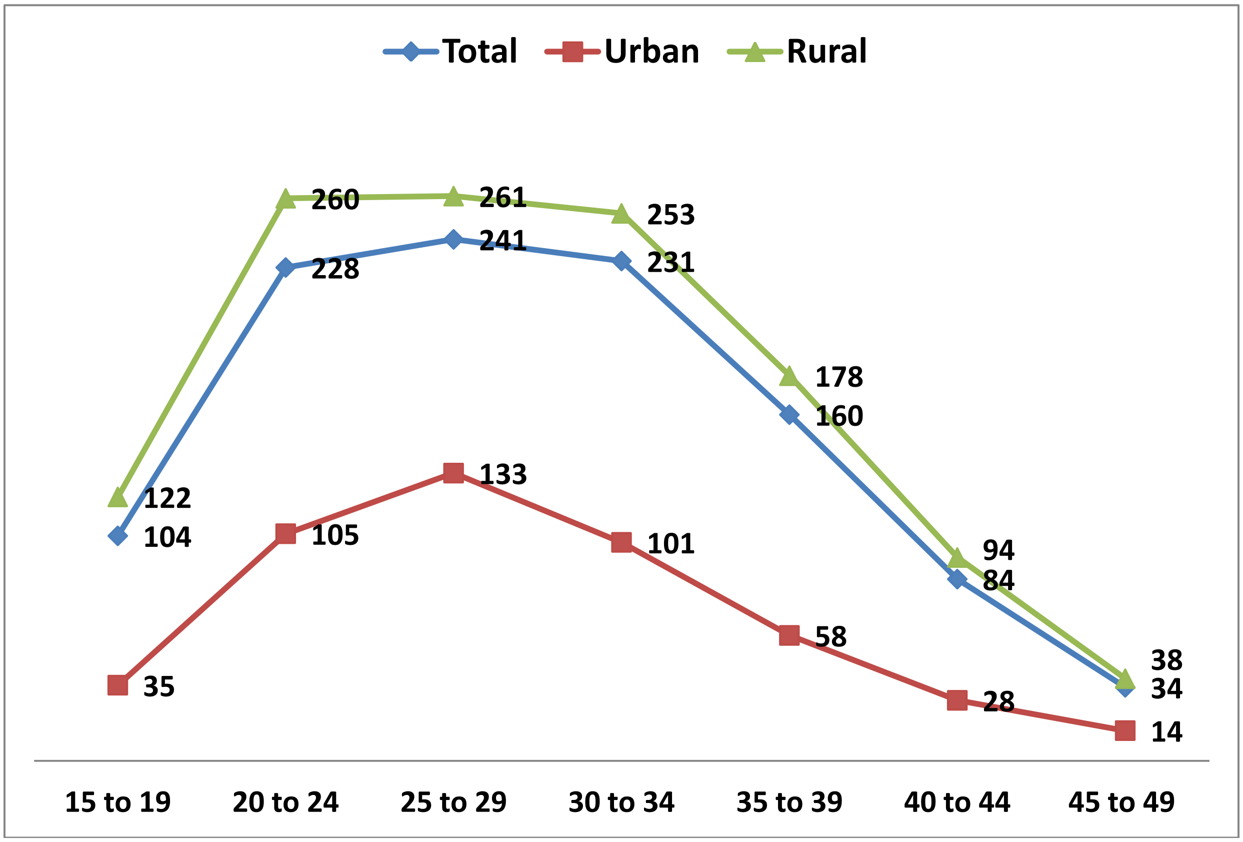
Age Group	Population of women *	Number of babies born**	Age-specific birth rate, 2008 (per 1000)***
15-19	4032325	419362	104
20-24	3664510	835508	228
25-29	3177429	765760	241
30-34	2660634	614606	231
35-39	2181807	349089	160
40-44	1783644	15006	84
45-49	1435124	48794	34
Total	**18935473**	**3048126**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

Age specific firth rates can be graphed. Fig 5.5 shows a typical shape of an ASFR curve, reflecting a rapid rise at first, a peak in the mid to late twenties, and a gradual decline to low levels after age 40. As has been observed by Newell [6] "these regularities make [ASFRs] 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 fertility rates (ASFR) and total fertility rate (TFR). The 1994 census data for rural women in the Tigray has been selected.

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

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 as the age specific fertilit rate (ASFR).

The total fertility rate shows the total number of children a woman would have if she were to experience at each age, the observed age specific fertility rates, and survive to the end of her reproductive life 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, for instance, 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 ASFRs (col. 4) remained unchanged throughout their reproductive period. Note that there is no need to multiply the sum of ASFRs 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: Based on [1]

As is the case with most other rates in population studies, the usefulness of calculated TFRs such as those 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 interview responses 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

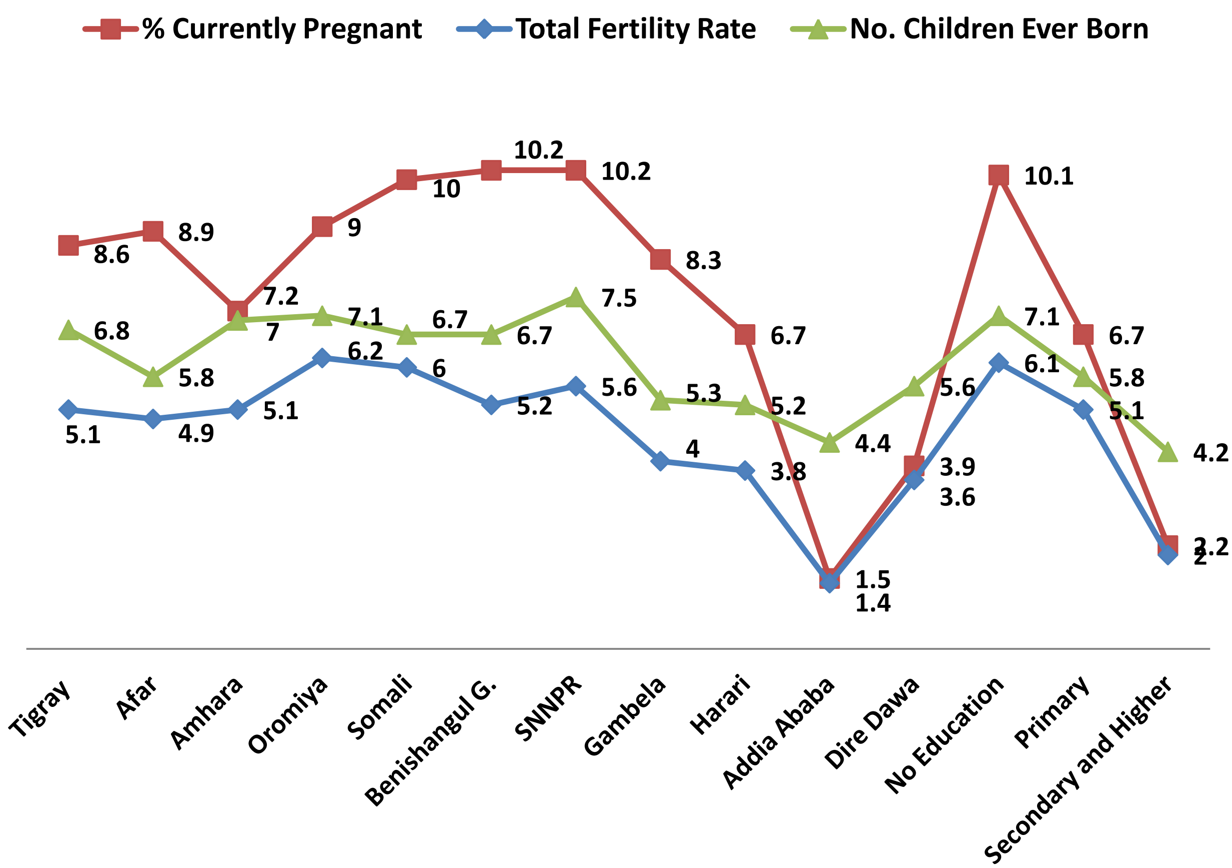
Excluding the predominantly urban regions of Addis Ababa, Dire Dawa and Harari, total fertility in Ethiopia ranges from 4 in Gambella to 6.0 in Somalia and 6.2 in Oromiya. In other words, given current rates, women in the latter two regions will have 2 more children each than those in Gambella by the 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 rate of 10 percent in Somali, Benishangul-Gumuz, and SNNPR to a low rate of 7.2 percent 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 that higher rates of miscarriages or abortions or still-births in Gambella, or underreporting of live births have resulted in low the TFR of 4.0? A follow-up study might reveal the true reasons behind these contradictory numbers.

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

The difference by education is a lot more pronounced than the difference by geography/region. 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

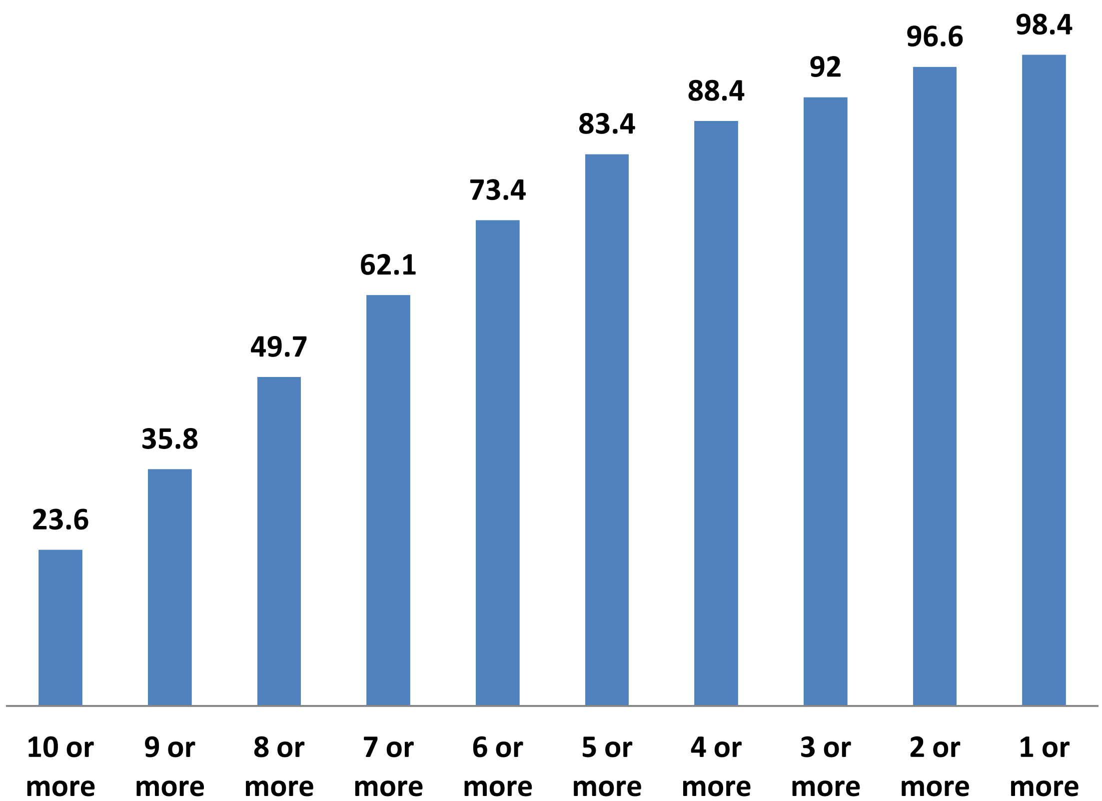


Source: Based on [1]

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). A noteworthy observation is the very low level of childlessness in Ethiopia (only 1.6 percent). At the other extreme (CBE 10+) emerges a picture of a highly productive generation of women in that 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 possible 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.



Comparison with the rest of Africa

The average total fertility rate for Africa as a whole is 5.3 and 5.8 for countries south of the Sahara. This 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 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 than 2.1 would be required to replace a generation. If we assume that the required rate for the country of Somalia is 3, we are then implying that 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.

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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 when countries within Africa are compared to each other although the country of Gabon where the per capita GNP of US$ 4170 (the highest GNP per capita for any mainland African country but with a TFR of 5.4 – among the highest in Africa) is a notable exception. 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. Given the histories of civil conflict and widespread economic disruptions and deterioration in standard of living in the countries of Somalia and the Democratic Republic of Congo high TFR values might be a reflection of lack of access to family planning services.

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 calculated. The rates are denoted by (F_P [0,T]), and could be computed using the formula:

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

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:

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

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].

GIS map-based comparisons between Ethiopia, Eriterea and Kenya are given in Appendix 1, 2, and 3 at the end on this lesson.

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 1970, have reached the end of their childbearing years in 2019. In other words, the total cohort fertility rate **(TCFR)** for the birth cohort of 1970 won't be known until about 2019. If the fertility of the cohort members who died before the end of year 2019 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 calculated on the bases of the long-term ***(cohort)*** approach, or 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 has changed 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. 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].

Quantum vs. Tempo

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 births forward or postpone them. In demography, a timing shift is known as a **'*tempo*'** change whereas a real increase or a decrease in fertility between successive cohorts is known as **'*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 projections 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 ***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 the decades since is an example of a ***tempo*** change in fertility. It shows that Kenyan women slowed their reproductive performance a great deal in the run toward the finish line (their 50th birthday).

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 analyzed. 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 all of the births she gave. The parity progression ratio is a measure of a woman's, or groups of women's, progression from one parity ***(i)*** to the next parity **(*i* + *1*)**. It is a measure of the proportion of a birth cohort of women, say those born in Arsi in 1970 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 <u>*the probability that a woman who has given birth to a certain number of children would go on to have one more child.*</u> For, example, if a woman has already given birth, the PPR would state the probability of her having a second as (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 come 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)

		Women 45 -49		
	Women	**With at least**		
Parity	**Aged 45 - 49**	**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. 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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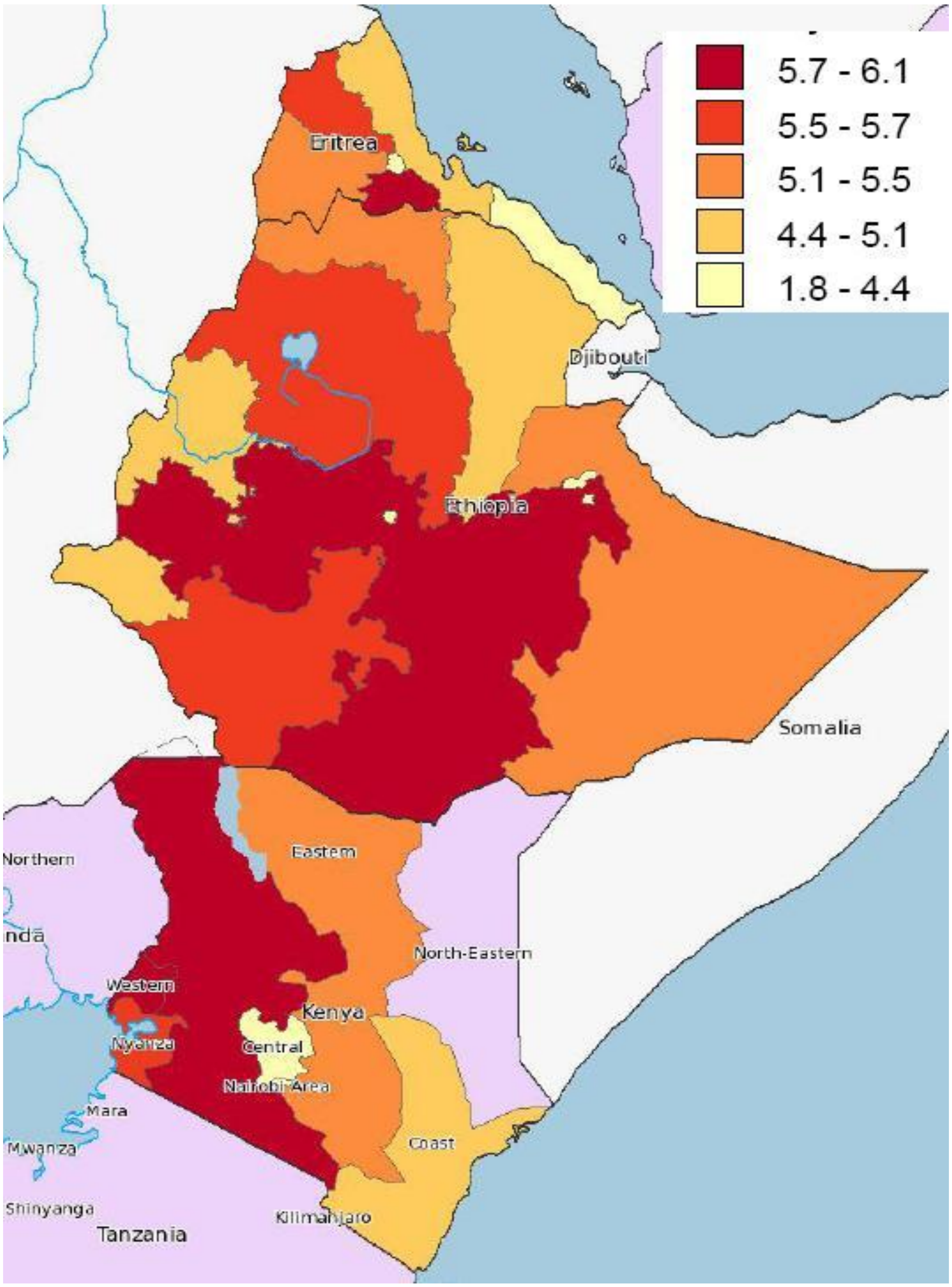
Appendix 1. Total Fertility Rate Ethiopia, Eritrea and Kenya

Coutry	Adm. Region	Year	TFR
Eritrea	Anseba	2002	5.6
Eritrea	Debub	2002	5.7
Eritrea	Debubawi Keih Bahri	2002	3.9
Eritrea	Gash-Barka	2002	5.1
Eritrea	Maekel	2002	3.4
Eritrea	Semenawi Keih Bahri	2002	4.5
Ethiopia	Addis	2000	1.8
Ethiopia	Affar	2000	4.4
Ethiopia	Amhara	2000	5.5
Ethiopia	Ben-Gumz	2000	5
Ethiopia	Dire Dawa	2000	3.5
Ethiopia	Gambela	2000	4.4
Ethiopia	Harari	2000	4.2
Ethiopia	Oromiya	2000	6.1
Ethiopia	SNNP	2000	5.6
Ethiopia	Somali	2000	5.1
Ethiopia	Tigray	2000	5.3
Kenya	Central	2003	3.4
Kenya	Coast	2003	4.9
Kenya	Eastern	2003	5.1
Kenya	Nairobi Area	2003	2.7
Kenya	Nyanza	2003	5.6
Kenya	Rift Valley	2003	5.8
Kenya	Western	2003	5.8

Map: Total Fertility Rate: Ethiopia, Eritrea, and Kenya



Source: Map: Drawn with help, web-based mapping (http://macroint.mapsherpa.com/statmapper/)
Table: http://macroint.mapsherpa.com/statmapper/table.phtml?sid=4bbf8fd9c256c

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Appendix 2. Percentage of Women Using Any Method of Contraception, Kenya, Ethiopia, and Eritrea*
Percentage of Women Using Any Method of Contraception

Country	Adm. Region	Year	%
Eritrea	Anseba	2002	4.41
Eritrea	Debub	2002	7.86
Eritrea	Debubawi Keih Bahri	2002	7.09
Eritrea	Gash-Barka	2002	1.91
Eritrea	Maekel	2002	19.62
Eritrea	Semenawi Keih Bahri	2002	5.08
Ethiopia	Addis	2000	45.16
Ethiopia	Affar	2000	7.7
Ethiopia	Amhara	2000	7.48
Ethiopia	Ben-Gumz	2000	8.74
Ethiopia	Dire Dawa	2000	28.44
Ethiopia	Gambela	2000	13.5
Ethiopia	Harari	2000	21.96
Ethiopia	Oromiya	2000	6.62
Ethiopia	SNNP	2000	6.36
Ethiopia	Somali	2000	2.59
Ethiopia	Tigray	2000	10.17
Kenya	Central	2003	66.37
Kenya	Coast	2003	24.08
Kenya	Eastern	2003	43.7
Kenya	Nairobi Area	2003	50.74
Kenya	Nyanza	2003	24.69
Kenya	Rift Valley	2003	34.38
Kenya	Western	2003	34.06

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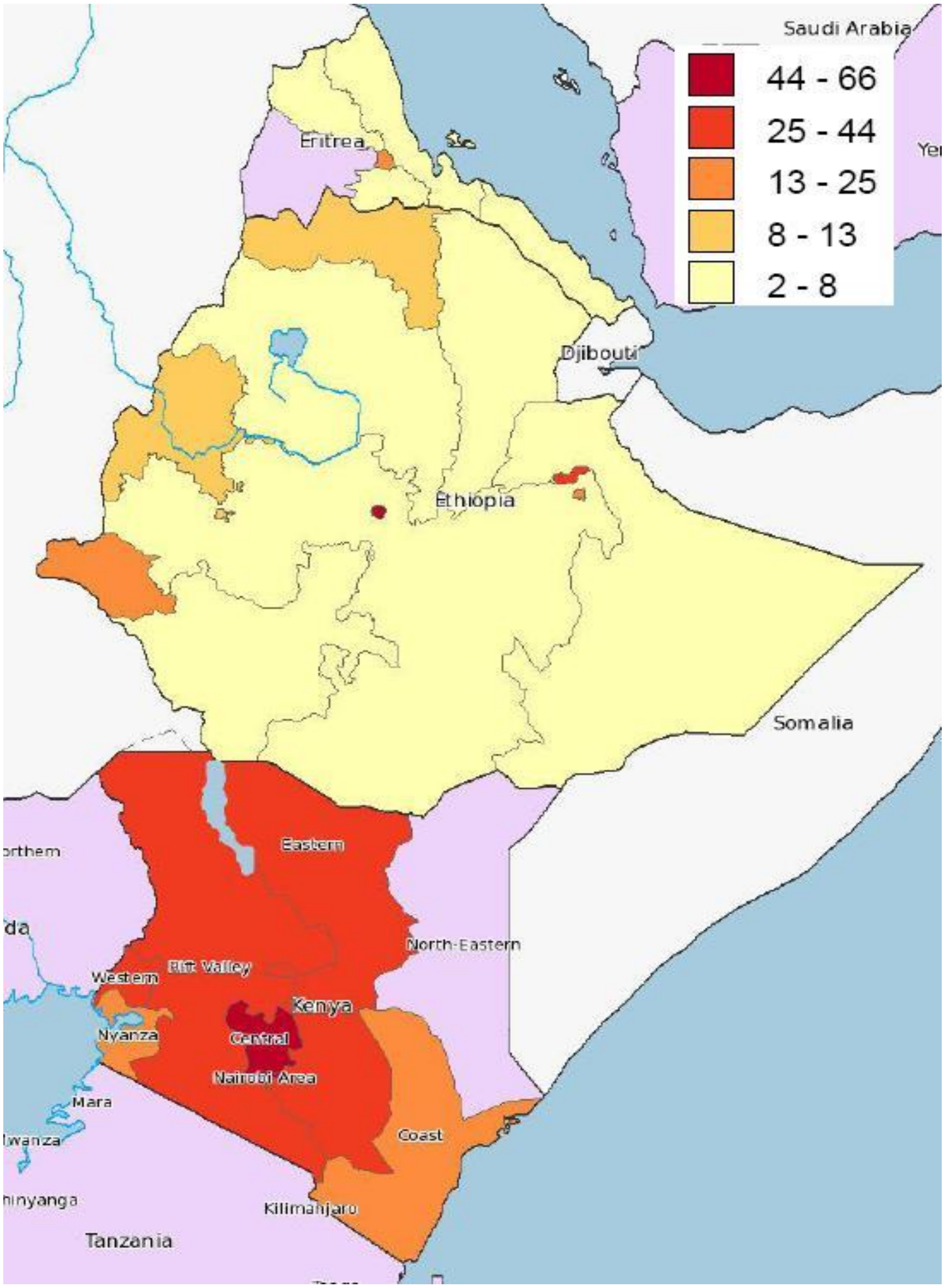
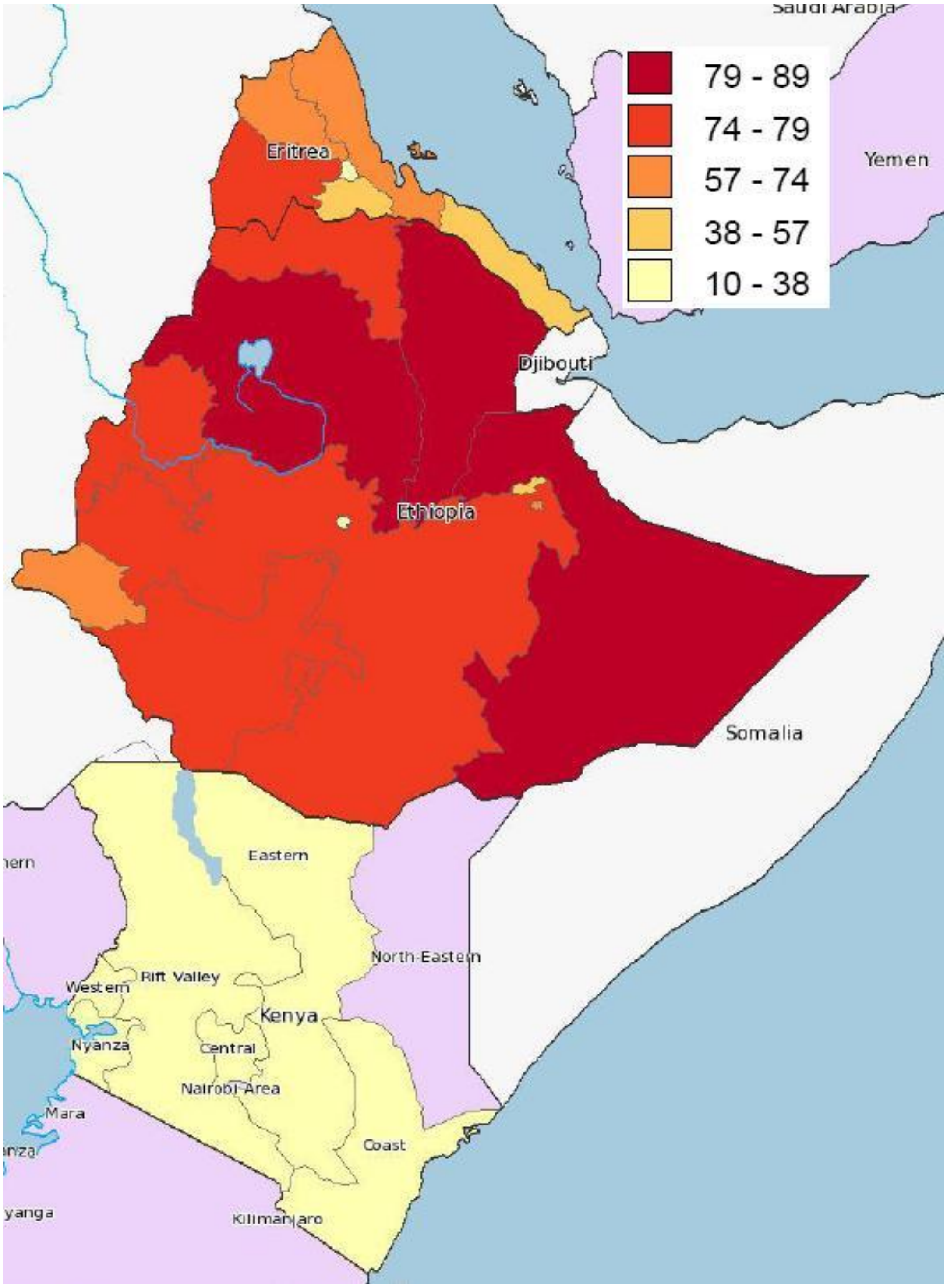


See Table above for year of survey

Source: Map: Drawn with help, web-based mapping (http://macroint.mapsherpa.com/statmapper/)
Table: http://macroint.mapsherpa.com/statmapper/table.phtml?sid=4bbf8fd9c256c

Appendix 3. Percentage of Women with no Education

Country	**Adm. Region**	**Year**	**%**
Eritrea	Anseba	2002	60.2
Eritrea	Debub	2002	52.67
Eritrea	Debubawi Keih Bahri	2002	54.76
Eritrea	Gash-Barka	2002	74.24
Eritrea	Maekel	2002	23.91
Eritrea	Semenawi Keih Bahri	2002	69.19
Ethiopia	Addis	2000	30.63
Ethiopia	Affar	2000	85.02
Ethiopia	Amhara	2000	80.14
Ethiopia	Ben-Gumz	2000	76.52
Ethiopia	Dire Dawa	2000	53.39
Ethiopia	Gambela	2000	62.01
Ethiopia	Harari	2000	57.2
Ethiopia	Oromiya	2000	78.6
Ethiopia	SNNP	2000	77.34
Ethiopia	Somali	2000	89.34
Ethiopia	Tigray	2000	76.82
Kenya	Central	2003	11.98
Kenya	Coast	2003	37.78
Kenya	Eastern	2003	29.61
Kenya	Nairobi Area	2003	9.97
Kenya	Nyanza	2003	18.33
Kenya	Rift Valley	2003	28.64
Kenya	Western	2003	18.15



See Table above for survey dates:

Source: Map: Drawn with help, web-based mapping
http://macroint.mapsherpa.com/statmapper/)
Table: http://macroint.mapsherpa.com/statmapper/table.phtml?sid=4bbf8fd9c256c

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